

KVID Infrastructure Update Project

Infrastructure Refurbishment Evaluation

Revision 1.3

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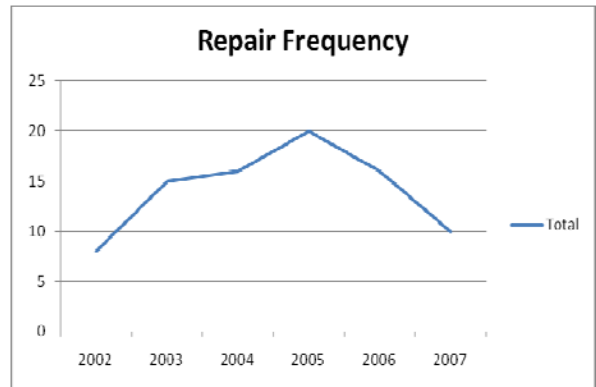
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Executive Summary

In July of 2007 KVID undertook a detailed evaluation of the Kachina Village potable water distribution system. Extensive geographic information systems (GIS) data was collected for all components within the infrastructure and documented in an ARCView GIS data base. Various analysis alternatives were evaluated and the maintenance and age history process was selected.

State of the Infrastructure

The evaluation indicated that imminent failure of the system is highly unlikely. It can only be noted that the repair frequency between 2002 and the end of 2007 peaked in 2005 and has decreased through today. The failure rate in 2007 is only slightly higher than the 2002 failure rate. This does not indicate a rising failure rate as illustrated by the bathtub curve explained in the Fourth Alternative Approach on page 9. In addition the Toho-Tolani paving project may have influenced the peak in 2005.



Alternative Solution Approaches

Five alternative solution approaches were identified. The first alternative (do nothing) may end up costing the residents a significant sum of money. The second alternative (Mass Replacement in FY '09 or FY '10) is the highest initial cost option and can only be implemented through debt or grant financing. The alternative three (Incremental Replacement) strategy appears to be workable both time wise and financially but would require continued fund raising or rate increases over the next twenty years. The fourth alternative (Continue Monitoring) is the best short term alternative but the risk of a do nothing approach may be unacceptable. Alternative five, a combination of alternative two and four, appears to be the best alternative and balance between risk and cost.

Recommended Approach

Alternative five continues to monitor the condition of the infrastructure but performs replacement as significant issues are identified. What differentiates this approach from alternative two is that KVID will earmark \$75,000 per year in the fund balance for future infrastructure replacement and will include these funds as operating expense in the years to follow. This fiscally responsible approach is currently being utilized by many utilities in the country. *However, it must be understood that alternative five will not ever accomplish total replacement of the Kachina Village infrastructure.*

The "Continue Monitoring" (fourth alternative) and replace as required would provide maximum flexibility and the minimum incremental cost increases over the next twenty years. Alternately, grant funding would be sought to be added to the supplement infrastructure replacement costs.

In the final analysis the cost of scheduled or mass infrastructure replacement, given the current county mandated backfill requirements, is financially not a viable solution and cost-benefit analysis strongly suggests the best approach is to undertake Alternative Five where funds are accumulated and infrastructure repairs are continued as has been done over the last forty years.

Funding Approach

The utility management intends to earmark funds for infrastructure replacement and continue to pursue grant funding rather than debt funding. We believe this would provide the best value for the residents of Kachina Village and the greatest system reliability.

Introduction

Several events have occurred over that past four years that have culminated in the development of the Infrastructure Refurbishment Plan. The first critical event occurred in September of 2004 (FY '05) when the new management team was installed. Financial analysis indicated the fund balance was insufficient to maintain financial solvency of KVID in the event of a catastrophic failure within the system. In addition the 2003 vulnerability assessment established that the highest value assets were the most vulnerable assets. The immediate response to this event was the development of a strategic plan to address these and other issues.

The second strategic approach was to increase the utilities revenues to match the cost of operations and capital improvements. A rate increase study was conducted, with the assistance of Brown and Caldwell, along with public hearings and meetings in 2005. The water/wastewater rates were increased with the intent of producing revenue sufficient to support operations and capital projects. In addition the rate increases were designed to increase the contingency fund to approximately \$500,000 over a period of five years.

At the beginning of 2005 the utility undertook the third strategic plan involving an aggressive energy savings program which resulted in savings equal to approximately five percent of the operations budget. The immediate tasks undertaken resulted in reduced electrical and sludge hauling costs by improving the sludge management process in the wastewater treatment plant. The combined savings of this process was in excess of \$50,000 per year.

As a result of the rate increase and the improved efficiencies after only two years the contingency fund is approaching \$400,000.

In the 2005-2006 timeframe the GASB-34 evaluation was performed. At start of the evaluation the assumption was that the KVID infrastructure was worth approximately four to five million dollars. The results of the GASB-34 evaluation indicated the infrastructure value was closer to fourteen (14) million dollars. This revelation led to the updating of the strategic plan to include review of the utilities insurance structure and replacement value of potentially vulnerable assets. At this juncture the utility team determined that supervisory control and data acquisition systems would be required to move forward with systems efficiency and capacity improvements.

In addition the state of the current piping infrastructure was called into question. In much of the village the piping infrastructure has been in place in excess of forty (40) years. The vast majority of the water infrastructure is composed of asbestos-cement (AC) piping. The useful life expectancy of AC pipe is generally accepted as fifty years. The physical inventory and evaluation of the infrastructure and development of a replacement and/or refurbishment plan was included in the FY '07 strategic planning document. Starting early in FY '08 data was collected, assembled, scrubbed and analyzed. This document describes the results of this infrastructure evaluation.

Infrastructure Evaluation

Development of the infrastructure evaluation and refurbishment plan involved the following steps:

- 1) A study of existing infrastructure evaluation methods was undertaken and the best practices were chosen using American Water Works Association (AWWA), American Public Works Association (APWA) and Water Environment Federation (WEF) best practices. From a number of methods the best suiting the needs of KVID was selected based upon available resources, dollars and time commitment.
- 2) Data collection and documentation of the infrastructure components was undertaken. Information on the following was documented; water and wastewater piping, valves and manholes, the condition of the components, the age of the components, the construction material of the components and the geographic location and relationship of the components.
- 3) The location of all infrastructure components (pipes, valves, fire hydrants, manholes, buildings, evaporation ponds, etc.) and the condition of these components were combined and loaded into a geographic information system (GIS) database along with aerial views, topological maps, parcel data, and boundary information.
- 4) The infrastructure condition evaluation was conducted based upon the following parameters:
 - Pipe construction material,
 - Bedding material and condition,
 - Number of main line repairs (2002 – 2007),
 - Number of service line repairs (2002 – 2007),
 - Number of valve replacements and repairs (2002 – 2007),
 - The social costs (inconvenience to the residents of the village and number of resident affected),
 - Pipe line specific issues, and
 - Age of the segment and the build phase in which it was constructed.
- 5) The data was aggregated along with the repair costs, the refurbishment costs and the water pipe runs were segmented into single project refurbishment lengths and prioritized.
- 6) The environmental engineering firm of Brown and Caldwell reviewed the work performed by the utility personnel. (Brown and Caldwell did review the work performed by the utility personnel on the 13th of February 2008 and made some minor recommendations. Overall they felt the work was well done and accomplished the purpose well.

Replacement/Update Alternatives

First Alternative Approach (Do Nothing)

Using the information described in the Infrastructure Evaluation (page 6) section of this document several strategies were evaluated. Figure 1 - Monitor & Replace as Needed illustrates the estimated replacement cost of the water piping infrastructure over the next twenty (20) years assuming no

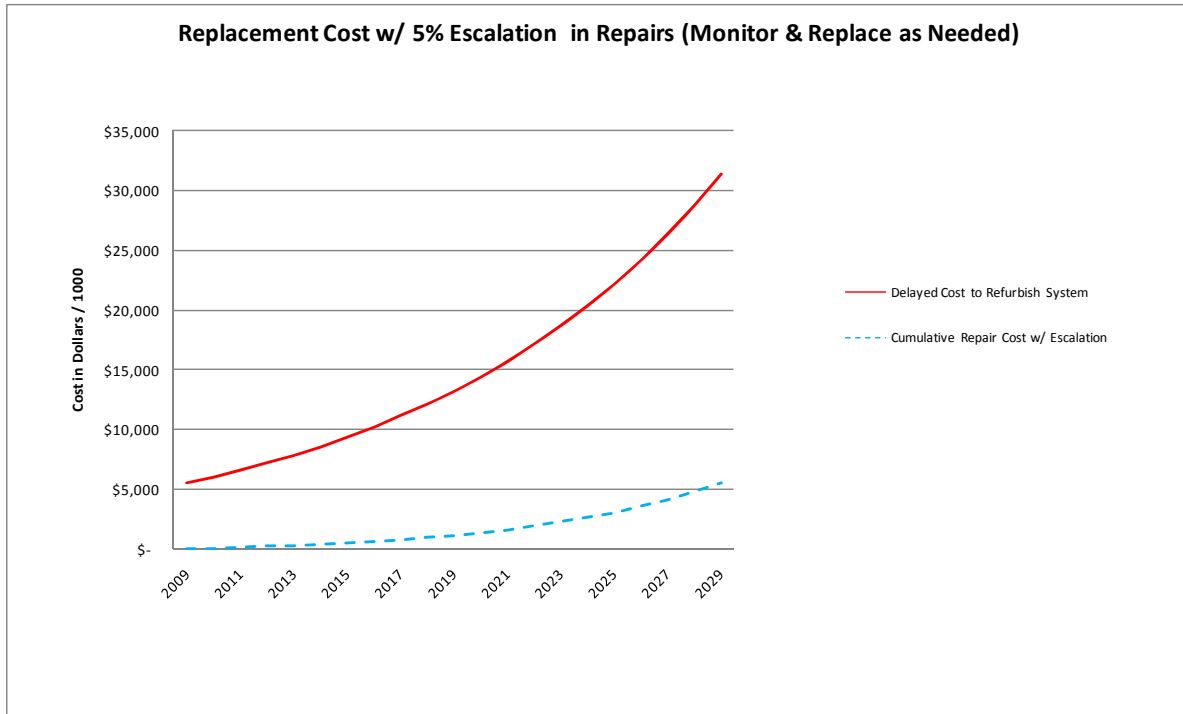


Figure 1 - Monitor & Replace as Needed

remedial action is taken. The dotted line represents the rising cost of repairs assuming the number of repairs increases by 5% per year and an annual escalation of horizontal construction/repair costs of 9%. As is evident by Figure 1 - Monitor & Replace as Needed, the cumulative cost of repairs in the year 2028 to 2029 time frame will be equal to the replacement cost in 2009.

Second Alternative Approach (Incremental Replacement)

Figure 2 - 20 Year Replacement Cycle illustrates the *cumulative* cost of annual incremental replacement of the infrastructure over a twenty (20) year period. It is estimate that over a twenty (20) year period the total cost of replacement of the identified infrastructure will amount to approximately eleven million dollars and the cumulative repairs costs will be minimized to approximately one million dollars over twenty (20) years.

Several other replacement scenarios were tested but the one illustrated in Figure 2 appears to be a good cost option given the labor and time constraints on the utility. This scenario assumes incremental \$200K to \$600K (a significant number of dollars) replacement projects are undertaken each year. The size of the project (pipe run length) is projected from the GIS “Water Rehab” layer which segments the water piping into project size lengths for replacement.

The down side of such an approach is the necessity of acquiring funding each year to pay for the projects

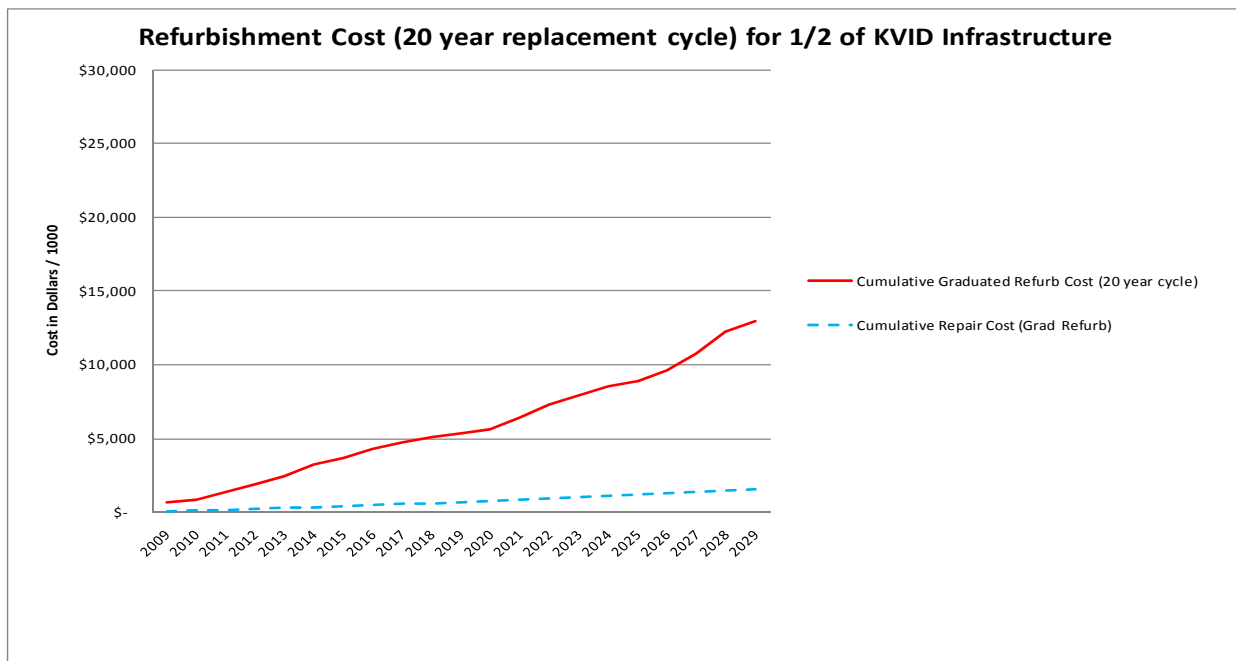


Figure 2 - 20 Year Replacement Cycle

and the continual year-after-year effort by the KVID employees to complete other capital projects and the infrastructure replacement project. The toll on employee morale can be significant when this kind of continuous effort is demanded.

Third Alternative Approach (Mass Replacement)

The least expensive long term approach is to secure funding for replacement of the necessary infrastructure in a single or possibly two year project. This alternative is predicated on the successful acquisition of grant or debt financing and is very costly. This approach would place a heavy burden on

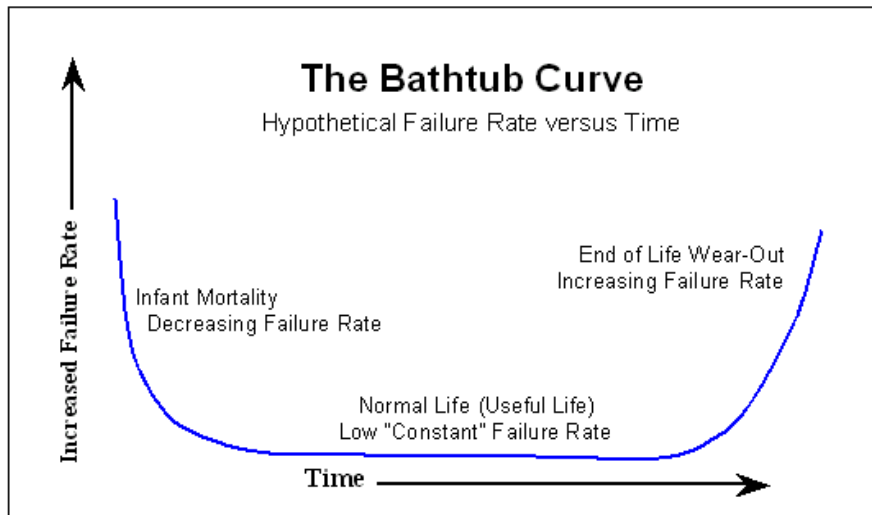
the KVID employees to manage and participate in the strategy and would produce a rather high social cost as a result.

The feasibility of such an alternative was not deemed acceptable and the financing costs of such an approach were not determined.

Fourth Alternative Approach (Continue Monitoring)

The projection of the repair costs is based upon a linear increase of problems of five percent per year. However, there is a relatively high probability that this does not reflect true reality. Dennis J. Wilkins, a retired Hewlett-Packard Senior Reliability Specialist states it well. "Reliability specialists often describe the lifetime of a population of products using a graphical representation called the bathtub curve. The bathtub curve consists of three periods: an infant mortality period with a decreasing failure rate followed by a normal life period (also known as "useful life") with a low, relatively constant failure rate and concluding with a wear-out period that exhibits an increasing failure rate." The graph (Weibull Distribution) demonstrates how infant mortality, normal life failures and wear-out modes combine to create the overall product failure distribution.

We can only project that the failure rate of the piping infrastructure may follow this curve but there is no way of knowing at what point on the curve we are now operating. The failure rate as illustrated in Figure 3 - Five Year Repair Frequency, indicates we are not at the knee of the bathtub curve.



The fourth alternative is to continue tracking failure rates over the following years and attempt to identify the elbow point on the right. At that time it would be advantageous to implement a replacement/refurbishment program.

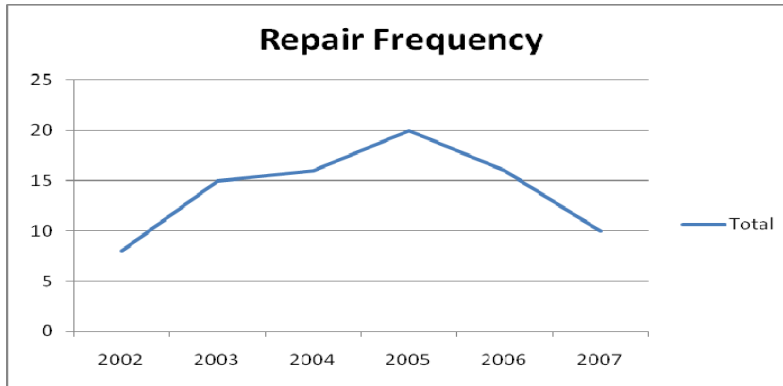


Figure 3 - Five Year Repair Frequency

Fifth Alternative Approach (Continue Monitoring w/ Replacement)

The recommended approach is a combination of the second and fourth alternative, that is to say the utility is to continue monitoring and attempt to identify the knee of the bathtub curve and to continue replacement of infrastructure over the next 20 years and beyond. To implement this alternative the utility will earmark \$75,000 per year for infrastructure replacement. As time progresses the utility will continue to monitor the system failures and replace infrastructure as is deemed necessary based upon current observations. It must be understood that Alternative Five will not ever accomplish total replacement of the Kachina Village infrastructure. Under the current cost structure and assuming the \$75,000 annual set aside it will take 144 years to replace half of the water infrastructure in the village.

There still exist three very serious problems with this alternative; very initial high replacement cost, excessive time to implement (as mentioned above) and very high lifecycle maintenance costs. At the present time the backfill requirements set down by the county require the use of two sack slurry. This significantly adds to the initial construction cost and increases the cost of replacement in excess of 100%. In addition when a problem, e.g., a water leak, does occur in the new infrastructure the time and effort required to perform the repair as a result of the monolithic slurry cover is significant compared to standard compaction practices.

Until such time as the back fill requirements become acceptable no mass replacement (lengths of 100 feet or more) will be undertaken and the funding shall be used to address high priority infrastructure issues not involving the placement of monolithic cement structures over the pipe lines in Kachina Village.

Analysis Details

ARCView GIS Database: The entire KVID infrastructure was documented utilizing the ESRI ARCMAP GIS data base application. The data included the wastewater mains, July 2007 wastewater main CCTV mpeg

files, manholes, water mains, water valves, street centerlines, hydrants, KVID buildings, village build phase information, geographic contours (elevations), reclaimed water mains, KVID parcel data, evaporation ponds and aerial photographic data.

The water main GIS data was documented in the ARCMAP system on the “Water Mains” layer and the valves were documented in the “Water Valves” layer. Two additional layers were created the “Water Rehab” and the “Water System Repairs.” The “Water Rehab” layer consists of the same data as the “Water Mains” layer with the following modifications. The piping lengths in the “Water Rehab” layer were segmented into project size lengths based upon several factors. The factors included consideration of the length of road closures, the physical constraints of access by construction crews and equipment, the labor impact on KVID employees and the social impact. The social impact is based upon the inconvenience caused to the residents and the number of residents impacted due to road closures, the traffic flow of the street segments involved, and the number of connections that could reasonably be expected to be shutdown simultaneously, and the inconvenience caused to the residents due to low flow or no flow conditions. The “Water System Repairs” layer documents the repair locations of main lines, service lines and water valves within the “Water Rehab” segments.

Analysis Spreadsheet: An analysis spreadsheet was created in the “Condition Assessment 011808” MS Excel 2007 workbook. Global variables were documented in the “Variable” work sheet. The repair data from the KVID work order system was loaded into the “Repair History” worksheet. The data loaded included work orders from 2002 through 2007 or the past five years of data.

In addition “Fuzzy Tables” were created to enable the use of fuzzy data calculations. Included were the materials type table, the bedding condition table, the social cost table, the service line repairs table, the main line repairs table the Refurbishment segment age table. The purpose of the fuzzy tables is to enable calculation of condition points based upon the various parameters described in each table. In addition there is a relative weight table that assigns a relative weight multiplier for each of the parameters.

The fuzzy table data was use to calculate the condition points assigned to each “Water Rehab” segment. A pivot table rating the condition of the segments can be found in the “Eval Table” worksheet. Additionally the estimated replacement cost per year is tabulated on this worksheet providing a refurbishment/replacement cost by year and an estimated repair cost by year. In addition the cumulative repair costs are calculated for 2009 through 2029.

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