Asset Management at Seattle Public Utilities

What is Asset Management?

Operating based on Asset Management principles at SPU means that we focus on cost effective delivery of services to customers – today and into the future, decisions are made in a transparent manner fully informed by knowledge of life cycle triple bottom line costs and benefits, risk is managed, and we measure our results.

See Attachment A for more to the story.

How does Asset Management benefit customers?

1. We are able to more consistently meet the needs, desires, and expectations of customers. We do this through establishment and monitoring of service levels, as described in Attachment A. We also do this through application of triple bottom line decision making, also discussed in Attachment A.

2. We are able to keep capital and operating costs low, and this relates directly to rates. See Attachment B.

How does Asset Management help SPU plan for the future?

With asset management we are making sustainability of our existing infrastructure central to our mission. We are assessing the condition of many of our assets, understanding the likelihood and consequence of asset failure and managing these risks, considering life cycle implications of today’s investment decisions, implementing technology tools and data systems to understand asset ownership costs and system operations (in order to help us make smart decisions in the future), and teaching employees to meet the challenges of the future.

What have we learned from Australia?

Best practice in utility asset management exists in Australia and New Zealand, while asset management is still in its infancy in US water and wastewater utilities. For two years, SPU had executives from one of the most successful utilities in Australia work directly with us, we have sent SPU employees to several different Australian and New Zealand utilities to learn asset management best practices, and we have participated in Australian benchmarking studies wherein our performance in a range of asset management practices and outcomes is measured against theirs, resulting in our ability to focus improvement efforts and learn from the successes of others.

See Attachment C for additional information regarding the Australian influence.

What are some of SPU’s Asset Management success stories?

See Attachment D.
The business of providing water and wastewater services is very infrastructure intensive – that is, we rely heavily on built things such as pipes and pumps and treatment facilities in order to provide services to customers. For several years now, the water and wastewater industries in the US have focused efforts on how to manage the huge portion of our infrastructure that is beginning to fail at higher rates due to age, or is predicted to begin more rapid failure. Ratepayers across the country simply cannot afford to replace all of the assets that were installed in the early and mid 1990s. Seattle Public Utilities, like many other similar organizations across the country – and in fact across the world – have management strategies resulting directly from these concerns. We have, however, taken a more aggressive and comprehensive approach than any other utility in the US. We are leading the US utility industry in application of asset management principles.

Asset Management at SPU is defined as “Meeting agreed customer and environmental service levels while minimizing life cycle costs.” Asset Management is a management philosophy and set of tools for making decisions in an environment where resources are limited, and where focus is on customer needs, expectations, and desires.

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Cost effective delivery of services to customers – today and into the future

Asset Management obligates us to ask the question “How can we best meet the needs of our customers?” When making the decisions needed to manage the utility – every day, big and small – about how to allocate resources, we ask the question – to ourselves and to each other – “What would the customer think?”, and “Is this how customers would want their money spent?”

In each of our four lines of business we are setting service levels. When service levels are set, we can manage to them. With the exception of regulatory requirements, prior to asset management, there was little consistency with the level of services provided to customers. Employees at Seattle Public Utilities have a passion for providing good, reliable, consistent service to customers, but prior to asset management, this was done in a poorly coordinated manner without clear and measurable corporate objectives. It is important for us to set service levels in order to ensure and measure how well we are meeting these across our entire customer base, in order for our customers to understand what they can expect, and in order to ensure that we are making investments necessary to meet these service levels – today and into the future.

Through the process of setting service levels, we are better understand those services -- and the specific aspects of those services -- that customers find desirable.

We are attempting to find out what's important to customers in a few different ways:
1. Through our bi-annual Residential Customer Survey. With this ask 1200 customers to identify the services that are most important to them, and we find out how customers are feeling about the services they are receiving.

2. We are beginning to do opinion research through focus groups to learn from customers what services are most important to them. Through this method – which we are currently just piloting – we receive input that helps us to set service levels. Once the pilot is completed, our intent is to repeat the method on a regular basis and sequence through all the services we provide. This information will feed into our investment decisions.

A few examples of service levels are:

- In the wastewater line of business, 80% of problems (for example, backups, voids, maintenance lid displaced, and ponding) will be responded to within one hour.
- In the water line of business, fewer than 4% of retail customers will experience water outages for one or more events totaling more than 4 hours per year.
- In the solid waste line of business, a typical household will experience a missed collection of garbage, recycling, or yard waste no more than once every ten years.

Then the real challenging part is to convert the service levels into something meaningful to the 1400 employees of SPU. We do this by establishment of performance indicators, which let our various work groups know how they are doing with their part of meeting service levels. A few examples of performance indicators at SPU are:

- Because sewer cleaning is closely related to sewer backups for many of our sewer lines, we measure the amount of planned cleaning activities that we are able to accomplish on a quarterly basis.
- We measure the number of water quality complaints we receive. Such complaints are typically aesthetic in nature (related to taste and odor of the water rather than health), and are often related to nearby construction activity. Measurement and tracking of these complaints allows us to manage in a manner that will improve overall customer satisfaction.
- We are tracking the cost of performing various field activities such as water service replacements and installation of small taps.
- We are also measuring the efficiency of our capital project delivery through tracking of hard costs and soft costs (hard costs are the portion of capital project costs that go toward the built asset while soft costs are the design and management activities).

*Establishment of service levels and performance indicators requires us to focus externally on customers and internally on our own productivity.*
Decisions are made in a transparent manner fully informed by knowledge of life cycle triple bottom line costs and benefits

In 2002 we established an Asset Management Committee (AMC) in order for there to be a single place in the organization where the big investment decisions are made – for example which project alternative to select, or even whether or not a project is even needed.

The AMC consists of SPU executives, and its role is to:

- Review and authorize funds for capital improvements,
- Ensure that funding decisions are based our AM principles,
- Approve program implementation strategies, and
- Monitor the implementation of projects to ensure that they are being accomplished based on approved schedule, budget, scope, and performance.
- In addition, the AMC serves as the authority for the establishment of Customer and Environmental Service Level targets.

Capital funding decisions at the AMC are made based on the presentation of Project Development Plans (PDPs) which are documents within which we analyze the costs and benefits of the alternative methods for solving problems. PDPs consider life cycle costs and benefits, and analyze alternatives based on triple bottom line considerations.

We make investment decisions – large and small – based on an understanding of the total life cycle costs and benefits. This may include initial capital investment, life cycle operations and maintenance costs, other asset ownership costs such as electricity, future renewal and rehabilitation costs, and disposal costs. We are teaching planners, engineers, project managers, and others within SPU to consider the life cycle costs and benefits of projects and programs when making initial investment commitments.

We also assess projects and initiatives based on a triple bottom line approach. Triple bottom line, or TBL, refers to consideration of not only the financial implications but also the social and environmental costs and benefits of the various alternative solutions under consideration. Actually learning how to do this and making sure it’s being done in an accurate and consistent manner is more difficult than it sounds. For example, in order to do this well we need to quantify the inconvenience caused to customers when their water service has to be shut off, or the cost to people to wait in line at the transfer station. Once we have these values, we can use them in comparison of the alternatives and use them along with the more readily quantifiable estimated costs to build new projects or change maintenance or operations practices.

The AMC meets on average once per week for a full afternoon. We estimate that the amount of time executives are spending reviewing capital project and program decision information has at least doubled from the time before asset management really took hold at SPU in 2002. AMC advance materials, agendas, and meeting summaries are available for anyone in the organization to review. The AMC holds itself accountable for making decisions based on asset management principles, and
we are teaching other decision makers in the organization about these principles because they are expected to make decisions in the same well informed and rigorous manner.

**Risk is managed**

We are managing our corporate risk in order to be confident that we are appropriately investing in risk mitigation activities. In addition, we are assessing and quantifying risk and considering the likelihood and consequence of failure when making asset investment and other resource allocation decisions.

At a corporate level, we have nine risk categories and we are working to understand how likely it will be for something to go wrong with that category, and how bad it will be. When something has a high likelihood of failing and if it does, will have high consequences, we label that activity as “critical” and based on this, take measures to reduce that risk.

**Measure our results**

We are establishing and measuring our outcomes with performance indicators (as discussed above) in a quarterly Key Performance Indicator Report. Another way for us to know how efficient we are and how well we are providing services to customers is benchmarking.

Benchmarking is a way for us to compare how we’re doing to the results of other public utilities, and by private entities also. We use the information for creation of improvement strategies.

We have participated in a variety of benchmarking studies through industry associations we are involved in such as the American Water Works Association.

Since 2003 we have also participated in three different benchmarking studies with the Water Services Association of Australia. We find this to be particularly useful because Australia and New Zealand utilities have been implementing asset management principles in their organizations for about 15 years. Many of these organizations are known to be the very best in the world with regard to asset management and we can learn a huge amount from them. Benchmarking helps us to understand how we’re progressing and it also puts us into contact with other utilities who are considered best practice in the various initiatives we have underway or seek to implement. We learn from these organizations and have adopted many of their practices.
Some of the most compelling information we have regarding cost and rate benefits is through comparison of the projections we had prior to implementation of asset management in 2002 to the actual costs and rates since then.

Utility rates have been reduced in comparison to earlier planned levels. In 2002 – before implementation of asset management – we projected 2004, 2007, and 2010 rates in our four lines of business, then predicted them again in 2004. In those years, we see a reduction of between $6 and $13 for combined rates for each of the prediction years.

The actuals for the 2003/2004 operations and maintenance budget were about 6% (or about $16 million) lower than the 2002 projection. There has also been an 18% reduction (that’s about $60 million) reduction in the capital budget – comparing the 2002 prediction for our combined (WF, DWF, SWF) capital budget in 2005 and 2006, to the actuals for those years.

Staffing, as measured by regular, temporary, and contract employees was reduced by about eight percent.

We’ve also been able to increase our cash contribution to the capital budget. As you can see on the screen, for the water fund, our cash contribution was 19% in 2003, and we project it to be 22% in 2005. For the drainage and wastewater fund, the cash contribution was 5% in 2003 and we project it to be 15% in 2005. For the solid waste fund, it was 6% in 2003 and we project it to be 30% in 2005.
Changes in the Australian water industry took place in the mid-1980's and 1990's. Utilities were directed by the federal government to become commercially based and customer focused. The government set policies and regulations, and utilities were to meet them. They were directed to participate in nationwide annual benchmarking activities to assess their performance. Most of these utilities lived up to the challenge and are now very successfully managed. We are attempting to recreate what has been done in Australia and New Zealand in a manner that works for our environment.

The 24 largest Australian water/wastewater utilities have achieved almost twenty percent savings per account over the past twelve years with at least one utility – Hunter Water – achieving far more. These savings have involved both capital and operations/maintenance costs and have not been at the expense of service levels provided to the customer or the environment. Hunter Water is a large regional water and wastewater utility in Southeast Australia. It is widely viewed as having developed one of the most advanced and effective asset management programs in the world.

Chuck Clarke, SPU's Managing Director, has developed a regular consultative relationship with Kevin Young, Hunter Water's Chief Operating Officer. Mr. Young spent a year working at SPU in 2002 and 2003, and assisted in education of the principles, establishment of many of the practices, and creation of the current organizational structure at SPU. Many staff within SPU have built relationships with staff from Hunter Water, and regularly seek advice and guidance through these contacts.

We have also participated in Australian benchmarking studies wherein our performance in a range of asset management practices and outcomes is measured against those of utilities in Australia and New Zealand. The studies are conducted by the Water Services Association of Australia (WSAA), and our participation results in our ability to focus improvement efforts, learn from the successes of best practice organizations, and in the future will allow us to track our overall success with asset management.

One of the most persuasive imperatives brought to SPU from Australia and New Zealand has been the drive to understand the true costs of the business in order to appropriately set rates and ensure sustainability of the infrastructure and continued levels of customer services. SPU has been attempting to follow the Australian course by endeavoring to thoroughly understand the trade-offs between capital and operating expenses, while ensuring the most cost effective manner of delivering each.

Influence from the Australian and New Zealand way of managing assets has caused SPU to:

1. Clearly establish **service levels** (those measures important to customers), and performance indicators (internal measures created to track performance in meeting service levels),

2. Assess and quantify **risk** and consider the likelihood and consequence of failure when making resource allocation decisions,

3. Consider **life cycle** costs and benefits of projects and programs when making initial investment commitments,

4. Assess projects and initiatives based on a **triple bottom line** approach (wherein we consider financial, social, and environmental costs and benefits),
5. Consider the importance of asset data and data systems, and recognize the value of asset attribute and condition information as well as real time system information,

6. Clearly define the role of system Specifiers within the utility,

7. Begin development of short term planning documents wherein information about various asset categories is compiled and capital renewal plans are developed along with maintenance strategies (these documents are called Strategic Asset Management Plans),

8. Create a more explicit capital resource decision making body (the Asset Management Committee), where decisions are made based asset management concepts and in a transparent manner,

9. Track, assess, and focus improvement initiatives on efficiency and effectiveness of operations and maintenance activities (SPU uses Service Agreements to help do this), and

10. Assess our performance relative to others through benchmarking.
Attachment D

Cultural changes – improvements in how we focus our attention and how we make decisions.

Since beginning to implement asset management at SPU in 2002, we have made many positive changes in how we manage the utility, including the following:

1. We seek to understand problems then explore alternative ways to resolve them – for example implementation of large capital projects isn’t the only way to solve problems, we also consider changing maintenance practices or changing our emergency response protocols.

2. Our exploration and presentation of alternative solutions to defined problems is done in an objective manner. We no longer rely only on intuition, or make decisions based on the advocate able to make the most passionate argument for a given solution.

3. We make funding decisions more fully informed by life cycle costs, benefits, and risks.

4. We make decisions not only based on financial implications but also based on solid analysis of social and environmental implications.

5. Alternative solutions are teased out early, in order to optimize cost savings and overall implementation success. (Historically, we frequently had to cycle back to planning processes when new solutions were identified half way through implementation of another solution.)

6. We make decisions on large investments only following rigorous economic analysis of alternatives, and by executives placed highly in the organization.

7. We no longer tend to over-design or over invest in capital projects – a common phenomenon with public works.

8. We have an organizational focus on efficiency in project and program implementation and as part of this are now tracking soft cost percentages. (Hard costs are the portion of capital project costs that go toward the built asset while soft costs are the design and management activities.)

9. Our decisions are made in a transparent manner within the organization and we are able to provide the asset management justification when discussing alternative solutions with regulators, elected officials, and community groups.

10. We have developed decision models to ensure consistency and efficiency, and to help ensure timely decision making.

11. Our specifier/service provider organizational model allows service providers to become proficient at the service they are tasked with providing rather than on the policy decisions associated with that task.
12. Problems, challenges, and issues are elevated to decision makers in a more timely manner than prior to asset management.

13. We have greater knowledge of our infrastructure and are thus better able to ensure solid financial management.

14. We are better able to track the reasons customers contact us – so that we can focus on systematic problems in a more timely manner.

15. We are better able to track our response times to system emergencies and other incidents.

16. Employees have a better understanding of our organizational objectives and on a project-by-project basis are better able to explain customers the reasons behind our implementation of solutions.

17. Employees push the envelope on innovative solutions because there is a clear process for evaluation of alternatives and quantification of future benefits to creative solutions.

18. Our technology solutions are driven by corporate needs, and thus are better coordinated and structured to meet organizational objectives.

19. We can track our decisions and our ability to successfully implement approved solutions. We routinely track budget, schedule, scope, and performance outcomes, and use this information to focus improvement efforts.

20. We are more clearly able to describe our desired outcomes and do so with internal and external Service Agreements.

21. We understand our corporate risk, have a common language to enhance dialogue about risk, and have a greater ability to manage risk.

22.

Project and Program Success Stories

1. **Sewer Grease Abatement Program Improvements**

   **Problem:**
   For the last several years grease has entered the City’s sewer pipe collection system in steadily increasing quantities. This has occurred primarily because enforcement of the City’s various grease-related ordinances has lapsed due to a shift of field personnel to other pressing needs within the utility. The result has been a sewer grease abatement strategy which is passive, reactive, and costly. The amount of grease-related sewer backups has increased as has the number of sewer mains scheduled for grease removal by field crews. There are approximately 200 sewer mains scheduled for physical grease removal by SPU
at least once every 24 months and some pipelines have grease buildup removed as often as once per month.

**New Solution:**
A business case was brought to the Asset Management Committee showing the potential financial benefit of increasing education and outreach to area restaurants concerning the disposal of fats, oils, and grease (FOG). Enforcing existing sewer codes, which restrict the amount of fats, oils, and grease which a user is allowed to dispose of into the City’s sewer system, was also integral to the business case. AMC approved the recommendation of the business case, which was to create a Grease Abatement Inspector position and become more proactive in SPU’s approach to FOG. It is anticipated that the addition of this position, which was filled in September 2005, will save considerable field crew time and significantly reduce the number of sewer backups related to grease.

2. **2005/2006 Wastewater Pump Station and Force Main CIP Prioritization**

**Problem:**
The wastewater pump station program at SPU did not have a formalized way to create and prioritize potential CIP projects.

**New Solution:**
A programmatic approach to optimizing ownership and operation of wastewater pump stations and force mains was presented to the AMC in September 2005. Both a short and long-term approach to assessing CIP needs was analyzed. The short-term approach included the use of risk models to calculate consequence and likelihood of failure scores for pump stations and pump station components. This scoring system led to a recommendation of specific risk reduction strategies involving near-term CIP improvements. Long-term CIP recommendations included acceptance of the concept of remaining useful life (RUL), which predicts the approximate replacement date of an asset based on its expected life. In this way, the prioritization process as presented in the business case included the expected CIP schedule for replacement of wastewater pump station components, to at least a planning level of accuracy, until the year 2075.

3. **Landsburg Flood Passage Project**

**Problem:**
There are flood passage deficiencies at SPU’s Landsburg Diversion Dam on the Cedar River. The deficiencies could result in damage or complete loss of the dam during a major flood event, and potentially threaten our ability to deliver two thirds of Seattle’s drinking water supply.

**New Solution:**
The solution involves implementing a project to reduce the risk of significant damage to the dam during a major flood event, prevent a prolonged loss in ability
to deliver two thirds of Seattle's drinking water, supply and improve worker safety. The original design option was to modify the spillway to accomplish the above goal, at a cost of $5.17 million. Under asset management rigor, a new option to modify the bay instead of the spillway was selected at a cost of $3.10 million. This will save ratepayers $2.07 million.

4. Elmore Trestle Sewer Main Project

Problem:
SPU operates a 30" sewer mainline to convey combined stormwater from 205 acres and wastewater from 1,000 homes. On its way to treatment, the line crosses a steep ravine on an elevated wooden trestle, passing above a wetland and small creek. The pipeline and trestle were constructed in 1925. The latest condition inspections of the pipeline and trestle found a high likelihood of catastrophic failure, posing a higher-than-normal risk of emergency repair costs, discontinuity of service to customers, environmental damage, and human health impacts.

New Solution:
After the inspection, but before the formation of the Asset Management Committee, a design was completed to replace the existing pipeline, abandoning the old route, extending, and re-routing the line in a paved street right-of-way. The construction project was included in SPU's Capital Improvement Plan at an estimated cost of $3 million. The Asset Management Committee asked for a Project Development Plan to evaluate options and present a business case for the project. The Project Development Plan showed that the full function of the existing pipeline could be maintained, and the abnormally high risk costs eliminated, at about 20% of the cost of the original design. By relining the main and rebuilding the trestle, many additional years of reliable, low risk service could be gained, while saving almost $2.5 million in life cycle costs to the ratepayers and community.

5. Sewer Pipe Risk Model Success Story

Problem:
Understanding the condition of our assets is desirable in order to manage risks and determine optimal maintenance and renewal strategies. Televised inspection is known in the industry to be an effective way to monitor the condition of sewer pipes, but unfortunately televised inspection of all sewer mains and storm drainage pipes is not a justifiable strategy due to resource and cost constraints. Prior to initiation of asset management at SPU, the sewer pipe inspection strategy consisted of videotape inspection of each of the over 46,000 pipe runs in the system, but this could only be done for each pipe about once every 30 years. This 30-year cycle time for inspection was recently seen as inadequate for two main reasons. Firstly, television inspections performed infrequently seldom find failures before they occur. Secondly, this practice
focused too few resources on the higher risk pipes which, when failure occurred, resulted in extremely expensive or even catastrophic triple bottom line costs.

**New Solution:**

In 2003, SPU began use of a Sewer Pipe Risk Model, wherein we attempted to understand those pipes with highest risk and direct inspection resources towards those pipes. SPU’s sewer pipe inspection program now consists of an initial CCTV videotape inspection of all pipes found to be high risk by the model. This set of pipes currently includes the highest 15% of pipes as sorted by risk cost. (We define risk cost as the product of consequence of failure times the likelihood of failure.) After this initial CCTV inspection a high risk pipe is either referred to the Wastewater CIP program for rehabilitation and/or replacement (if defects are found) or placed on a future CCTV review cycle of anywhere from 5 to 20 years (if no defects are found). This approach means that about 85% of the sewer and storm drainage pipes will not be routinely inspected. The resources that would have been expended on this activity have been redirected to more frequent inspection of the pipes more likely to cause catastrophic problems should they fail.

6. **Plastic Water Service Replacement Program**

**Problem:**

There are currently over 34,000 small plastic water services in SPU’s water system, installed between 1968 and 1984. Installation of plastic services was discontinued after 1984 because SPU – and the water industry as a whole – determined that this material was not lasting as long as was originally thought. Plastic services constitute only about 20% of the total small services in the system, but over 80% of small service failures are on this type of service. In addition, leaking plastic services cause more damage and are more costly to repair than metallic services due to the failure modes of plastic. Prior to asset management, the approach to management of these services was to repair them upon failure. The failure rate had been increasing each year and associated impact on customers was increasing as well.

**New Solution:**

In 2003, a pilot program was trialed to determine whether a proactive program to replace plastic services would be effective. Where blocks of plastic water services existed, these were targeted for programmatic replacement. Service replacements conducted in this manner could be managed in a true production mode which would reduce mobilization costs. In addition, it was thought that if these services were destined to fail in time anyways, it would be less impact on customers, roads and traffic flow, the environment, and other nearby assets, if the replacements were planned. In a second category, plastic services deemed to have high consequences of failure were also targeted for this pilot. These were larger services where reactive replacement costs would be high due to damages that would occur, requirements for off-hours work, traffic mitigation, etc. The pilot then compared the proactive replacement costs to past histories of reactive costs.
SPU is now using both “run to failure” and “proactive” replacement methods for its plastic water services dependent on triple bottom line costing decision making in attempts to get to the optimal economic life replacement of these assets.

7. **N/NE 80th Street Feeder Main Rehabilitation**

**Problem:**
From a 1994 Study on water feeder mains, this project was identified as a high priority pipe for rehabilitation due to the number and frequency of leaks from ongoing failures at the joints. The project proposed to slipline (insert smaller pipe into the existing one) approximately 9,000 linear feet of existing pipe on N/NE 80th Street at a cost of about $4 million.

**New Solution:**
Although the historical number of leaks on this pipeline was high (26), the frequency was actually fairly low (approx. 1 per year). The business case analyzed the continued cost of repairs – about $20,000 per year – versus the annualized cost of rehabilitation. The economics showed that it was far more cost effective to spend $20k per year on repairs than move forward with a $4M construction project. The analysis was conducted on a triple bottom line basis, wherein impacts to customers of the annual leak repair and the impact to customers of the rehabilitation project were taken into consideration. This is a case where the status quo option was recommended, where in the past, we may have replaced the asset before the optimal economic life was attained.

8. **Watershed Bridge Replacement Program**

**Problem:**
There are over 600 miles of roads and 36 bridges in the Cedar River Watershed. Many of the bridges are old, deteriorating log stringer bridges that were originally installed when logging occurred in the watershed. There has been an ongoing program since the early 1990s to replace these stringer bridges with new concrete bridges that use poured-in-place concrete footings and abutments. The watershed bridge program replaced one or two bridges each year at costs ranging from $700,000 per bridge and higher for longer bridges. Prior to asset management review in 2003, the bridge replacement program projections (for the replacement of 19 bridges over 11 years) totalled $11,054,800, (PNV = $7,801,605).

**New Solution:**
One of our asset management principles is to consider life cycle costs and benefits when considering alternative approaches to solving problems. When life cycle considerations were applied to the Watershed Bridge Replacement Program, and rigorous analysis was conducted on the pros and cons of alternative approaches, the Asset Management Committee (AMC) reached two primary outcomes. First was that an analysis was needed to thoroughly
understand the need for each bridge in the watershed. Do they all need replacing? The AMC directed staff to quantify the benefits of each bridge and the risks that would exist if those bridges and associated roads were put out of commission. Second, the AMC determined that it would be more cost effective to replace the needed bridges with steel structures rather than the more costly concrete.

After AMC approval to install steel bridges, the eleven year Cedar River Bridge replacement projections were reduced to $3,021,000, at a savings of $8,033,800 (PNV$5,500,000). For a 5 year replacement plan the PNV = $2,268,443. This was not re-calculated to reflect a longer-term plan, which would further reduce the PNV.

AMC was instrumental in allowing Watershed staff to use the more appropriate steel bridges installed on reinforced earth or binwall supports. To date, three steel bridges have been installed in the Cedar River Watershed, and one in the South Fork Tolt Watershed.

Future steel bridge project cost estimates have been rising but remain far below the costs for concrete bridges.