Since early days of humankind, our species has been observing and recording environmental data. Whether it be migratory patterns of caribou or the beginning of wet and dry seasons, humans have collected and passed down knowledge of their surroundings so that they could better understand the planet that sustains them. We can see evidence of this in cave paintings and oral traditions well before the days of written language or the printing press. Environmental data has a long and vital tradition that lies at the heart of the human experience.

Fast forward to the present with modern technologies where the avenues for collecting environmental data are countless. Environmental professionals find themselves dealing with many sources of data. Among them:

- data from geography—remote sensing
- data from observations—field data
- data from sensors—high frequency continuous monitors
- data from analytical laboratories
- data collected for quality assurance purposes
- qualitative or unstructured data that supports or supplements more typical quantitative data

Now more than ever, there is a need to store, manage, and interpret these environmental data for effective decision-making in an ever more complicated world. Advances in technology in the wider world have led to an expectation for near immediate results. The public and the press—and often, upper management—want answers *now* to the pressing questions that well-managed data can help answer. Furthermore, the need for accuracy and quality of these data is of equal or greater importance. The demands to be better, faster, and smarter will continue to increase for state regulatory agencies and other organizations as expectations grow.

Given all this, the importance of enacting best practices for environmental data management cannot be overstated. Too many states' environmental agencies find themselves struggling so much with *basic data infrastructure* that they have a difficult time meeting their basic reporting requirements. Even more concerning is how unprepared regulatory agencies can be when called upon to deal with data-intensive environmental incidents. The agencies can be provided with mountains of data with no plans or ability to manage, process, or understand that data to make effective decisions. In the absence of established best practices, staff in these agencies may be left feeling helpless without knowing exactly what to do.

To the organizations and the staff that are struggling with these data requirements, and to those who have mature data management systems in place, we hope that you will find the following documents helpful in considering the fundamentals of environmental data management and apply some of the guidance to your individual organization's needs. As with so many things, there is not *one* right way to manage environmental data, but there are some sound principles we espouse here that we think you will find helpful. Growing your data infrastructure into a system that is more robust and leads to more accurate and efficient data-based decision-making is an ongoing process of incremental evolution.

Good data management requires planning and governance to ensure that all components of your data management workflow—from field data collection to reporting and public communication—are in sync and working together to accomplish your organization's mission. It requires investment of time and money to establish a system that ensures elements of data quality are met and data are usable for decision-making. While good data management is not free, this does *not* mean that it must be expensive. By comparison, the cost of poor data management can be extremely high, particularly if poor practices result in data that is unusable. Perhaps most importantly, the effort to implement good data management requires leadership. As stated earlier, the need to continuously maintain and improve your data infrastructure requires hard work and perseverance. If you are in a leadership position, we hope these guidance documents and case studies help you understand that your support of environmental data management and the data infrastructure is necessary to create a robust and well-functioning data management workflow. This includes the need to foster staff "buy-in" if major changes to data governance are required. Many organizations, including state environmental regulatory agencies, are touting their mission to operate in "evidence-based" paradigms using "data-driven" decision-making. These are lofty and worthy goals and require a comprehensive and well-built data management system to accomplish. Do not take for granted the hard work required to successfully implement these goals.

Finally, the advice and guidance laid forth in these documents is not prescriptive but rather a compilation of best practices from a diverse community of data managers, data users, and other practitioners from state government, industry, and consulting. While this is not a comprehensive treatise on every aspect of data workflows that you or your organization may encounter, we feel that it covers the fundamentals of data management in an environmental setting and is a solid

foundation for one to build upon based on your specific data management needs. We sincerely hope you find the guidance helpful in your efforts to continually improve your data management plans, strategy, and workflows. This team feels strongly that the aforementioned well-functioning data management workflow is a critical component of accomplishing our collective mission as environmental regulatory agencies to protect environmental quality for all.