Establishing a Pathway for Achieving Water Utility Infrastructure Management Excellence

Authors:

Tom Iseley, Ph.D., P.E. Professor & Director. dtiseley@iupui.edu
Olga Lucia Vargas-Lamanna. Graduate Student. MS Technology. olamanna@iupui.edu
Construction Engineering Management Technology. IUPUI-Purdue School of Engineering & Technology. 799 West Michigan Street (ET 201R) Indianapolis, IN 46202-5160.

ABSTRACT

This paper describes the research carried out by the Buried Asset Management Institute International, Inc (BAMI-I), which was sponsored by the Environmental Protection Administration (EPA) under EPA Grant-CP 83 282901-1. This project involved the cooperative effort of a unique team of academic research leaders of four major universities, utility representatives, and several professional associations.

A survey developed for one of the participating universities showed that the majority of utilities claimed to have some kind of asset management program. The majority considered that creation of a National Center of Excellence would provide the biggest benefit through training for manager, engineers and for personnel. Therefore, the existing need for knowledge, training and education about asset management practices in the water industry motivated the creation of this certification program.

Based on the individual projects of each consultant, BAMI-I created the Asset Management Training Certification Program. The Certification Program is an online educational process for obtaining certification of training in management of underground asset infrastructure. It is a pioneer program in the United States that is establishing a new path for stakeholders in the water industry interested in achieving water utility infrastructure management excellence.

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ACKNOWLEDGMENTS

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The Trenchless Technology Center (TTC) at Louisiana Tech University (La Tech)
The University of Texas at Arlington
The Georgia Rural Water Association (GRWA)

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ESTABLISHING A PATHWAY FOR ACHIEVING WATER UTILITY INFRASTRUCTURE MANAGEMENT EXCELLENCE
EPA GRANT -CP 83 282901-1

1.EXECUTIVE SUMMARY

Water utility infrastructure concerns have continued to increase on a global base for almost a century. The holistic approach for water utility infrastructure management must include:

- Drinkable (potable) water supply, treatment and distribution.
- Wastewater (sanitary sewer) collection, treatment and discharge.
- Storm water runoff, drainage, collection, treatment and discharge
- Industrial wastewater, collection, treatment and discharge

These are complex systems which have a direct impact on public health and safety, the environment, economic development and quality of life. For the most part, the systems that supply communities with the precious liquid and collect used water are "hidden". It has been estimated that, as much as, 75% of a typical municipalities assets are underground. The fact that most infrastructure is buried makes it easy for the average person to forget it exists, but for those who work in the water and industry, it is a reality that must be addressed daily.

Hundreds of billions of dollars have been invested in water infrastructure to meet growing needs. A large percentage of this infrastructure has exceeded its service life. These are critical assets which must be managed to meet present and future needs. The harsh reality is that this infrastructure is a perishable resource affected by age, use, and lack of maintenance. Therefore, it is essential to;

- Select and utilize advanced technology
- Develop and adopt best management practices
- Develop and implement effective training program
- Develop and execute awareness programs for public and political decision makers

The fundamental objective is to "enable the utility to consistently provide a desired level of service for the minimum long-term cost" (Najafi, 2008). This requires maintaining an adequate budget which can be highly impacted by developing and implementing an efficient and effective asset management program.

After conducting an international review of water utility management principle and practices, EPA (Environmental Protection Agency) embarked on an aggressive program of workshop presentations and publications to increase the awareness throughout the U.S. water industry of the critical importance of asset management. Among the specific initiatives involved in this effort, EPA entered into a cooperation agreement (CP 83 282901-1) with BAMI-I (Buried Asset Management Institute – International, Inc) to conduct an evaluation of the U.S. water industry to obtain insight on what utility managers and operators report that they need to achieve water utility infrastructure management excellence.

During the initial phase of this cooperative agreement, it was determined that the major barrier to pursuing and implementing an effecting asset management program was the lack of knowledge. This resulted in:

- Development of a Virtual Center of Excellence for Municipal Asset Management (CEMAM)
- Development and publication of the "Guide to Water & Wastewater Asset Management"
- Development of an "online" Asset Management Certification Program (AMCP)

- Implementation of the “online” AMCP

2.INTRODUCTION

The water (drinking, wastewater and storm water) industries in the United States, as in many other countries, were started as a solution to meet the needs. Often this was done with short term vision not with long-term projection to serve the future large population. This is understandable, as the expansion of many cities, the growing population and future uses of water resources were not foreseen at that time. Since 1755, when the first public utility started to provide water [1], many organizations, both public and private, have been created to satisfy the demand for water supply and wastewater. Currently, private water companies own about 16% of the nation’s community water systems[3] and 20% of all wastewater utilities (POTWs) in the U.S[2]

The varied uses of water expand with time affecting the quantity and quality demands. As systems expand, the necessary technology and complexity expand. This required managers, operators, and technicians to continuously improve their technical and managerial skills.

The varied uses of water are factors that have affected quantity as well as quality. As the systems grow in size they need to grow in technology too. Water utilities have to satisfy these two areas of demand. Also, water is a symbol of life, therefore the services should be provided in a way that assumes the responsibility of protection, conservation, and renovation of this precious liquid as well as of the environment in general.

A couple of generations ago, it was a luxury to have a water supply and wastewater collection system in the home. Today it is a “right” that all people expect to have access to. Often users do not take time to think about where this water comes from or where it goes to, or how it gets from one place to another. Only visible steps of the process count for users; the final step for water supply and the first step for wastewater collection. All too often what is “out of sight is out of mind” for typical consumer until is there a problem.

The fact that a major component of a water utility assets are “out of sight” significantly increase the complexity of the system to be managed. To satisfy all demands and operate as a profitable business in terms of financial and service performance, a high proficiency of best management practices is required. Also, an additional element will play an increasingly more significant role in business of managers of water infrastructure. This element is the fact that most utilities have not reinvested in their aging infrastructure resulting in a large component coming to the end of their useful life.

Asset management is an excellent program which contributes to utilities making wise decisions in order to provide anticipated levels of service, take care of the capital represented in their assets, and also be profitable. Most utilities are aware of the importance of infrastructure maintenance, replacement and renovation but financial limitations as well as lack of knowledge concerning best practices are the most common barriers preventing implementation of a plan to take care of this situation. Large investments of money, time and technology through the years makes it worthwhile to pay close attention to this industry to improve the services and control rate increases. Many years’ worth of hard work and efforts are at risk and this situation will continue to deteriorate if water stakeholders do not combine efforts to promote and implement good assets management practices.

The needed investment in water infrastructure maintenance and renewal is well established. It involves hundreds of billions of dollars. Most rate structures for utilities do not have the capacity to generate this amount of income. Small utilities in particular encounter more difficulties in covering all their needs. “Based on a survey of several thousand drinking water

and wastewater utilities, GAO reported in August 2002 that a significant percentage of the utilities—29 percent of the drinking water utilities and 41 percent of the wastewater utilities—were not generating enough revenue from user rates and other local sources to cover their full cost of service. Furthermore, roughly one-third of the utilities (1) deferred maintenance because of insufficient funding, (2) had 20 percent or more of their pipelines are nearing the end of their useful life, and (3) lacked basic plans for managing their capital assets"[4].

Even though investing money in water infrastructure is not the most attractive agenda for politicians, it is a topic that is being emphasized more and is included in the American Recovery and Reinvestment Act of 2009. It is not enough that the money invested go exclusively work on plants and pipes. Investment most be made in technology and people as well. Assistance, training and education are key ingredients in the sorely needed implementation of asset management programs.

But what is asset management? Numerous definitions have been developed, research has been done, theories and plans have been proposed and organizations have been created for asset management. This is not surprising due to the importance of asset management in different areas of interest and need. A good definition is provided in the Guide to Water & Wastewater Asset Management: "*Asset Management is the combination of management, financial, economic, and engineering and other practices applied to physical assets with the objective of providing the required level of service in the most cost-effective manner*" (Najafi, 2007)

In an effort to assist the water industry to establish a pathway for achieving water utility infrastructure management excellence, this research was developed by BAMI-I (Buried Asset Management Institute International) as a part of EPA (Environmental Protection Agency) commitment to sponsor and promote asset management principles and practices as a standard in the industry as part of its strategic plan meet the requirements of the "Clean Water Act (PL92-500) which became law in 1972 and the Safe Drinking Water Act of 1974.

BAMI was established in 2003 through the inspiration of Mayor Shirley Franklin, City of Atlanta (COA), and under the leadership of Commissioner Jack Ravan, COA Department of Watershed Management (DWM). The mayor's vision and the commissioner's challenge was to move the water program from its current status, accomplish consent decree mandate and achieve "Best in Class" status. This challenge could never be achieved without implementing major operational, technical, managerial, and cultural change. BAMI became the mechanism within DWM to identify, evaluate and integrate the appropriate products and process to achieve the mayor's vision. The name of this mechanism is significant because the main focus of DWM's consent decree involved buried assets, and the name emphasized that these assets must be managed.

The most demanding challenge for the DWM was not updating the above ground infrastructure, such as treatment plants, pumping stations, and others. It was upgrading the "hidden" or buried infrastructure. It has been estimated that our underground infrastructure consist of approximately two (2) millions miles of water (drinking, waste water and storm water) pipeline. Truly, this is our buried treasure.

Due to national and international interest in BAMI, the organization evolved into a non-profit organization (501(c)3) in July 2004 with the first Board of Directors being inaugurated in December 2004. With this development the name changed from BAMI to BAMI-International (BAMI-I).

It is essential to emphasize, that even though BAMI-I's primary focus is on buried (underground) assets, this project involves the holistic requirement of the U.S. water industry infrastructure. This includes all above and below ground water infrastructure.

Even though BAMI was conceived through the effort of Mayor Franklin and Commissioner Raven, they encouraged reaching out to others, to be proactive in the exchange of ideas, and provide a mean to show lesson learned as the COA moves forward in accomplishing one of the nation's most demanding consent decrees programs. This resulted in the establishment of a partnering relationship with the Georgia Rural Water Association (GRWA) and the National Conference of Black Mayors (NCBM).

This association provided BAMI-I with direct access to water utility managers and operator as well as the top political decision makers (local elected officials). These relationships provided a unique balance to the input acquired in developing the deliverables for this project.

3.PROJECT DESCRIPTION

The four main objectives of the research project were:

1. Assist with the development of transparent Assets Management Standards
2. Establish an international consortium for the development of a center of excellence for asset management
3. Establish a virtual, national clearinghouse of Asset Management Information
4. Conduct municipal forums as focus groups to establish the need of Asset Management in maximizing ratepayers' return on infrastructure investment.

For achieving the objectives of EPA Grant – CP 83 282901-1, BAMI-I assemble a unique team of academic research leaders and utility representatives to produce the following deliverables:

- Development of a Virtual Center of Excellence for Municipal Asset Management (CEMAM)
- Development and publication of the "Guide to Water & Wastewater Asset Management"
- Development of an "online" Asset Management Certification Program (AMCP)
- Implementation of the "online" AMCP

The BAMI-I project team was organized into four major components:

1. Project Management: IUPUI – Purdue School of Engineering and Technology
2. Water industry Input: Trenchless Technology Center (TTC) at Louisiana Tech University (La Tech)
3. Development of CEMAM (Center of Excellence for Municipal Asset Management): Virginia Tech
4. Education Program and Materials: University of Texas at Arlington and the Georgia Rural Water Association (GRWA)

Figure 1 shows the organizational Structure for this team. In the appendices, detailed work reports developed by each of these institutions are found.

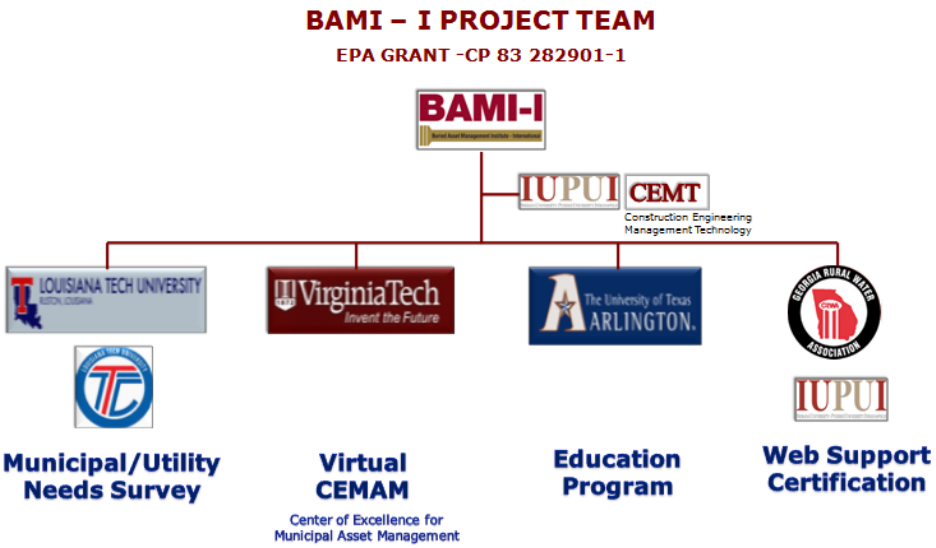

Figure 1. PROJECT TEAM ORGANIZATIONAL STRUCTURE

3.1 Administrative

The Construction Engineering Management Technology (CEMT) program at Indiana University Purdue University in Indiana, IUPUI, was responsible for project management and development of the final project deliverable and final report.

3.2 Establishing Water Industry Needs

Prior to developing specific deliverables for the project, it was essential to conduct a water industry assessment to obtain an accurate account of the need and adoption of asset management principles and practices.

Rather than simply distributing survey questionnaires, it was determined that the most reliable data would be acquired through the process of conducting Municipal Forums in key locations throughout the US to serve as focus groups to obtain input on the needs for asset management in maximizing rate payers' return on infrastructure investment.

The Trenchless Technology Center (TTC) at Louisiana Tech University is a cooperative research center and one of the participating project team members in this research. Due to its vast experience with the water industry and their Municipal Users' Forum Program for trenchless technology, TTC was asked to develop a survey "*Practices and Needs*", to determine asset management practices inside the industry.

The participants were representatives from municipalities and public work agencies that were attending forums in different states of the United States during the months of January to June of 2007. A total of 156 responses were registered. Figure 2 below shows how these participants were distributed.

Forum	Location	Date	Number of Responses
Northwest	Olympia	Feb 28, 2007	21
Colorado	Littleton (Denver metro)	Mar 1, 2007	29
Minnesota	Minneapolis	Apr 12, 2007	10
New York	Hoboken	May 15, 2007	27
Ohio	Columbus	May 17, 2007	14
California	Los Angeles	Jun 5, 2007	20
Texas	Dallas	Jun 11, 2007	30
Florida	Miami	Jun 14, 2007	5
TOTAL			156

Figure 2. INDUSTRY ASSESSMENT PARTICIPANTS

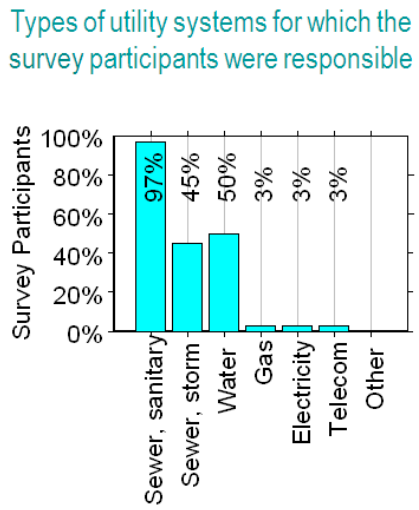

Figure 3. RESPONDERS

The vast majority of the responders were involved in sanitary and storm sewer operations and management (Fig 3). Fifty percent also had responsibility for drinking water distribution but there was only a very minor contingent responsibility for gas, electricity and telecom services.

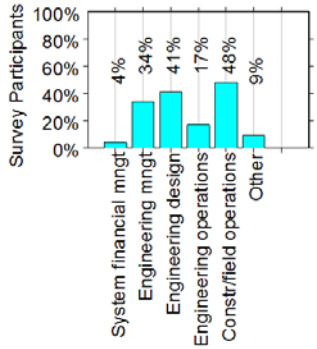

Figure 4. JOB FUNCTIONS

There was an excellent spread of job functions among the responders in terms of engineering management and design and construction/field operations. There was only minor participation from financial managers (Fig 4).

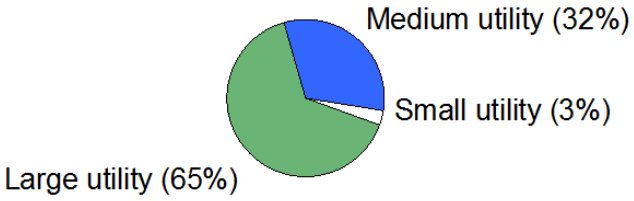

Figure 5. SIZE OF UTILITIES

The majority of responders were from large utilities (serving more than 100,000 customers). Medium utilities were reasonably represented but small utilities (serving less than 10,000 customers) made up less than 3% of the responders. (Fig 5)

Figure 6. ASSETS MANAGEMENT PRACTICES

Ninety three percent of responders considered that their utility practiced asset management approaches to some extent. When asked if their agencies were “readily and rapidly” adopting available asset management approaches, 67% said yes. 13% of responders that said no to this question (Fig 6).

Major Topics

Improving Assets Management Approach

If you believe that your agency could improve its approach to asset management, please indicate why you believe that it has not yet done so.

– Highest response: Comfortable with the approaches currently being used
– Moderate response: Can’t convince utility or city management of benefits
– Moderate response: Analysis tools not yet considered adequate to the decisions required

National Center Contributions

If a National Center of Excellence was created for buried asset management, what output(s) from the Center would you find beneficial? (Importance scored from 0 to 4.0. with 4.0 being the highest)

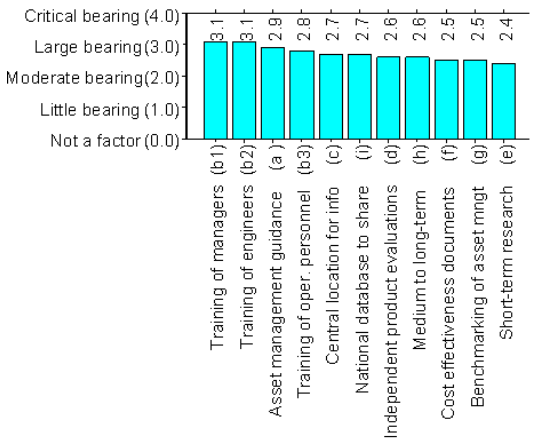

Figure 7. EXPECTED BENEFITS OF A NATIONAL CENTER OF EXCELLENCE AND THEIR ESTIMATED WEIGHT

As shown in Fig 7, the highest scores (3.1) were for training of managers and engineers with a slightly lower response for training of operations personnel (2.9).

Asset management guidance (2.9), central information source (2.7), sharable national database (2.7), independent product evaluations (2.6) and documentation of cost-effectiveness for asset management approaches (2.5) all received acceptance as beneficial.

When comparing the research horizon for such a center, the participants favored a medium to long-term horizon (2.6) slightly compared to a short-term research horizon (2.4)

3.2.1 Results

According to the responses, a high percentage of utilities claim to be familiar with asset management practices and adopt them. However, it would be important to examine the quality of those practices. Just because a utility is using some of the asset management techniques or principles does not mean that decisions are being made based on them.

It was clear that this research project could not address of all these important areas. It could be the subject for another study. Steps were taken to address the most urgent needs which were:

- Education
- Access to information.

3.3 Virtual Center of Excellence for Municipal Asset Management (CEMAM)

To address one of the most urgent needs identified from TTC, Municipal User's Forum Program, and accomplished one of the major objectives of this project; a national clearing house of asset management information was developed to provide access to information.

Virginia Tech developed the web-based Center of Excellence for Municipal Asset Management (CEMAM) in collaboration with BAMI-I, municipalities, universities, associations and industry. This Center of Excellence will be used for sharing and integrating the beneficial use of Municipal Infrastructure Assets Management Information. The main objective of this project is to establish a one-stop shop for a center of excellence to address, facilitate, promote and show case successful Municipal Infrastructure Asset Management Programs and Databases.

The CEMAM web site will serve as a central element in carrying out the Center's mission by providing an online resource for the municipal infrastructure asset management community. The Center's approach includes providing an online technical library of water and wastewater asset

management tools, documents, and other resources; municipal infrastructure asset management news and a calendar of conferences, publications, and other relevant events; online municipal asset management information for training, research and education, and outreach programs and publishes an online version of the Center's newsletter and other publications

The CEMAM will help in:

- Creating linkage to a wide audience;
- Provide timely access to asset management information and resources that will lead to more efficient programs;
- Promote and provide training, education, research and outreach programs
- Provide the public with a convenient tool to learn about municipal water infrastructure system.

The research team's process:

- Defined data elements required for condition assessment management of buried assets
- Develop a standardized data structure to serve as a common foundation for future analysis and research;
- Examined the implications of the standards on municipal utility programs;
- Created an example database that conflates the varied municipal data into a common data framework.

As shown in Figure 8, these four steps can be grouped in three more general steps once the participants have been established and what kind of data is needed.

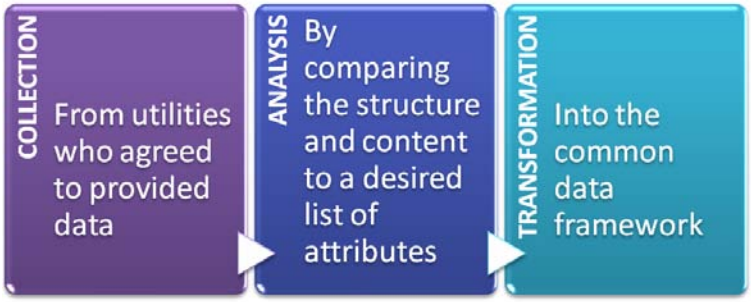

Figure 8. CONDITION ASSESSMENT STEPS

3.3.1 Collection

The methods for data transfer from each community have varied with the preferences of each community, and with technical limitations. Originally, an FTP site was set up to allow communities to send data to the Virginia Tech researchers. However, the FTP file transfer appeared to be efficient only for relatively small data transfers; for large files in many cases resulted more convenient to transfer data on physical discs (CDs or DVDs).

Bigger utilities have data stored in shape files or geodatabase tables which are compatible formats with ArcMap. Small companies can use Excel to transfer the data. The data is downloaded from the server and now being analyzed, as shown in Figure 9.

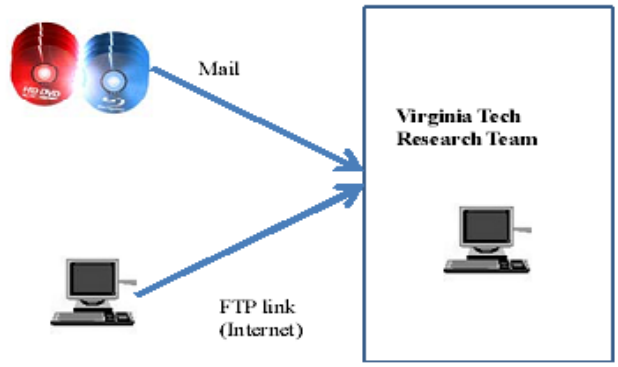

Figure 9. UTILITY DATA TRANSFER FRAMEWORK

After receiving the communities' GIS and tabular data, the Virginia Tech researchers are storing it at the San Diego Supercomputing facility, using an ArcSDE connection to Oracle tablespace at San Diego. The ArcSDE connection is being hosted by Virginia Tech's E-Corridors program.

The proposed effective structure to store data is to create a feature dataset for each city on its name and then create individual feature classes for manholes, pipelines etc in each dataset. The main advantage of this structure is that the data from each city is stored separately and can be retrieved also in a similar fashion. The illustration in Figure 10 gives a better understanding of the structured storage.

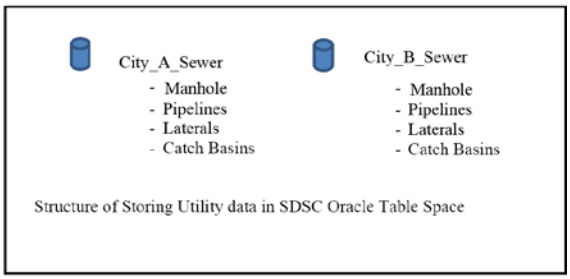

Figure 10. STORAGE OF UTILITY DATA IN STANDARD FORMAT

The data received from utilities would be reviewed and initial analysis would be done to familiarize with their fields and attributes. This data will be then loaded to the standard data model template, this would further be transferred to SDSC oracle table space. The schematic in Figure 11 gives a better understanding of the data transfer to SDSC.

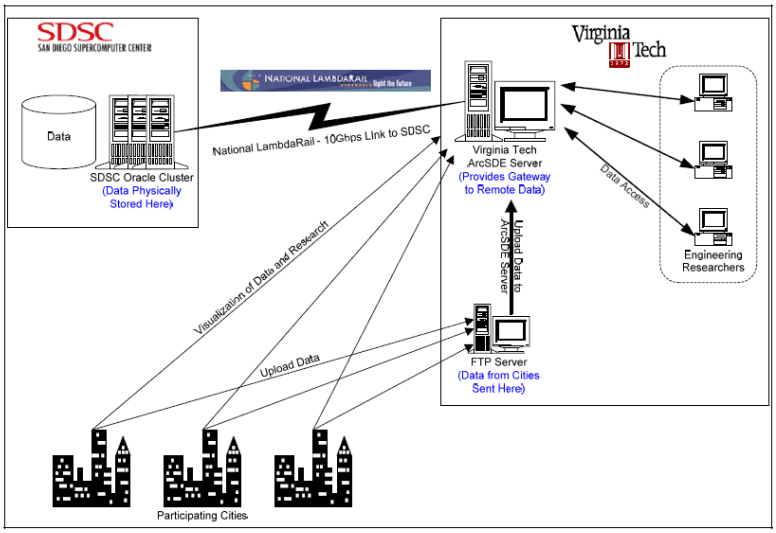

Figure 11. DATA TRANSFER, ANALYSIS AND VISUALIZATION PROTOCOL

3.3.2 Analysis

About 100 parameters which may affect the pipe infrastructure have been identified each for the wastewater and water systems. The goal is to eventually create a national standard data model for the pipe infrastructure. Along with an inclusive list of all parameters which can ultimately have an effect on the deterioration of the pipe infrastructure, a supplemental goal is to generate a report which details how to get the data collection protocol.

This national standard data model was developed to aid the decision making process in asset management program. The data model can be used in developing of condition index, prediction model, prioritizing repair and rehabilitation, prioritizing inspection, planning operation and maintenance, developing capital improvement program and making high level decision etc.

The parameters which may affect the pipe performance were divided into five classes based on their characteristics: Physical/Structural, Operational/Functional, Environmental, Financial, and Others. These classes are presented in Figure 12.

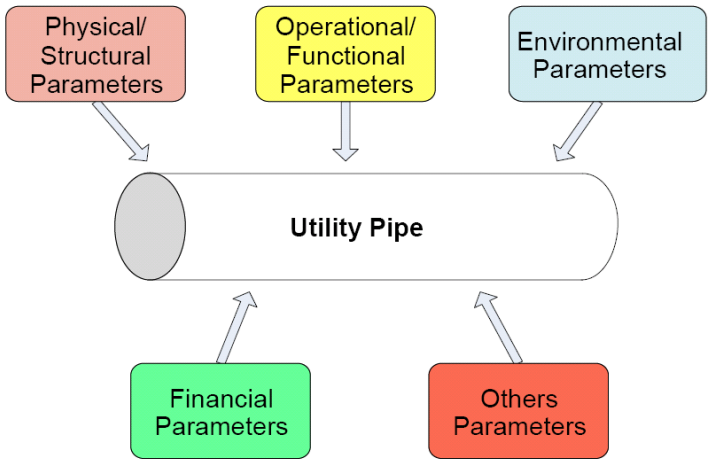

Figure 12. CLASSIFICATION OF PIPES PARAMETERS

3.3.3 Transformation

Once the data is received from utilities, preliminary analysis has been done. After the preliminary analysis, the data model of the utility is compared with the standard framework prepared by the researchers at Virginia Tech.

The data model was broken into four separate models: Wood, Bronze, Silver, and Gold. The wood data model is for utilities very small and do not have resources to collect enough data. The bronze data model is for utilities which are small and do not have a lot of man-hours due to a smaller workforce. The silver data model is for utilities which are larger than bronze utilities; however, still may not have a special team designed to devote all their time to developing pipe data parameters within a system. The gold data model is for the utilities which represent some of the largest cities within the U.S. and have a special team devoted to the continuation of updates to the data parameters.

As illustrated in Figure 13, a common data framework to support condition assessment have been defined and populated by conflating disparate datasets from several partner utilities.

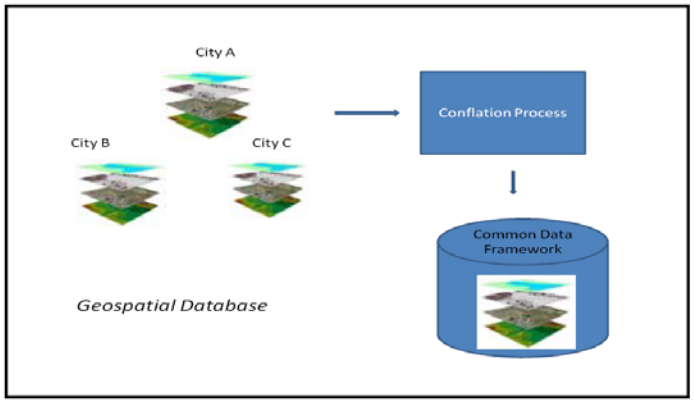

Figure 13. CONFLATION PROCESS BETWEEN MULTIPLE UTILITIES

Data mapping is the process of creating data element mappings between the distinct data models. Data mapping is used as a first step for a wide variety of data integration tasks including data transformation between a data source and a destination.

A geo-database data model is created from the standard data model proposed by the research team. This data model is used to develop mapping files. These files are used to transform the data from the utility files to the standard data model. The new geo-database with the utility data in standard framework is stored at San Diego Supercomputing Center.

3.3.4 Results

A prototype web application has been developed to help utilities and researchers to retrieve data as well for the public to know more about utility programs and reports. Different privileges have been created depending on the users, as shown in Fig 14. According to the memorandum of utilities, their data is to be kept confidential. So to demonstrate sample queries, dummy data is created for water and waste water systems. The dummy data consists of manholes, pipes, trees, rail tracks, water bodies, streams, soil in the sewer system and hydrants, pipes, trees, rail tracks, water bodies, streams, soil in the water system.

The web interface offers a plethora of possibilities to manipulate, analyze and visualize pipelines using the Arc Viewer. This also helps in easy accessibility of utility data by researchers or other utilities depending on the privileges of access granted.

The research team at Virginia Tech will have full access to query any kind of data. The proposed Center of Excellence for Municipal Asset Management website will become a major online asset management resource for utilities. The site will definitively succeed in achieving an "online community for municipal asset management".

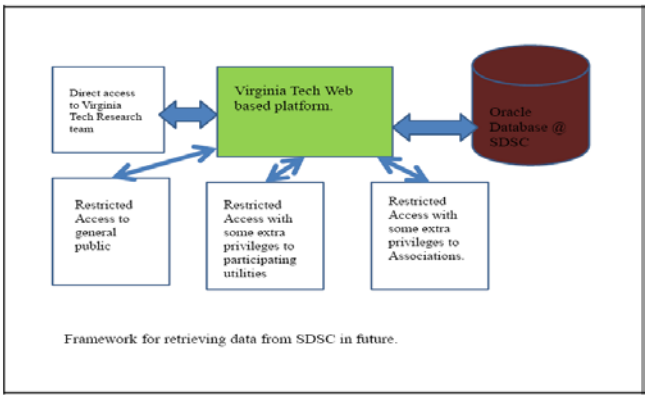

Figure 14. A PROTOTYPE WEB APPLICATION FRAMEWORK

Web Address: http://www.wiis.cee.vt.edu/ this webpage is still in development. Figure 15 shows some screen shoots.

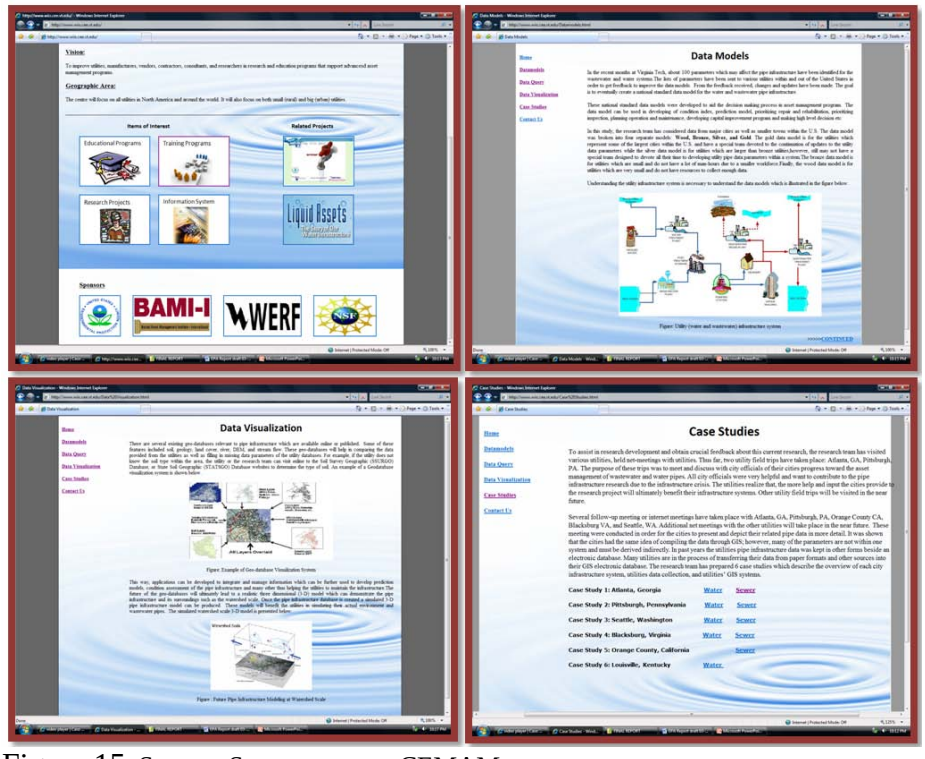

Figure 15. SCREEN SHOOTS OF THE CEMAM

3.4 Education Material

In an effort to respond to the most urgent need identified in the TTC – Municipal Users Forum industry assessment program and the overriding objectives of this research project, the project team embarked on the development of innovative and powerful educational tools and training program.

The University of Texas at Arlington (UTA) and its Center for Underground Infrastructure Research and Education (CUIRE) participated in the research, and development of a manual about asset management, "*Guide to Water and Wastewater Asset Management*".

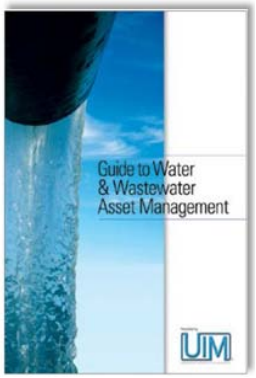

Figure 16. MANUAL

This manual provides information about asset management for water and wastewater infrastructure in an easily understood way and covers necessary material and methodology to help a utility to start or improve an asset management program. Each chapter presents a subject well clearly developed, examples, references, graphics and conclusions. This manual can be used as a reference for very experienced asset managers or as an introduction guide for neophytes in asset management.

Some of the subject covered in the manual are: an introduction to asset management, sharing asset management knowledge on a global scale, asset management technologies, risk management, government regulations and cases studies. Several articles published previously were used to prepare this manual.

Each chapter of the manual has a detailed power point presentation (Fig 17) which is intended to be used as a study tool and/or as material for teaching.

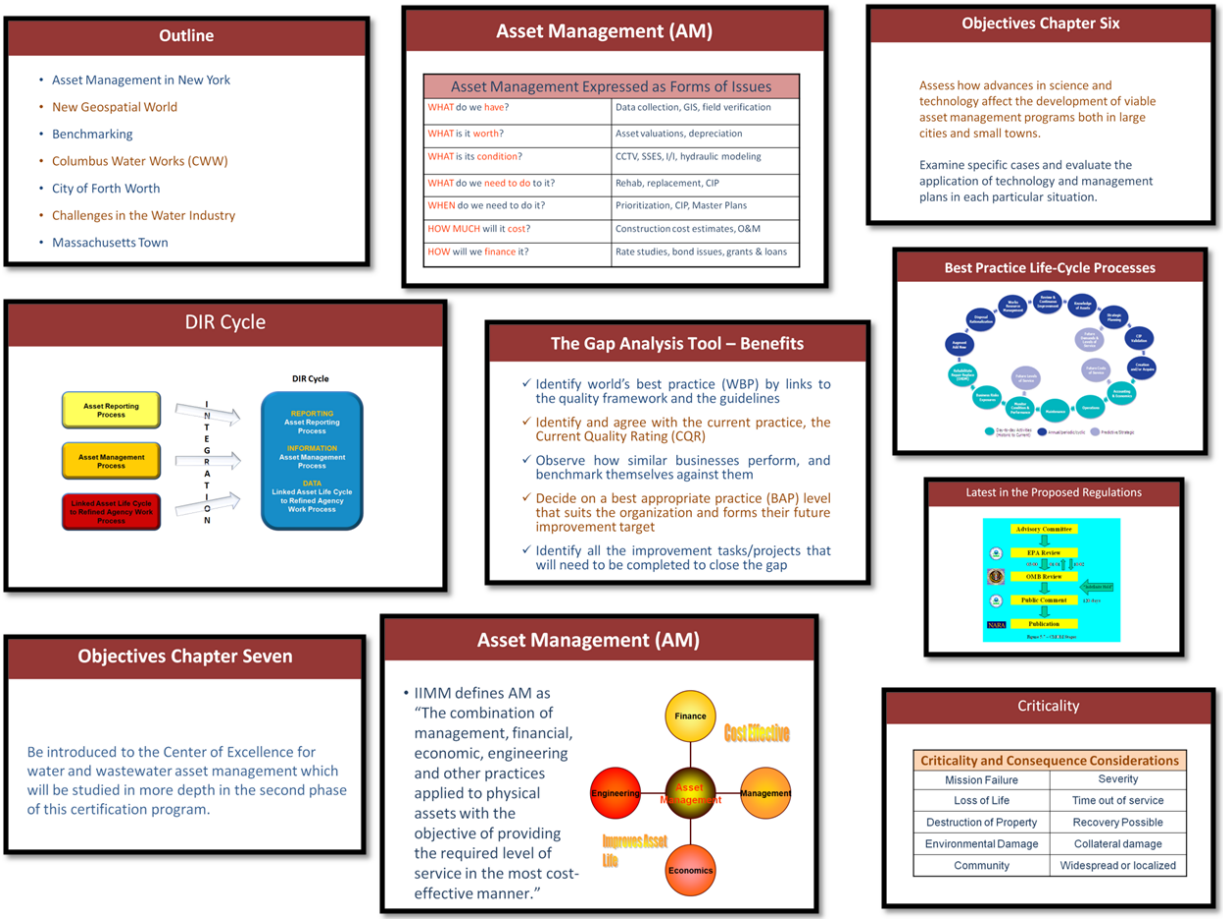

Figure 17. EXAMPLE OF MANUAL VISUAL PRESENTATION

4.BAMI-I ASSET MANAGEMENT TRAINING CERTIFICATION PROGRAM

Figure 18. BAMI-I ASSET MANAGEMENT CERTIFICATION PROCESS

The Construction Engineering Management Technology (CEMT) program at IUPUI-Purdue School of Engineering and Technology merged the deliverables from the three academic team members (Virginia Tech, TTC at La Tech, and CUIRE at UTA) into an "online" program. This figure ingeniously depicts the essence and outcome of this research project. Moving from left to right in the figure, one moves from dark problem associated with water infrastructure assets through the outcomes and deliverables of this research project to eventually obtaining the bright and colorful renewed infrastructure. Moving from top to bottom, one moves through the project team organization structure and sees their deliverables followed by the certification program, which merges the complete project into a powerful integrated program.

TTC surveys showed that the majority of utilities claimed to have some kind of asset management program. The majority considered that creation of a National Center of Excellence would provide the biggest benefit through training for manager, engineers and for personnel. Therefore, the existing need for knowledge, training and education about asset management practices in the water industry motivated the creation of this certification program.

Based on the individual projects of each consultant, BAMI-I created the Asset Management Training Certification Program. The Certification Program is an online educational process for obtaining certification of training in management of underground asset infrastructure. It is a pioneer program in the United States that is establishing a new path for stakeholders in the water industry interested in achieving water utility infrastructure management excellence.

The objective is to provide the participant with knowledge and resources on asset management that qualify him/her to initiate, continue and/or improve an asset management plan.

This program is designed for to all stakeholders in the water industry such as owners, managers, workers, supervisors, students, educators, decision makers, consultants, engineers, professionals, administrative personnel, and many others.

It is suitable for people just getting started in the industry as well as experienced professionals. The program covers both introductory and advanced material with technical but simple language suitable for all types of people.

4.1 Phases

The program has three phases: Phase I: Fundamentals. A manual and its correspondently examination; Phase II. Practical: Use of a virtual CEMAM and Phase III: Application to the industry.

4.1.1 Phase I. Fundamentals

This phase uses the manual "*Guide to Water and Wastewater Asset Management*". Visual material and evaluations complement the manual. The dynamic of the certification process proceeds chapter by chapter. The visual presentation contains the same subjects as the manual and is intended to be used to emphasize the content of the manual and for studying for the exam. The exam will test the knowledge acquired from the manual.

Those seeking certification should study and be evaluated on the chapters one by one until completing the manual's seven chapters.

4.1.2 Phase II. Practical Use of CEMAM

Phase II introduces virtual CEMAM (Center of Excellence for Municipal Asset Management). How to utilize the virtual CEMAM, data from existing utilities is available to allow students to learn from real world examples. It is a convenient tool to learn about municipal water and wastewater infrastructure system.

The objective of this phase is to give the participant the opportunity to manipulate, analyze and visualize national and international utility data. Also, the Center provides valuable information related with the industry as well with education and training opportunities.

4.1.3 Phase III. Industry Application

Phase III leads the participant through the existing resources and tools available on the water industry. It is important to know what kinds of resources are available and how to use them to promote excellence in asset management programs in utilities.

The goal of this phase is that the participants become familiar with organizations, institutions, fairs, events, and many other activities and resources in the industry. The participant must complete an evaluation during phase II and III.

4.2 Certification

The certification program is completely online. IUPUI allows BAMI-I to use Oncourse, an online course environment that permits BAMI-I and the certification program's participants access to learning resources. Fig. 19 shows some shoots of the general appearance of Oncourse.

Georgia Rural Water Association (GRWA) will participate by promoting the program on its webpage and through the association. Once the participant has completed all three phases, he/she will receive a **Certification of Training in Asset Management**

4.3 Application

Research results may be very impressive but if these only remain on paper, the process is incomplete. Often the most difficult component of the process is TRIP. To ensure that the deliverables of the research project would provide value to the user community, BAMI-I entered into a subcontract with Georgia Rural Water Association (GRWA) to provide input from water utility managers, operator, technicians and others. In this case, the research was done with clear objectives and desires for implementation in the industry

Putting a new theory into practice takes a lot of time - it could be years or even decades but asset management practices need to be started where they do not exist, improved where they already exist, and kept and repeated where they are working efficiently and effectively.

It is well known that the biggest barrier to overcome is resistance to change. Change is traumatic; it shakes structures and takes people out of their comfort zone but most of the time it is necessary. The water and wastewater industry is in great need of change, a change that helps to control the existing risk and avoid future crises. Change is a factor that has to be taken into account when the implementation process starts, but how change is going to affect the process is beyond the scope of this research project.

BAMI-I desire is that this certification program will be the first one of a series of educational programs and has the strong believe that through the Asset Management Certification Program is Establishing a Pathway for Achieving Water Utility Infrastructure Management Excellence.

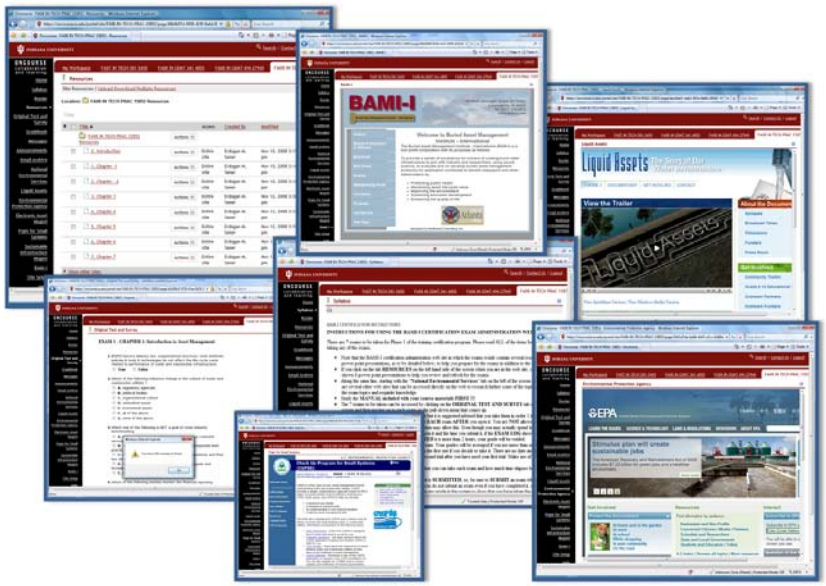

Figure 19. ONCOURSE BAMI-I ASSET MANAGEMENT TRAINING CERTIFICATION PROGRAM

5. DEVELOPMENT OF ASSET MANAGEMENT STANDARDS

From the initial establishment of BAMI within the Atlanta's Department of Watershed Management in 2003, it was clear that the concept of asset management could be confusing. BAMI-I leadership realized the importance of engaging a standards development organization to develop transparent material asset management standards for the water utility industry. ASTM (American Society for Testing and Materials) was engaged to initiate the standards development process. Team members from each subcontract of this research project participated in the organization of ASTM F36 Committee. Deliverables form this research project have been used to expedite the ASTM standards development process.

6. Establishment of an International Consortium

BAMI-I was instrumental in the establishment of the UIM (Underground Infrastructure Management) practice journal. Their publication has served as an effective mechanism for capturing international expertise in the area of water industry asset management. In addition, BAMI-I cooperates with the publishers of the journal to conduct an annual UIM Conference. This event also serves as the venue for BAMI-I to conduct workshops on this research project.

The project manger of this research project has participated in several international conferences, colloquiums, workshops and other events on asset management to present the development of the deliverable for this research project.

7.SUMMARY

The deliverables of this project have greatly exceeded the original expected objectives. It produced three (3) separated and unique products which together meet the original objectives. The products are:

- Virtual CEMAM (Virtual Center of Excellence for Municipal Asset Management)
- Industry Assessment Report
- "*Guide to Water and Wastewater Asset Management*" manual and the educational support materials.

The bonus deliverable included the merger and integration of these products into a powerful and innovative "online" certification program which will be launched to the user community through the GRWA (Georgia Rural Water Association) website. GRWA will eventually expand this to the national market.

It will also be available through the NCBM (National Conference of Black Mayors) and BAMI-I websites.

8. APPENDICES

The appendices are the deliverables produced by academic and industry consultants that participated with BAMI-I in this research project.

A. Industry: Louisiana Tech University and Trenchless Technology Center

"Survey of Selected Municipal Users' Forums Participants: Current Asset Management Practices and Needs"

B. Creation of CEMAM: Virginia Tech.

"Development of Virtual Center of Excellence for Municipal Asset Management (CEMAM)"

C. Education: University of Texas at Arlington

a. Manual *"Guide to Water and Wastewater Asset Management"*
b. Visual Material *"Guide to Water and Wastewater Asset Management"*
c. Evaluation.

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Buried Asset Management Institute International, Inc (BAMI-I)

Perdue School of Engineering and Technology

Indiana University Purdue University Indianapolis, IUPUI

799 W. Michigan Street

Indianapolis, Indiana 46202-5160

Phone: (317) 278 – 4970

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