Table 1
Characteristics of Pilot Studies

	Delaware Bay	Lake Michigan	San Francisco Bay
Watershed area (square miles)	13,539	45,600	68,600
Area of estuary or lake (square miles)	782	22,300	548
Major Tributaries	Delaware River plus 215 minor	20 rivers	Sacramento and San Joaquin Rivers
Ground water important	undetermined	Yes	undetermined
Major land uses in the watershed	9% urban 24% agriculture 60% forested 5% wetlands	9% residential 44% agriculture 41% forest 6% other	6.5% urban 25% agriculture 68.5% undeveloped
Population in watershed	8 million	15 million	11.4 million
Number of institutions involved in Pilot Study	14	24	22

Table 2
Management Issues

Management Issue	Network Design	Delaware Bay	Lake Michigan	San Francisco Bay	Coastal States Organization Survey[1]
Habitat degradation[2]	X	X	X	X	X
Habitat restoration		X	X	X	
Contaminants	X	X	X	X	X
Sediment management	X	X	X	X	X
Nutrient enrichment	X	X	X	X	X
Non-indigeneous species	X		X	X	X
Loss of native species			X	X	
Oxygen depletion	X				
Harmful algal blooms	X		X	X	
Pathogens	X	X	X	X	
Wetlands, loss, alteration, status & trends		X	X	X	

[1] Results from Coastal States Organization 2004 national survey of resource managers. Issues that were identified by over 50% of the 230 responses.
http://www.coastalstates.org/documents/misc%20docs/ConvertedFiles/surveyreport/surveyreport.htm
[2] Habitat degradation includes changes in water levels or changing freshwater flows resulting from drought or water diversion.

Table 3
How a fully-implemented Network would improve ability to address management needs

San Francisco Bay

- Nutrient and contaminant loads
- Trace history of introduction of new contaminants
- Monitor reproductive success of water birds and the status of the Pacific flyway
- Monitor food chain (zooplankton and phytoplankton) of endangered pelagic fishes in the Delta
- Sediment toxicity
- Exposure of swimmers, surfers, and kayakers to pathogens
- Atmospheric deposition of mercury
- Improved data management
- Ocean pH

Delaware Bay

- Contaminant monitoring
- Monitoring tidal wetlands
- Improve linkage among physical, chemical, and biological measures
- Nutrient system dynamics
- Improved data management
- Alternative resource management models to achieve environmental quality objectives

Lake Michigan

- Improved data management
- Monitor changes over the entire shoreline
- Consistent approach to monitoring tributary rivers
- Improved wetlands monitoring to establish baseline and track changes
- Improve monitoring of Great Lakes embayments and near shore

Table 4
Inventory of monitoring efforts in pilot studies

Note that some monitoring organizations have on-going efforts for more than one environmental compartment. This the numbers in the major and minor columns for each of the Pilots will not sum to the total given in the cells at the top of the table.

	Delaware (14 total)		Lake Michigan (24 total)		San Francisco Bay (22 total)	
	Major effort[1][2]	Minor effort	Major effort	Minor effort	Major effort	Minor effort
Estuaries/Embayments	4	9		6	6	6
Near-shore	2	4		9	2	5
Off-shore	2	2		4		
Rivers	7	5	3	9	3	2
Ground Water	2	6		5		
Atmospheric deposition	1	7	1	5	1	
Wetlands	1	6	2	7		
Beaches	1	3		5	5	

[1] A major effort is defined as have at least two of the following characteristics: (a) cost is equal to or grater than $1.0 million per year; (b) monitoring has been underway for 3 or more years; and (c) standard procedures and protocols are used for a large area.
[2] Minor efforts have some level of on-going monitoring but does not reach level of activity specified for a major effort.

Table 5

Data Access, Management, and Delivery

Table shows percentage of all programs in each category for each of the Pilot Studies and the National Water Quality Monitoring Council survey conducted as part of the Network design. The table is similar to Table 5-1 (page 77) of the Network design document. The four highlighted rows are those recommended by the Network design document.

	Delaware Bay	Lake Michigan	San Francisco Bay	NWQMC survey percentage of 178 monitoring programs
Access				
• Unknown; not able to determine from a brief web search			15	22
• Not easily available to public; limited to originator and close collaborators	19	15	0	10
• Hard copy only	6	0	0	2
• Digital format	25	55	15	61
• Access via web services; available for automatic machine-to-machine transfers	50	30	70	5
Search & retrieve				
• Unknown			15	36
• Hidden/Restricted Access; data cannot be found by conventional searches	19	32	0	6

• User can find existence of data but must gain access to individual databases	12	14	15	21
• Search by location-retrieve data summary	25	23	0	13
• Search by location-retrieve individual values	44	32	70	24
Metadata Level				
• Unknown			17	47
• Undocumented	38	0	2	5
• Matadata available for database as a whole but individual entries minimal documentation	38	10	81	31
• Partial compliance with ACWI standards	0	68	0	17
• Full compliance with ACWI standards	24	21	0	0
Archive method				
• Unknown			53	59
• At risk; no formal procedures exist	50	54	0	0
• Preserved; data stored at a single geographic location	12	18	0	30
• Redundancy;	38	27	47	11

	data preserved in failure-resistant system, stored at multiple geographic locations				

Points to be made in the text

1. Brief explanation of why this topic is important. Refer to the Network design document.
2. Brief explanation of the NWQMC survey and who participated
3. Explain why access is important and what the levels in the table mean. Observe that a clear majority of monitoring organizations nationwide and the Pilots have data available in digital format (which also includes web services). Pilots have more ability for direct machine to machine transfer than the survey. This may reflect the fact that the three Pilots already had some level of coordination in place prior to the Network Pilot Phase, which, in turn, may have made it more likely that they would volunteer to be a Pilot study.
4. Explain why the ability to search and retrieve data is important. Pilots have a greater ability to search for and retrieve data than the survey results. This would make it easier for monitoring organizations and others interested in data from the Pilot study areas to find data for a given location.
5. Explain why metadata are important and what ACWI standards are. In regard to this aspect of data management, the picture is more mixed with varying degrees of documentation among the Pilots. For example, about one-third of the monitoring organizations in the Delaware Pilot do not have documented metadata which is high compared to the other Pilots. However, about one-quarter of the monitoring organizations in the Delaware area have full compliance with ACWI standards. A large percentage (81%) of the monitoring organizations in the San Francisco Bay Pilot have metadata for the database as a whole but there is minimal documentation for individual entries. The Lake Michigan monitoring organizations have a very high percentage of either partial or full compliance with ACWI standards. It is important to point out that the adoption of metadata standards by ACWI is relatively recent (????) and it is likely that monitoring organizations are moving towards full use of these standards as they update and improve their data management systems. Finally, it is difficult to compare the Pilots to the NWQMC survey because the level of metadata documentation was unknown for almost half of the respondants.
6. Explain why archiving data is important. Note that there is a significant amount of data that are either at risk or for which the archive method is unknown. This is true for the Pilots as well as for monitoring organizations nationwide.
7. Overall conclusions are that, in general, Pilots are ahead of nationwide survey in terms of data management and access. This may reflect the fact that there was a

pre-existing effort for coordination and collaboration in these areas which may have lead to improvements in data sharing.

8. The Delaware Pilot reports that they in the process of developing a prototype for a watershed to ocean observing system that will allow the display of data from a large variety of data sources. Technical improvements in approaches to data management such as the Delaware data sharing effort will be important to Network implementation. In addition, such improvements would help to fill some of the shortfalls in data management and access that were identified in the nationwide survey.

Table 6 Gap analysis of San Francisco Estuary Pilot Study
W=Water; S=Sediment; N=Nutrients; C=Contaminants; B=Biology; P=Physical Characteristics

Note that there are two NOAA estuaries within San Francisco Bay (see table 3-3 of design report): (1) Central San Francisco/San Pablo/Suisun Bays and (2) San Francisco Bay. Thus the number of sites for condition (50 per estuary), transport (15 per estuary), and short-term variability (2 of the transport sites are to be instrumented for continuous monitoring) shown in columns 2, 3, and 4 are multiplied by 2.

	Estuary embayment *Condition*	**Estuary embayment** *Transport*	**Estuary embayment** *Short-term*	**Estuary embayment** *Other*	**Near-shore coast** *Condition*	**Near-shore coast** *Other*	**Off-shore coast**	**Rivers** (Monitor stream gauges at downstream point)	**Groundwater**	**Atmospheric Deposition**	**Wetlands**	**Beaches**
Network Design	**N, P:** 100 randomly-selected sites sampled monthly 1 year out of 5 (W) **C:** 100 randomly-selected sites sampled 1 year out of 5 (W,S) **B:** 100 randomly-selected sites sampled 1 year out of 5	**N, C, P:** 30 sites distributed along 2 gradients (15 sites per estuary) sampled monthly every year (W)	**P:** continuous monitoring (ex: depth of water, salinity, dissolved oxygen, pH, etc.) 2 sites along each of the gradients in transport (total 4 sites)	Other existing monitoring not specified in Network design and not captured in columns 2-4. For example buoys, shipboard cruises, remote sensing, etc	**N, C, B, P:** 50 randomly selected sites per IOOS region, sampled once per year. (See table 3-1 of design report)	Other existing monitoring not specified in Design and not captured in column 6 using buoys, shipboard cruises, or remote sensing, etc	IOOS monitoring	Sacramento & San Joaquin Rivers **N, C:** monthly & high flows (~15x per yr) **B:** once per year **P:** stage & stream flow measured continuously; other characteristics measured monthly & high flows	Evaluate groundwater design. Is groundwater significant in the area based on the Design? If important, what kind of data would be required to address groundwater in the area? What data gaps exist for the Pilot?	**N, C:** 1 wet & 1 dry deposition station monitored weekly per waterbody		
% Complete	**N:** 6% **C:** 60% **B:** 20% **P:** 8%	**N:** 75% **C:** 0% **P:** 100%	**P:** 100%	**C:** bioaccumulation in bivalves; monitoring of fish (small fish for identifying hotspots & sport fish for human health); monitoring of bird eggs **B:** endangered species monitoring of fish and birds; avian community assessments	**N:** 20% **C:** 60% **B:** 20% **P:** 20%	**N:** **C:** demersal fish histopathology (annual) **B:** demersal fish community (annual); bird community **P:** 13 realtime stations	**N:** 0% **C:** 0% **B:** 0% **P:** 0%	**N:** 40% **C:** 7% **B:** 40% **P:** 100%	See text.	**N:** 0% **C:** 0%	See text.	100%
% Need additional stations	**N:** 0% **C:** 0% **B:** 50% **P:** 0%	**N:** 0% **C:** 100% **P:** 0%	**P:** 0%		**N:** 0% **C:** 0% **B:** 0% **P:** 0%		**N:** 100% **C:** 100% **B:** 100% **P:** 100%	**N:** 0% **C:** 0% **B:** 0% **P:** 0%		**N:** 100% **C:** 100%		0%
% Need increased frequency	**N:** 69% **C:** 0% **B:** 50% **P:** 87%	**N:** 0% **C:** 100% **P:** 0%	**P:** 0%		**N:** 80% **C:** 80% **B:** 80% **P:** 80%		**N:** 100% **C:** 100% **B:** 100% **P:** 100%	**N:** 20% **C:** 93% **B:** 0% **P:** 0%		**N:** 100% **C:** 100%		0%
% Need additional parameters or change detection limit	**N:** 25% **C:** 40% **B:** 50% **P:** 5%	**N:** 25% **C:** 100% **P:** 0%	**P:** 0%		**N:** 25% **C:** 40% **B:** 50% **P:** 0%		**N:** 100% **C:** 100% **B:** 100% **P:** 100%	**N:** 55% **C:** 100% **B:** 60% **P:** 0%		**N:** 100% **C:** 100%		0%
Existing monitoring to address local needs beyond Network Design	**N:** **C:** **B:** **P:**	**N, P:** 7 more sites (37 sites total)	**P:** 49 more buoys or fixed stations (53 realtime sites total)		**N:** **C:** **B:** **P:**		75 sites quarterly Pt. Conception to Mexican Boarder for: **N:** various **B:** fish trawl & chlorophyll & phaeo-pigments **P:** CTD +	**N:** 12 sites monthly **B:** 125 fish sampling events (Delta smelt, salmon, stripped bass); 6 benthic community, 9 phytoplankton, 12 zooplankton sampling events **P:** 88 realtime stations; 15 sites monthly		**N, C:** Ambient air quality is measured at 14 stations around the Bay		Monitor *enterococci*, fecal coliform, & total coliform

Table 7 Delaware Pilot Study Gap Analysis Summary Table
W=Water; S=Sediment; N=Nutrients; C=Contaminants; B=Biology; P=Physical Characteristics

	Estuary embayment *Condition*	**Estuary embayment** *Transport*	**Estuary embayment** *Short-term variability*	**Estuary embayment** *Other monitoring*	**Near-shore coast** *Condition*	**Near-shore coast** *Other monitoring*	**Off-shore coast**	**Rivers** (Monitor at stream gauges at downstream point)	**Ground water**	**Atmospheric Deposition**	**Wetlands**
Network Design	**N, P:** 50 randomly-selected sites sampled monthly for 1 year out of 5 (W) **C:** 50 randomly-selected sites sampled 1 year out of 5 (W,S) **B:** 50 randomly-selected sites sampled 1 year out of 5	**N, C, P:** 15 sites distributed along salinity gradient sampled monthly every year (W)	**P:** continuous monitoring (ex: depth of water, salinity, dissolved oxygen, pH, etc.) 2 sites at ends of salinity gradient	Other existing monitoring not specified in Network design and not captured in columns 2-4. For example buoys, shipboard cruises, remote sensing, etc.	**N, C, B, P:** 50 randomly selected sites per IOOS region, sampled once per year. (See table 3-1 of design report)	Other existing monitoring not specified in Network design and not captured in column 6 using buoys, shipboard cruises, or remote sensing, etc.	IOOS monitoring	**N, C:** monthly plus high flows (about 15 times per year) **B:** once per year **P:** stage and stream flow measured continuously; other characteristics measured monthly plus high flows **Design calls for sites located to represent 90% of freshwater outflow from HUC-6 watershed.**	Evaluate ground water design. Is ground water significant in the area based on the design document? If important, what kind of data would be required to address ground water in the area? What data gaps exist for the Pilot area?	**N,C:** 1 wet and 1 dry deposition station monitored weekly per waterbody	**N, C, B, P:** Network design currently is being refined to include wetlands, no guidance issued yet; entries are based on DEWWG recommendations
Delaware Pilot Design	**Delaware Pilot: Particpate in National Coastal Assessment Program**	**Delaware Pilot:** 22 fixed location stations regularly sampled 12 times a year from March through October. **B:** on subset of 8 Stations every sample time. **C:** on subset of 14 stations every sample time.		**Delaware Pilot: See Appendix III.**		**Delaware Pilot: See Appendix IV.**	**P**: Continuous monitoring of sea surface temperature and surface currents through satellite remote sensing and HF radar. Periodic sub surface temperature, salinity, and currents measured along MARCOOS glider AUV sections. **B**: Continuous surface CHL-a through remote sensing and periodic sub-surface CHL-a and CDOM measured along MARCOOS gilder AUV sections.	**Delaware Pilot:** **To capture 90% of freshwater flow to estuary, need to capture data at HUC-8 watershed level and five tributary locations as specified in text.**	**Delaware Pilot: Significant Monitoring Underway (See Text)**	**N: Phosphorus:** 4 sites measuring total P in rain and particles **Nitrogen:** 7 NTN sites, 2 CASTNET sites **C: SOCs:** 6 NJADN sites monitoring for PCBs, PAHs, and organochlorine pesticides in gas, aerosol, and precipitation **Mercury:** 7 MDN sites, 4 MTN sites	
% Complete	N: 80% C: 20% B: 20% P: 80%	N: 60% C: 20% P: 100% B: 50%	P: 50%	N: C: B: P:	N: 0% C: 0% B: 0% P: 0%	N: 0% C: 0% B: 0% P: 25%	N: 0% C: 0% B: 20% P: 80%	N: 10% C: 5% B: 5% P: 100% S: 5%		**N: Phosphorus:** 0% **Nitrogen:** 90% **C: SOCs:** 25% **Mercury:** 75%	N: 0% C: 0% B: 5% P: 10% S: 0%

% No on-going monitoring	N: 0% C: 0% B: 0% P: 0%	N: 0% C: 0% P: 0% B: 0%	P: 50%	N: C: B: P:	N: 100% C: 100% B: 100% P: 100%	N: 40% C: 100% B: 0% P: 50-60%	N: 100% C: 100% B: 80% P: 20%	N: 60% C: 60% B: 60% P: 60%		**N: Phosphorus:** 100% **Nitrogen:** 0% **C: SOCs:** 0% **Mercury:** 0%	N: 100% C: 100% B: 95% P: 90% S: 100%
% Need increased frequency	N: 10% C: 20% B: 20% P: 20%	N: 0% C: 10% P: 0% B: 50%	P:	N: C: B: P:	N: 100% C: 100% B: 100% P: 100%	N: 100% C: 100% B: 50% P: 75%	N: 100% C: 100% B: 100% P: 100%	N: 90% C: 95% B: 95% P: 0% S: 95%		**N: Phosphorus:** 0% **Nitrogen:** 0% **C: SOCs:** 0% **Mercury:** 0%	N: 100% C: 100% B: 95% P: 90% S: 100%
% Need additional analytes or change detection limit	N: 20% C: 80% B: 80% P: 10%	N: 40% C: 80% P: 0%	P:	N: C: B: P:	N: 100% C: 100% B: 100% P: 100%	N: 100% C: 100% B: 100% P: 10%	N: C: B: P:	N: 90% C: 95% B: 95% P: 0%		**N: Phosphorus:** 100% **Nitrogen:** 0% **C: SOCs:** 100% **Mercury:** 0%	N: 100% C: 100% B: 950% P: 90% S: 100%
% Other gaps	N: C: B: P:	N: C: P:	P:	N: C: B: P:	N: 100% C: 100% B: 100% P: 100%	N: C: B: P:	N:100% C: 100% B: 100% P: 100%	N: C: B: P:		**N: Phosphorus:** 0% **Nitrogen:** 0% **C: SOCs:** 0% **Mercury:** 0%	S: 100%
Existing monitoring to address local needs beyond Network Design	N: C: B: P:	N: C: P:	P:	N: C: B: P:	N: C: B: P:	N: C: B: P:	N: C: B: 10% P: 20%	N: C: B: P:		**N: Phosphorus:** 0% **Nitrogen:** 100% **C: SOCs:** 100% **Mercury:** 0%	B: P: C:

Table 8 Lake Michigan Gap Analysis

In this table, we attempt to quantify some of the gaps that arise during the comparison of the Network design with ongoing monitoring efforts in the Lake Michigan basin. Row 1 is based upon the specifications in the Network design document. Rows 2-6 give the percentages of various types of gaps that may exist between ongoing monitoring and Network design. Row 7 acknowledges the fact that local or regional needs may require more monitoring than what is specified in the Network design such as additional tributaries or additional monitoring for a given resource component.

	Type of Gap	Embayments (Estuaries)	Shallow Near Shore	Medium Near Shore	Off Shore	Rivers	Ground Water	Atmospheric Deposition	Wetlands	Beaches
Row 1	Number of sites or level of effort needed for national Network design	8 (eventually all 15 embayments in Lake MI would have to be monitored. The 8 monitoring points are only a sample set for 1 year of monitoring.)	20	15 100%	9 (spring 13; summer 21)	17	25	Per technical experts	70	268 beaches (currently monitored)
Row 2	% Sites or level of effort where national monitoring is complete	0%	0%	0%	100%	0%	0	National design based on Great Lakes	0	Estimated 40 beaches have actual data and models
Row 3	% Sites or level of effort where there is no ongoing Monitoring	53%	60%	100%	0%	0%	80%	National design based on Great Lakes	90%	276 beaches (50%)
Row 4	% Sites or level of effort with ongoing monitoring but need to increase frequency for National design	0%	0%	0%	0%	85%	20%	National design based on Great Lakes	10%	110 beaches in Michigan are monitored once per week and should be monitored more frequently as beaches in IN, IL,

										and WI. 276 more beaches in IL, MI, and WI are not monitored at all. Indiana monitors all 25 of their beaches.
	Type of Gap	**Embayments (Estuaries)**	**Shallow Near Shore**	**Medium Near Shore**	**Off Shore**	**Rivers**	**Ground Water**	**Atmospheric Deposition**	**Wetlands**	**Beaches**
Row 5	% Sites or level of effort with on-going monitoring but need to add specific analytes or observations or change detection levels for National design	47%	100%	0%	0%	100%	5%	National design based on Great Lakes	10%	100% of the 268 currently monitored beaches, as well as 100% of the 276 beaches with no monitoring.
Row 6	% Sites or level of effort with other type of gap when compared to National design	100%	100%	100%	0%	0%	0%	National design based on Great Lakes	Unknown	238 (89%) of the currently monitored beaches; 276 (100%) of the beaches with no monitoring
Row 7	Number of additional sites or increased level of effort with ongoing monitoring to address local or regional needs	100%	12	100%	2	3	20%	See recommendations in Gap Analysis Notes below	5%	238 beaches that are currently monitored have local and regional needs yet to be addressed.

Table 9

Cost estimates for monitoring all environmental compartments (in $1000's rounded to the nearest $50,000). The cost estimates do not include the costs for existing or needed monitoring in the near shore and off shore resource compartments. See text for additional discussion.

	Delaware Bay	Lake Michigan	San Francisco Bay
Annual cost of existing monitoring as specified by Network design	1,950	2,100	13,300
Annual incremental cost of monitoring needed to fill gaps	2,500	9,900	1,350
Total cost for Network implementation	4,450	12,000	14,650
Annual cost of existing monitoring beyond Network design to address local management isses	7,300	9,100	9,000