THE CANADIAN NATIONAL WATER AND WASTEWATER BENCHMARKING INITIATIVE:

USING PROCESS TO DRIVE IMPROVEMENT

Strategic Management of Water in Urban Areas

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Abstract AECOM has been successfully benchmarking Canadian municipal water, wastewater and stormwater utility operations since 1997. While the fundamental purpose of this project was metric benchmarking for the purpose of making performance comparisons to guide continuous improvement, the project is now serving as a dynamic platform to consider, examine, and implement a broad range of utility best practices that have resulted in superior performance where they have been implemented. The keys to success however were based more on a process that emphasizes communication, teamwork and collaboration rather than the trend to push computerized data management systems to their fullest potential, and most importantly in recognizing the importance of "hard work". With these success factors now well understood and documented, it is feasible to benchmark almost any public infrastructure amongst agencies that are willing, regardless of their level of technological development. Finally by sharing this methodology, the performance measure descriptions and detailed definitions, it is also feasible to make international comparisons in a simple and cost effective manner, thus opening the door to the broad exchange of international best practices.

Keywords: Benchmarking, Continuous Improvement, Performance Measurement, Asset Management.

Introduction

In 1997, a group of four municipal wastewater utilities, AECOM Canada, Inc, and the National Research Council of Canada met with the purpose of looking for a framework to answer four seemingly simple questions that had been posed by each of the utility's boards:

- "How well are we doing?";
- "How do we compare with similar organizations?";
- "Are we getting value for money?"; and
- "How can we get better at what we do?"

Benchmarking, defined as " the continuous process of measuring products, services and practices against the toughest competitors or those companies recognized as industry

leaders" was pioneered by Robert C. Camp at the Xerox Corporation in the 1970s. Because of its widespread use in all leading corporations through the 1990s, it was agreed that benchmarking could be effectively utilized to provide the answer to these important questions. What seemed straightforward and intuitive through many Best Practice publications, was in fact very challenging. The difficulty appeared once the practice was recommended for use in the public sector. In the private sector, competition results in ruthless selection of the "fittest". Whereas virtually all private sector corporations ultimately roll all performance metrics into only one final performance measure (total return to shareholders as measured by profit and shareholder equity); public agencies have always had a much broader set of objectives, including performance on social, environmental, as well as financial matters. Benchmarking was assumed to be a well documented process, but in fact had to be redesigned from the ground up in order to develop a management process that reflected the attainment of goals that by definition will always compete with one another (for example, improved environmental performance will be at the expense of bottom line financial results).

An extensive literature search showed that benchmarking in the public sector had been conducted in the past, even within the municipal water and wastewater utility industry. Further analysis however, showed that past exercises tended to be short lived, usually terminating after one or two iterations. Only in exceptional cases, has benchmarking appeared to deliver remotely satisfactory results. Weaknesses within all examined examples included:

- Inability to provide accurate and comparable data;
- Lack of agreement regarding what to measure;
- Lack of patience within participants to optimise the benchmarking process; and
- Few if any tangible improvements in participating organizations.

By focusing efforts at the early stage of the project on each of the above, the National Water and Wastewater Benchmarking Initiative was able to design a robust methodology for conducting metric benchmarking within the public sector successfully and continuously. The project has found success not only in its fundamental purpose of metric benchmarking, but also as a dynamic platform to consider, examine, and implement a broad range of utility best practices that have resulted in superior performance. As well, the project has developed into a highly effective network of peers from which to share and exchange ideas about utility management.

What is Benchmarking? (And More Importantly, What is it Not?)

In some circumstances, benchmarking has become another in a long list of management buzzwords that have been promoted as a single strategic management "cure-all". It is not. In fact, if all you do is benchmarking, then there is no value to the process whatsoever. Benchmarking must be utilized in association with a coordinated series of management and operational actions that produce change. If you agree, however, that you cannot improve what you do not measure, then benchmarking is an essential part of a strategic management framework. As shown in Figure 1, this was affirmed by Boston-based Bain Consulting's annual "Management Tools & Trends" Bain & Co. (2003) survey of the most effective strategic management processes used by more than 700 global companies over the past 9 years. According to Bain & Co., Strategic Planning (used by 89% of firms), was followed by Benchmarking, (used by 84% of firms), as the most effective of all management tools. "They are your basic management tool kit" Bain & Co. (2003).

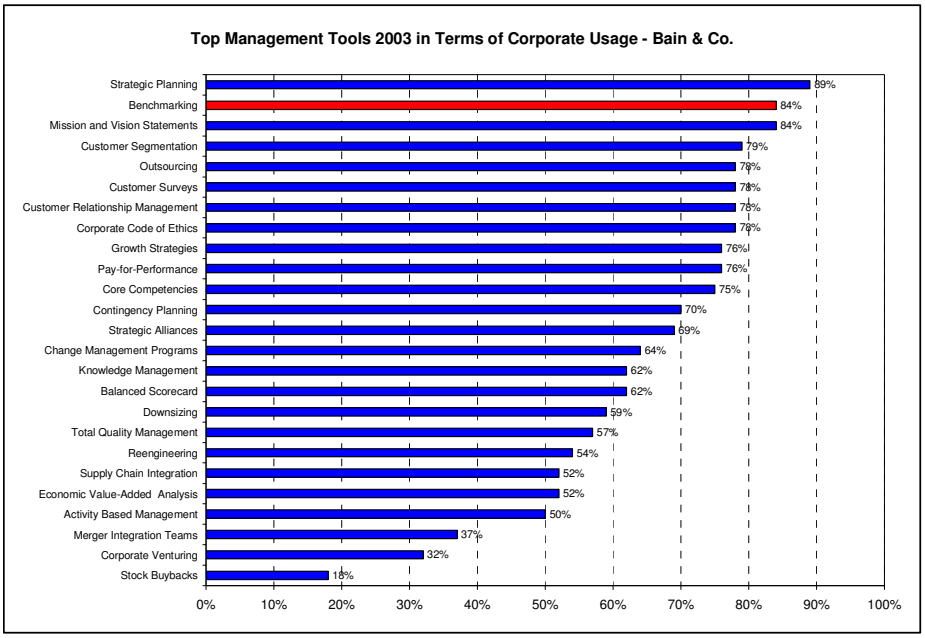

Figure 1 Most Effective Management Processes: 2003

For the National Water and Wastewater Benchmarking Initiative (NWWBI), benchmarking encompasses regular annual comparisons regarding the attainment of common goals for the purpose of identifying performance gaps. Equally important is implementing the improvements, monitoring the progress, and reviewing the benefits of the implemented changes. What differentiates this program from the traditional consultancy-lead private sector programs aimed at competitor analysis is that the NWWBI has been undertaken collaboratively, through the willing sharing of performance data, to learn about the circumstances and processes that underpin superior performance. In tandem with this, is the realization that no single organization has all the answers, and that success is measured through a wide range of criteria that may include financial-; sustainability-; reliability-; environmental- and customer service criteria.

Participation is National in Scope

Launched in 1997 as a pilot project that included four participating cities as well as team members from AECOM (as the Program Manager) and the National Research Council for technical advice, the Benchmarking Initiative has grown to the point where it serves as a national standard. Today, the National Water and Wastewater Benchmarking Initiative include 37 of Canada's leading municipal and regional utilities. The partnership now represents the Canadian urban centres that account for over 60% of Canada's population.

This wide participation base is not without its challenges. Canada is the second largest country in the world. It spans 4 ½ time zones, and includes climates that range from near Mediterranean to Arctic (including permafrost). In terms of precipitation, it ranges from desert to temperate rain forest. In the past, comparisons amongst such a diverse base were discounted. But by taking local factors that may affect cost, performance, or the selection of practices into account in the methodology, participants are rewarded by being able to

evaluate an enormous range of practices in use. The fact remains, regardless of where we operate, we are all in the same business of operating public water and wastewater utilities. Figure 2 shows a map of the distribution of participating utilities.

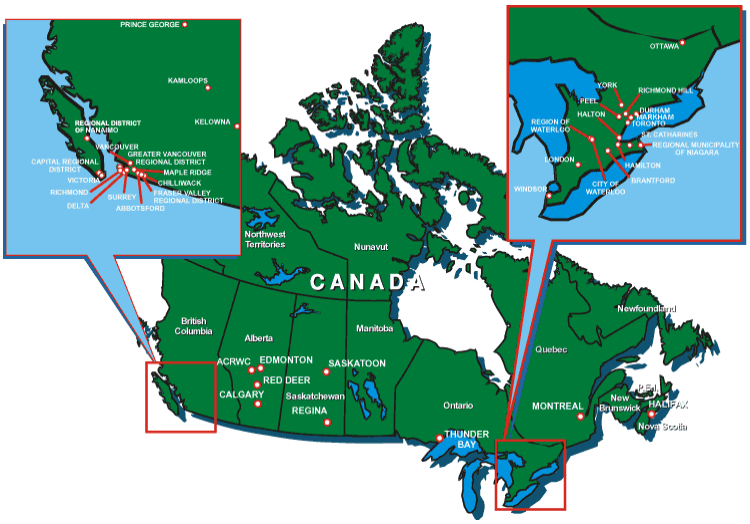

Figure 2 Participating Cities in the National Water and Wastewater Benchmarking Initiative

Methodology: Its Not Rocket Science, but It is Hard Work

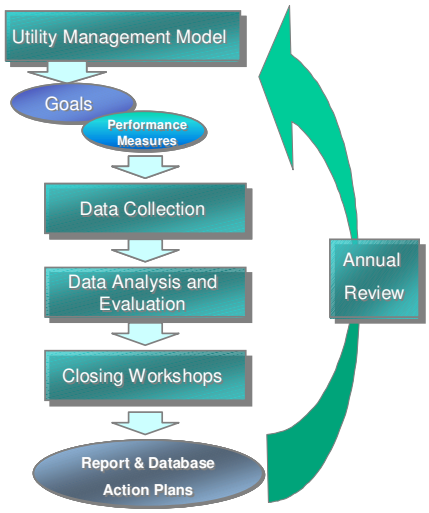

Figure 3 Annual Methodology

The NWWBI utilizes a non proprietary benchmarking methodology that follows a conventional annual cycle as shown in Figure 3. Great efforts are placed on keeping the methodology simple and focusing on the effectiveness of each task within the overall process. The management premise is that if even one link is broken; the overall program has no chance for success. The following continue to be critical in the program's ongoing success:

The Utility Management Model: What Should We Measure?

The first task of the project was to develop a standardized "Utility Management Model" that would provide the framework for the selection and definition of performance measures. This single step was proven to be critical to the

foundation of the entire project. Figure 4 illustrates the Utility Management Model that was adopted, with the Utility Goals and the relationship to the many Performance Measures. The Utility Management Model defines a framework of high level goals to which all water and wastewater utilities in Canada aspire to. Success therefore, is literally based on the attainment of these goals. The Model provides the basis for selecting practical and relevant performance measures to measure goal attainment.

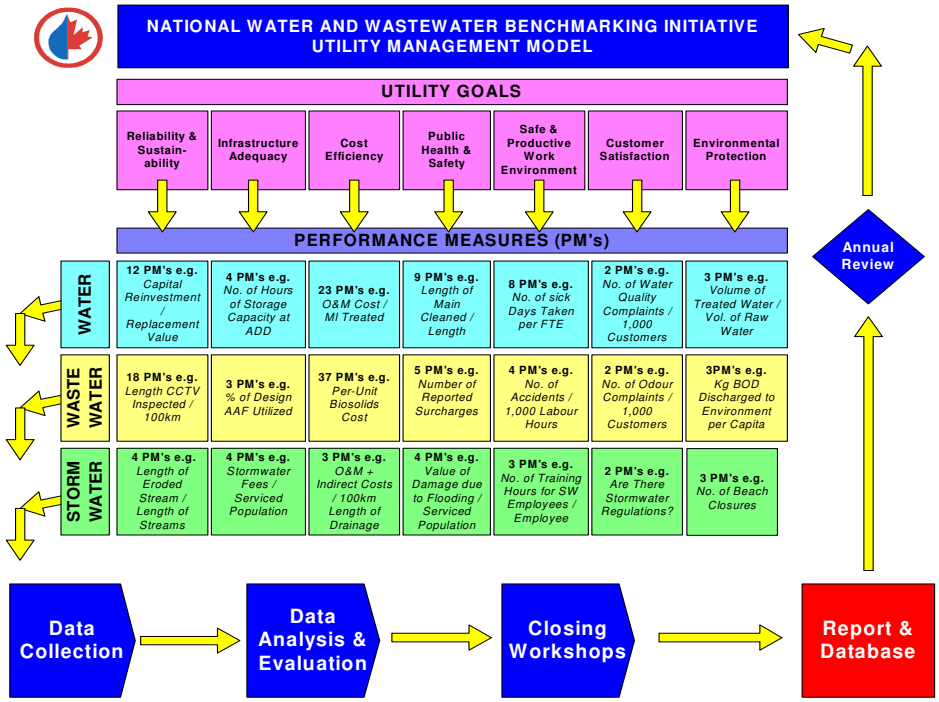

Figure 4 Utility Management Model

Complete Utility Management Goals are presently stated as:

1. Provide reliable and sustainable infrastructure.
2. Provide accessible and sufficient infrastructure (capacity).
3. Meet service and performance requirements at minimum sustainable cost.
4. Protect public health and safety.
5. Provide a safe and productive work environment.
6. Have satisfied and informed customers.
7. Protect the environment and minimize environmental impacts.

With the Utility Management Model in place, a comprehensive set of performance measures were formulated to measure a utility's success in attaining each individual goal. A very detailed definition for each performance measure numerator and denominator was also documented so that comparable data could be collected to assure valid comparisons. In most cases, each performance measure includes a numerator (expressing the level of goal attainment) and a denominator (normalization factor to enable comparisons, amongst agencies of differing sizes). Table 1 below shows an example performance measure and its corresponding definition:

Table 1 Example of Performance Measure and Definition

Performance Measure	Numerator Definition	Denominator Definition
Total Operations & Maintenance Cost / km Length of Distribution system	Sum of the actual O&M costs incurred in the operation of the distribution/transmission/ integrated system (excludes capital costs, indirect costs, transfers to reserves and debt/interest charges). Includes O&M costs for both linear (pipes, meters etc) and non-linear (pump stations, reservoirs etc) infrastructure. Revenues are only included where they are recoveries for work done by water distribution staff that is extraneous to the utility (for example, lab tests for other utilities).	Total length of mains in the distribution/transmission/integrated system (i.e. excluding length of service connections). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system.

In all, the NWWBI conducts benchmarking on about 50 performance measures for each of water and wastewater treatment, water distribution and wastewater collection. There are presently about 15 performance measures for the stormwater drainage function. In keeping with our approach to an open methodology, all the NWWBI performance measures and the definitions are published and available to any interested party on the project website (www.nationalbenchmarking.ca). Other benchmarking practitioners are encouraged to leverage their efforts from NWWBI published standards. It is our view that the more international agencies that use these same measures, the easier it will be to make international comparisons if the parties are so interested.

Data Collection: Communication and Team Work; Not Data Processing

Data collection is the most difficult and time consuming aspect of benchmarking. It is also vitally important, for without accurate and reliable data, it is impossible to make performance observations. AECOM's early research into past exercises demonstrated that the data collection effort was severely underestimated and the resulting data collection flaws resulted in the termination and/or failure of the examined benchmarking examples. Our experience is that no less than 30% of the benchmark effort must be dedicated to this single activity at least in the early stages before quality information can be assured. A key distinguishing factor of this benchmarking project over similar benchmarking efforts is that data is collected through on-site data collection visits with the use of trained data collection staff from AECOM in close association with key utility staff.

In addition to effort, participants must be willing to be patient in the development of a robust benchmarking database. OFWAT, the government regulator for the UK and Wales water industry, predicted that it would take two years (two complete iterations) before reliable data could be assumed in their benchmarking efforts[1]. In our experience, two years

[1] International Benchmarking Presentation by S. St. Pier (OFWAT) to the NWWBI, May, 2003.

has been an optimistic target that only some utilities were able to achieve. For the NWWBI, it has taken about five years to develop reliable, useable data that is statistically significant, historically sound, and accurate for historic trending. However, this longer term has allowed the NWWBI to document best practices for the collection and management of utility data. Unlike other best practices that rely on computer-based data management system, the key to success is communication and team work within each utility department. Computerized data management projects must be designed only after business processes have been developed and installed.

Because of the need for communication and cooperation within utility agencies, a personable approach to the collection of information has helped to develop greater insight into a utility's local factors and operations. The personal involvement of AECOM staff in collecting the information also helps to ensure that quality assured data is collected and is comparable. The unexpected benefit to many participating agencies is that benchmarking may be the first time many utility staff have been asked for very specific information. It is not until the data collection task begins that utilities begin to realize both how much information they actually have about their system, and then whether they can locate it. Many utility organizations still rely on the memories of veteran utility operators or foremen, with intimate knowledge of each valve, pipe, and pump. This complex knowledge is in danger of disappearing with the impending retirement of long-time operators. We try to maintain a personal aspect to the data collection process to ensure that someone talks to this operator (and documents the detail) if the information is not kept elsewhere.

The well documented and rigid structure required of the NWWBI data collection provides a detailed framework to begin the difficult process of documenting operational and management information. The ultimate aim is to get this information into key management systems, (such as CMMS, GIS, etc.) and therefore, ensure that valuable knowledge will not be lost with the retirement of that "one" utility operator.

The results are worth the effort and investment. Because the participants are able to use the results with confidence, the project has been able to tackle a wide range of performance related discussions productively. Each year, the project has added valuable content that make the results more and more accessible to municipal utility practitioners.

Results: From Data Collection to Continuous Improvement

The usefulness of benchmarking data only becomes apparent when continuous improvement actions are formulated. To start this process, the NWWBI produces a vast array of pictorially based graphs (approx. 5,000) that depict overall group performance, and personalized historical trending graphs. These results are published in an annual report, and are always available online through the project website. AECOM even provides a "help desk" service to customers to assist in customizing the data to meet a wide variety of reporting needs. All data is generated from a relational database management system, but the MS Access-based application tends not to be that intuitive for the occasional user, therefore assistance is always available.

Group Comparison Graphs: How do we compare with similar organizations?

First, group graphs are produced which compare results within similar groups. Performance measures are calculated from the compiled data in each of Water Distribution, Water Systems, Wastewater Collection, Wastewater Treatment and Stormwater. In comparing the data in group graphs, we compare similar systems for example, only conventional water treatment plants less than 60 ML/day are compared for measures such as O&M cost to avoid

the large gap from economies-of-scale and because clearly conventional treatment plants cannot be compared to unfiltered or even direct or membrane filtration plants. As we make further comparisons and interpretations of the graphs, our personal knowledge of the systems help to evaluate what local factors may be considered as well as regional issues that may be of importance. Despite these unique characteristics, there are always comparable issues and factors. The following are example group performance graphs:

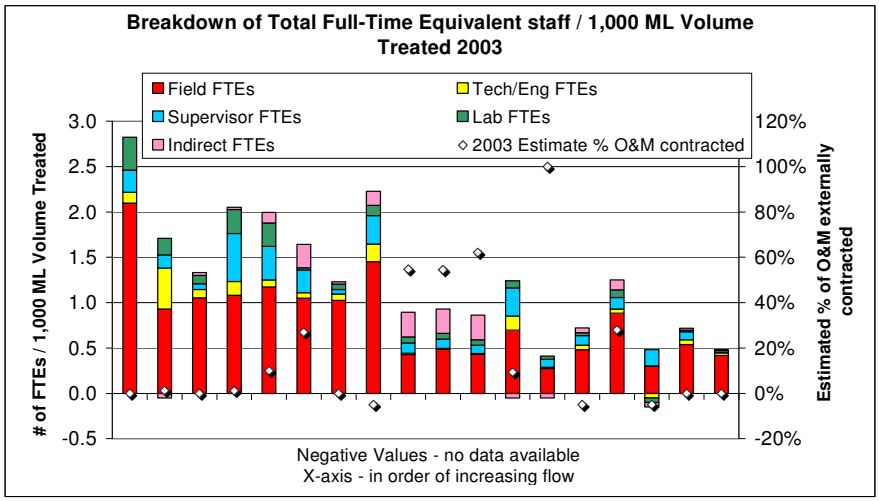

Figure 5 Example of a group comparison graph.

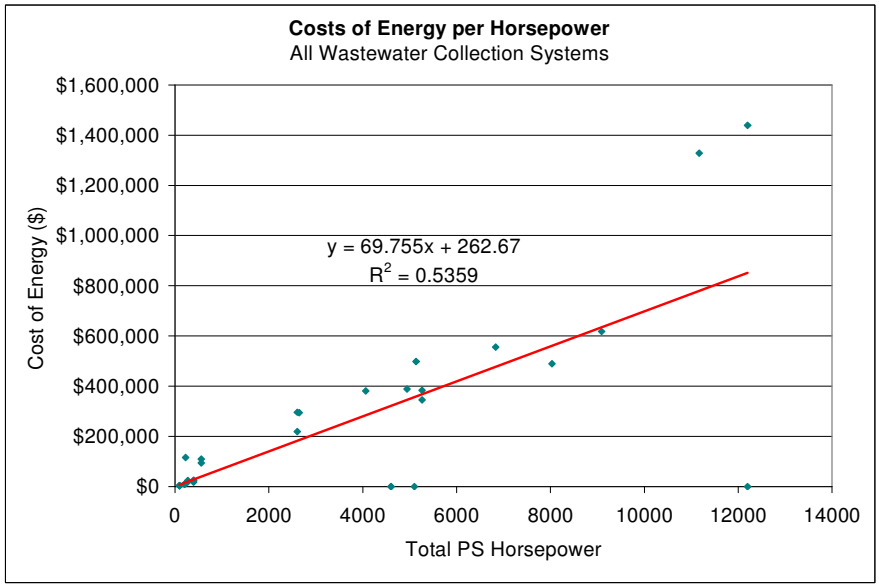

Figure 6 Continuous Improvement example of a trend for Energy Costs normalized by total Horsepower of all pumps in wastewater collection systems.

Minimum, Maximum and Average Graphs: How are we doing?

One of the other types of graphs that are produced is the personalized minimum, maximum and average trending graphs. The group average, minimum and maximum are shown over three years as well the utility's own data for three years. In this way, an easy visual comparison can be seen for overall improvement, comparability and performance gaps within a comparable group.

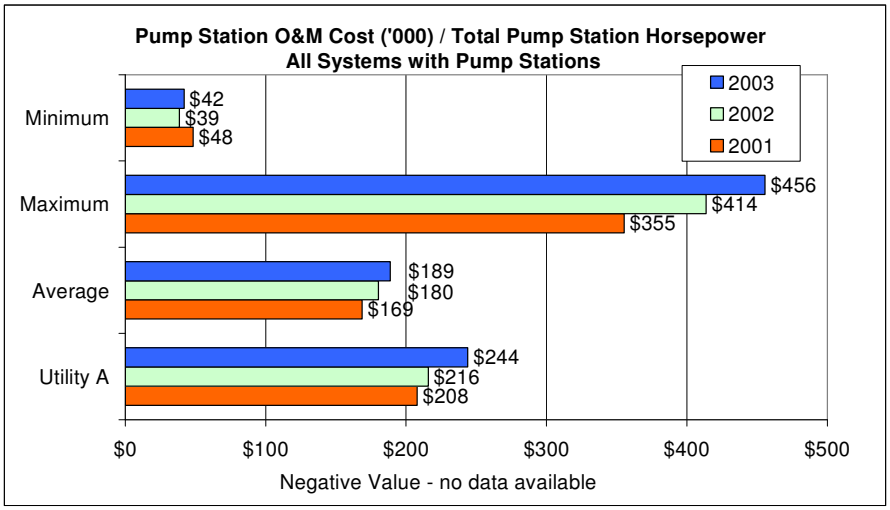

Figure 7 Example of a minimum/maximum/average personalized graph for water distribution systems.

For example, Utility A is clearly above average in terms of Pump Station O&M Cost per Total Pump Station Horsepower. To realize the full benefits in identifying this performance gap, the personable approach to a utility's data collection and operations lends insight to the unique local factors that are affecting the results from this utility. Perhaps energy costs are higher in this area; or perhaps they have oversized pumps. The key to improved performance is to understand what the performance driver is and then be able to respond to it. The graphs only help to identify performance gaps; the personal knowledge of the utility allows the information to be applied into a relevant continuous improvement action plan.

Radar Charts: How are we doing overall?

When asked how a utility was doing on a whole, we did not initially have a visual representation of the utility's total performance. The radar chart, as observed in the Environmental Sustainability Index project (Yale Center for Environmental Law and Policy, and the Center for International Earth Science Information Network (CIESIN) at Columbia University), was configured as a roll-up of the various Goals and Performance Measures to help utility managers and operators get a quick view of their utility's performance amongst competing goals, where each goal forms its own axis on the radar chart.

Both high and low targets for performance had to be determined to calculate a utility's performance based on their achievement of the targets. To quantify each utility's performance on the goals, representative performance measures were used. The logic for

quantifying the performance measures for the radar charts is based upon discussion, assumptions, and conclusions that were agreed upon at the annual Workshop.

A radar chart does not eliminate the need for bar charts but instead summarizes the information provided in the bar charts. A benefit of the radar charts is that it identifies where to start focusing energy on improving the performance of the utility. For example in Figure 8, it is clear that on Goals 3, 4 and 5 the utility is performing on average with the group but on Goals 1 and 2 work needs to be done. The utility would now have to look at the bar charts for the relevant performance measures under Goals 1 and 2 to assess what can be done to improve their performance.

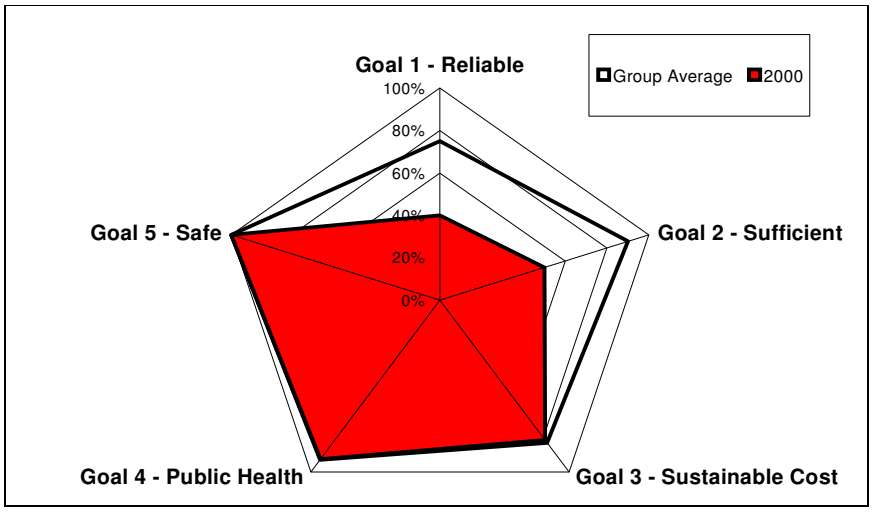

Figure 8 Example of a radar chart.

Radar charts can provide annual comparisons for a utility as well as comparisons to "best practices" or targets established by the group. They allow utilities to compare their overall management to similar utilities. Radar charts are very useful as a method to analyse and summarise large amounts of data. They do not replace the analysis of each bar chart and the details behind each performance measure but will enhance the utility's ability to take a quick "snap-shot" of their performance which can be used to communicate performance to all the stakeholders in the utility.

Comparing graphs is one thing, but benchmarking cannot end here. In order to improve any function, you must use the information to assist your overall strategic management program. While this is ultimately the responsibility of each participant, the NWWBI is directly involved in the process with the creation and facilitation of an enormous peer to peer network, to consider, plan, and execute a wide variety of continuous improvement initiatives.

Peer to Peer Network and Annual Workshop

From the outset of the NWWBI, each benchmarking iteration was thoroughly debriefed in a multi-day workshop forum dedicated entirely to understanding the results of benchmarking. Early workshops were informal events, usually located in meeting rooms of a volunteer host utility. But as the partnership grew, and the cross-departmental interest in the results in each

participant also increased, these modest facilities proved inadequate for a productive workshop.

The summary workshop is now a major annual event that has total attendance of up to 150 participating utility staff. The key to success remains the event's workshop orientation, and does not duplicate the professional association "conference" format. It is also the major networking opportunity for all participants. After benchmarking for over five years, the partnership has grown and made significant strides towards continuous improvement through various strategic partnerships, task forces, identifying utility gaps and, not least of all, the development of a network of industry operators and managers collaborating and sharing their information. The network is unique in that a similar private sector partnership could never be expected to share this type of information with their competitors. An atmosphere of familiarity, comradeship, and trust has developed through adherence to the group confidentiality protocol[2] by all partners that encourages individual and organizational learning, and ultimately increases public sector efficiency and accountability. There is no doubt that one of the greatest benefits and results of the Canadian National Water and Wastewater Benchmarking Initiative is the network of peer contacts that has emerged.

Effective Continuous Improvement

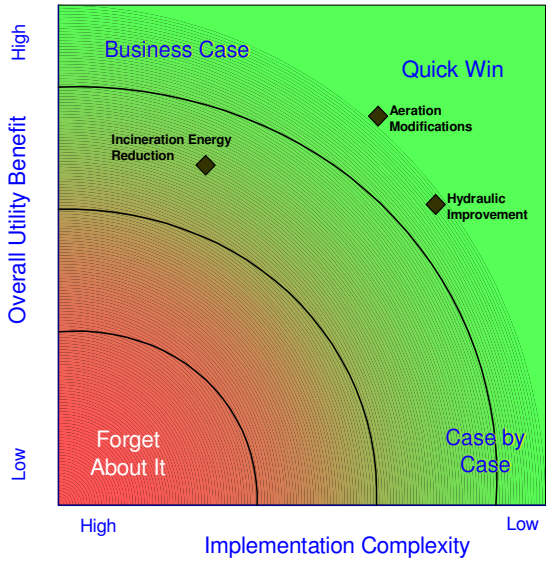

Figure 9 An example Effort and Benefits diagram

While many of the participants have developed confidence in their data and more accurate methods of data collection, the NWWBI is now recommending the Effort and Benefits diagram as a tool to document Continuous Improvement priorities. The Effort and Benefits diagram illustrates a scale of ease-of-implementation and benefit-of-action that helps to prioritize a Continuous Improvement action. To gain the most benefit for the ease of implementation it is important to conduct an effort and benefits analysis for the top five Continuous Improvement initiatives identified through a high level review. By rating each Continuous Improvement initiative identified for each utility along those two scales, the effectiveness of each action can be seen relative to the others. Those performance improvement initiatives in the upper right hand corner are the initiatives that deserve more focus in the next year as they have been identified as being not very complex to implement and achieving a high level of benefit.

[2] Un-blinded benchmarking results are confidential to the partnership.

Conclusions

For organizations that are interested in utilizing benchmarking to assist continuous improvement, the above methodology will provide answers to the first three of the four questions originally posed in this paper's introduction:

- "How well are we doing?";
- "How do we compare with similar organizations?";
- "Are we getting value for money?"

But if you look at benchmarking in isolation, you will not have addressed improvement. To address the final, and ultimately most important question (How can we get better at what we do?), the organization must be willing to accept change. Accepting and embracing change is by far the hardest thing that any organization faces, and there are no easy answers, since human beings are creatures of habit. But if you approach benchmarking not as a numerical exercise that relies on data, automation, and computerization, but rather as a process to expand communication, teamwork, and collaboration, the door to performance improvement will suddenly open, and you will be surprised at the result.

As the National Water and Wastewater Initiative matures, we are now starting to benchmark the final result: success in implementing change. To state it another way, the final "question" becomes "Did you do what you said you were going to do?" By answering this question with "Yes; and here is the proof" we now see organizations focusing their efforts on what is truly important. Only now, the leading Canadian municipal utilities that participate in the National Water and Wastewater Benchmarking Initiative know that hard work, communication and teamwork will once again be the keys to success.

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