Active vs. Passive Leak Detection Methods a Comparison

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PNWS AWWA
5/12/10 2:30 – 3:30pm

OBJECTIVES

1. Did you know?
2. Leak Detection - Current Mindset/Current Terms.
3. Theory of Leak Detection.
4. What Warrants Leak Detection?
5. Two Methods of Leak Detection.
6. Pros and Cons.
7. Case Study.
8. Key Conclusions.

DID YOU KNOW?

NATIONAL

- 225,000 public water systems.
- 30% are community serving 90% of the population.
- 980,000 miles of pipe (2003 AWWA Est.).
- $386 Billion replace cost (Distribution only).
- .27 main breaks/mile.
- 264,000 main breaks/year.
- 4,500 miles of line replaced/year.
- 25% CI & ST in poor condition.
- It takes 39,000 Gallons of H2o to make 1 car!

DID YOU KNOW?

NATIONAL

- AWWA estimates NRW nationwide is 30%.
- Of that, 50-75% can be recovered with leak detection.
- California Dept. of Water Resources estimates 81 billion gal/yr leaks in California alone.
- Leakage can be controlled for approximately $150/million gallons.
- A production cost of $.50/1000 would equate to $500/million gallons.

DID YOU KNOW?

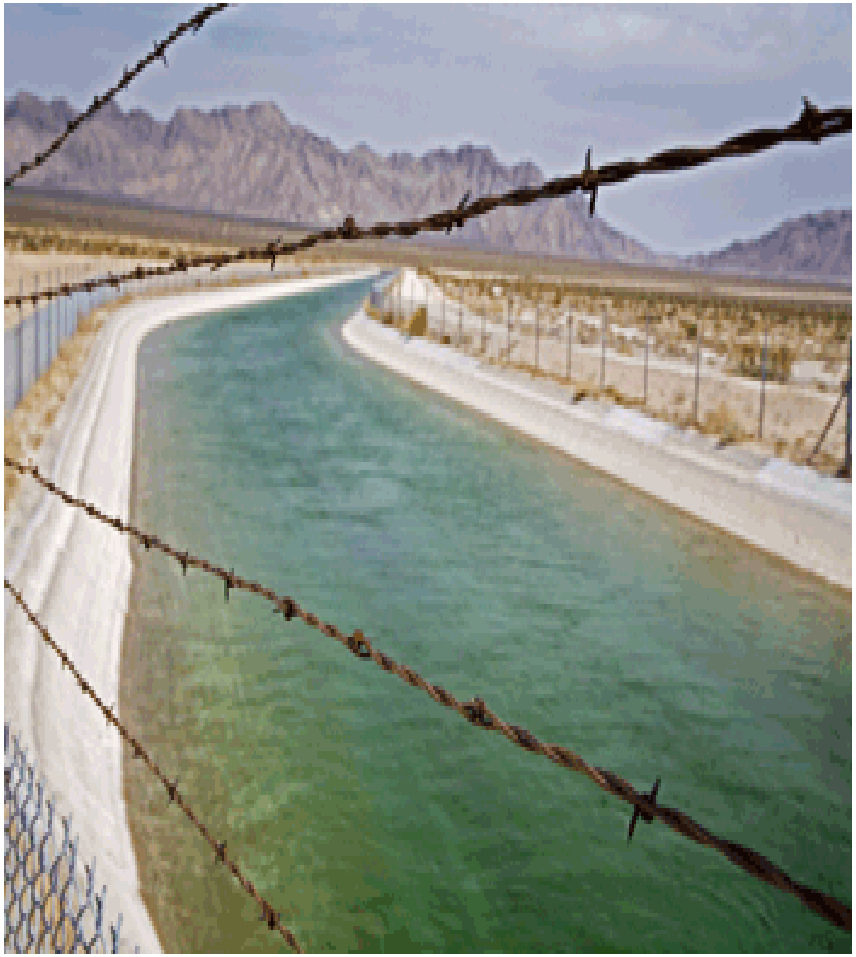
GLOBAL

- According to World Bank it is estimated that 33 Billion Cubic Meters (33 trillion gallons…yes, trillion) of treated water is lost annually at an estimated cost of 15 billion dollars per year. Enough water to fill 43,629,729 average size swimming pools!

- Actual percentages of loss in select utilities in developing countries can be as high as 70%.

CHANGING MINDSET - US

- As recently as early 1990's leak detection was considered a "luxury service".
- Drought in Southern US.
- Changing Laws concerning Water Loss Management.
- Several States have adapted IWA standards and have laws in place or in draft form.
- Southern States like California & Texas are taking the lead due to extreme water shortages.
- Utilities in Philadelphia, Orlando & Nashville and many more have active water loss programs in place.
- AWWA activities and involvement increasing (see next slide).



AWWA – WATER LOSS CONTROL INITIATIVES

- AWWA Water Loss Control Committee Adopts IWA Methodology in Aug. 2003.
- Committee issues a free Water Audit Software in 2005. Updated in 2009 (Built on MS Excel).
- M36 Manual of Best Practice to address new water loss control technologies issued in late 2008.
- Committee actively promoting new methods at conferences and to state and federal regulators.
- AWWA Research Foundation projects #2811 and #2928 completed for utilities to assist them with water loss control.

CURRENT TERMS

- DON'T US THE TERM "UNACCOUNTED FOR" ANYMORE!!!!
- AWWA WATER LOSS COMMITTEE STUDY FOUND THERE WERE SIMPLY TOO MANY MEANINGS AND VARIATIONS.
- MOST IF NOT ALL WATER CAN BE "ACCOUNTED FOR"

CURRENT TERMS

- Efficiency – Best use of resources to conserve water and recover revenue.
- Active Leakage Control – Proactive approach to control unknown leaks includes regular surveys.
- Passive Leakage Control – Policy where no systematic attempt to locate and repair unknown leaks is made. New technology allows for some forms of Passive Control.
- Apparent Losses – Customer losses including metering, accounting, theft, etc. Often called “paper losses”.
- Real Losses – Physical losses from system (up to customer consumption point). Leakage (usually the largest component of real losses).
- District Metered Area (DMA) – An “isolated” section of the water system which is closely monitored and analysis is used to differentiate usage and leakage (Real Losses) used for IWA Audit.
- Economic Level of Leakage (ELL) – Found by determining the level of Real Losses where the sum of the cost of real loss reduction and the cost impact is at a minimum.
- Bottom Up Water Audit Approach – Detailed investigation into loss components to describe the nature of the occurrence of loss and accurately quantify the loss volume and cost impact.
- Top Down Water Audit Approach – Compiling annual water balance from available data and records no matter how accurate and reliable they are.
- Water Balance – Summary of key water audit data showing management from source to customer. The sum of all columns equal and thus balancing.

LEAK DETECTION THEORY

No matter how good the equipment gets or what type of equipment is used, leak detection theory will always be the same…

- Leak Detection is based on acoustics.
- Water traveling through pipes does not make noise.
- Only when disturbed does noise occur:
- Pipe blockages, sudden changes in diameter, sudden change in direction, flow through pumps and meters, service draw, throttled valves, pipeline damage and leakage.
- The sound generated is transmitted through the pipe wall and surrounding soil structure and minimally through the water.

LEAK DETECTION THEORY

Sound transmission is based on these factors:

- Type of Pipe Material: Metallic is best, asbestos cement is good and plastic of any type is poor.
- Diameter of pipe: The larger diameter the pipe, the less distance the noise will travel and the leak will have a lower frequency component.
- System pressure: Higher pressure creates more energetic leak noise.
- Soil conditions: Sound travels best in rocky, sandy, volcanic condition, poorest in compact clay soils.

WHAT WARRANTS LEAK DETECTION?

- Provide exact location of known leaks (water surfacing, etc.).
- Unknown Leaks (telemetry indicates higher than normal usage).
- Water Audit (audit indicates high non-revenue water loss).
- Establish System Integrity especially on un-metered systems.
- Preventative Maintenance Tool.
- Increase Efficiency. Conserve Water.
- **State and Federally Mandated!**

TWO METHODS OF LEAK DETECTION

- Active and Passive
  - Active Leak Detection
  - Proactive approach to control unknown leaks.
  - Typically using a crew with an assortment of electronic devices.
  - Includes regular surveys.
  - Passive Leak Detection
  - Policy where no systematic attempt to locate and repair unknown leaks is made.
  - Leaks are addressed when they are known or reported. No active search for them is conducted.
  - Latest Passive Leak Detection Method is accomplished using Leak Noise Loggers.

ACTIVE LEAK DETECTION METHODS

- The Active Method allows for the user to listen for themselves if a leak is present.
- Requires good equipment and a trained technician.
- The majority of “in-house” Active Programs fail.
- Many qualified firms that offer Active Surveys.
  1. Multiple types of equipment.
  2. Experienced “Ears”.
  3. Be careful of “mom and pop” companies!

ACTIVE LEAK DETECTION METHODS

- Hydrant to Hydrant – 7-10 miles of line per day.
- Standard/Comprehensive Survey – 4-8 miles per day.
- Service to Service – 2-3 miles per day.
- Correlator Survey – 1-2 miles per day.

ACTIVE LEAK DETECTION CONSIDERATIONS

- Usually requires full time assistance of one utility employee with a consultant.
- Usually requires significant investment in equipment for a proper in-house program.
- Service companies average .01 - .08/ft based on a number of variables.

ACTIVE LEAK DETECTION EQUIPMENT

- Electronically-Amplified Leak Detectors
  - All have amplifier, sensor and headphones.
  - Much better sound quality and more sensitive.
  - Some have adjustable filters.
  - Vary greatly in performance and price.

Around $4,500.00

Around $1,350.00

Around $3,300.00

ACTIVE LEAK DETECTION EQUIPMENT

- Leak Noise Correlators
  - Most expensive technology.
  - Relatively few utilities have one.
  - Very accurate as long as pipe type, size and location are known.
  - Both digital and analog models available.

Around $20,000.00

Around $35,000.00

PASSIVE LEAK DETECTION METHODS

PASSIVE LEAK DETECTION METHODS

Meanwhile outside somewhere in the system…..

…This method is often called…Managing Failure!

PASSIVE LEAK DETECTION METHODS

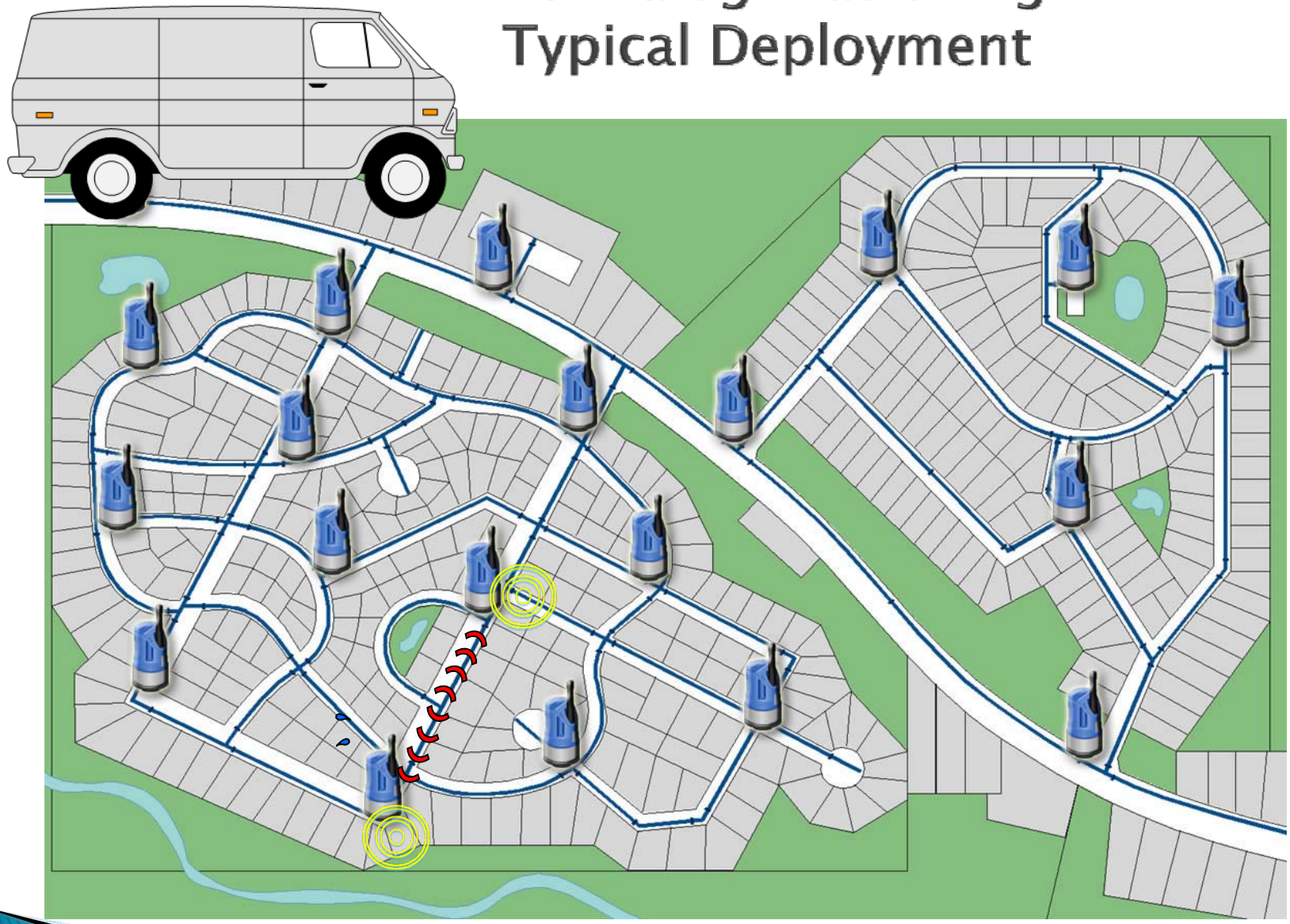
A new approach to Passive Surveys

- Noise Acoustic Data Loggers.
- Many types, based on similar technology.
- “Dumb Loggers” and “Smart” Loggers.
- Correlating Loggers (labor intensive).
- AMR.
- Used for permanent or “lift and shift” deployment.

PASSIVE LEAK DETECTION METHODS

- AMR Compatible Systems hear leaks only in close proximity. Nearby service draw might be recognized as a leak.
- Correlating Loggers are labor intensive (lift and shift). Not so Passive. Programmed to run at night.
- Dumb Loggers only respond to noise. Additional equipment needed to pinpoint.
- Loggers allow for surveys as time permits, therefore the “passive” tag.

Permalog® Patrolling – Typical Deployment



PASSIVE LEAK DETECTION CONSIDERATIONS

- Dedicated employees.
- Pipe type (plastic vs. metal).
- Conditions of pipes (new vs. old).
- Distance between valves (long vs. short)
- Condition of valves (sediment, water, throttled, buried).
- Security
- Theft

PASSIVE EQUIPMENT USED

- Data Loggers
  - Leak/No leak loggers.
  - Correlating loggers.
  - Both require large investments.

Around $10,000.00
for a set of 6-10

Usually require
additional equipment to
pinpoint the leak

Around $20,000.00
for a set of 8

Usually requires “lift
and shift”

ACTIVE LEAK DETECTION PROS AND CONS

Pros:

- Fewer dry holes.
- Easy Maintenance.
- Can do with minimal equipment.
- Cost outlay for utility is small when using a company.
- Can break survey into yearly and rotate through the system.

Cons:

- Survey can take longer.
- Requires dedication (if in-house program is done).
- Tying up personnel to assist or do in-house.
- Equipment can be expensive for in-house programs.
- Turn over for in-house programs (update training for new users).

PASSIVE LEAK DETECTION PROS AND CONS

Pros:

- Minimal amount of labor to deploy.
- Can cover same area as Active Method more quickly.
- Does not take extensive training to deploy.
- Computer assisted.
- Alarm mode.

Cons:

- Can be very expensive particularly for whole system coverage or AMR system.
- Limitations (valve distances, pipe type and false leak noises).
- Maintenance (corrosion, battery failure and theft.
- Transmission from valve boxes generally poor.

CONJUNCTIVE USE OF BOTH METHODS

- The two methods can be used together and depending on what type of loggers (dumb loggers) must be.
- Unless used together, is one method better than the other? You decide!

CASE STUDY NO. 1

Albuquerque, NM 2006/2007

1. Study funded and managed by New Mexico Environmental Finance Center (as a 3rd party) for the Albuquerque Bernalillo County Water Authority.
2. Passive Field work completed by Fluid Conservation Systems (FCS). Active Field work completed by Hughes Utility Services.
3. Objective was to compare Active vs. Passive in the same sections of the system.
4. 4 Grid Zones were tested.
5. Some control questions (hydrant leaks were inadvertently repaired by crews).
6. Active method produced 25 confirmed leaks.
7. Passive methods produced 3 confirmed leaks.

SCOPE
CASE STUDY NO. 1

Table 2-1, Grid Zone Pipe Type Properties

Zone	Miles of Pipe	Pipe Material and percentages	Pipe Size Range	Pressure Variation	Contact Points
E-11	22.6	45% CI/DI 14% AC/CCYL 41% PVC	2.5" to 20"	30 to 115 PSI	Contact points (valves, hydrants, and services) are within 300 feet in most cases
K-11	25.7	64% CI/DI 8% AC/CCYL 7% STL/GSP 21% PVC	1.25" to 36"	30 to 115 PSI	Contact points (valves, hydrants, and services) are within 300 feet in most cases
G-18	23.5	98% CI/DI 2% PVC	4" to 18"	30 to 115 PSI	Contact points (valves, hydrants, and services) are within 300 feet in most cases
J-22	25.5	76% CI/DI 13% AC/CCYL 10% PVC	2" to 30"	30 to 115 PSI	Contact points (valves, hydrants, and services) are within 300 feet in most cases
Pipe Types: **CI/DI** – Cast Iron, and Ductile Iron; **AC/CCYL** – Asbestos Cement, and Concrete Cylinder; **STL/GSP** – Steel and Galvanized pipe; **PVC** – Polyvinyl Chloride pipe					

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

FCS SURVEY RESULTS

Table 3-1: Summary of the FCS Leak Detection Results, 2006

Type of Leak Recorded	Number of Leaks per Type	Percentage of Total Leaks Recorded
Main Water Line	6	46.2%
Fire Hydrant	2	15.4%
Valve	0	0%
Service Water Line	3	23.0%
Service Connection	0	0%
Meter	2	15.4%
Total	**13**	**100%**

Source: FCS data was obtained from the Permalog® Summary Report, Leak Detection Log, 2006.

HUGHES SURVEY RESULTS

Table 3-2: Summary of the Hughes Leak Detection Results, 2006

Type of Leak Recorded	Number of Leaks per Type	Percentage of Total Leaks Recorded
Main Water Line	5	12.2%
Fire Hydrant	15	36.6%
Valve	0	0%
Service Water Line	5	12.2%
Service Connection	3	7.3%
Meter	13	31.7%
Total	**41**	**100%**

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

SURVEY SUMMARY OF RESULTS

Table 3-3: Summary of the Leak Detection Surveys By Grid Zones, 2006

Grid Zones	E-11		G-18		J-22		K-11		Total	
	FCS	Hughes	FCS	Hughes	FCS	Hughes	FCS	Hughes	FCS	Hughes
Main Line	0	2	1	0	0	3	5	0	6	5
FH Leak	0	0	1	5	0	7	1	3	2	15
Service Line	0	5	1	0	0	0	2	0	3	5
Service Conn.	0	1	0	0	0	2	0	0	0	3
Meter Leak	0	4	1	3	1	6	0	0	2	13
Valve Leak	0	0	0	0	0	0	0	0	0	0
Total	0	12	4	8	1	18	8	3	**13**	**41**

Source: FCS data was obtained from the Permalog® Summary Report, Leak Detection Log, 2006. Hughes data was obtained from the Leak Detection and Repair Project Final Report, 2006.

PINPOINTING SUMMARY RESULTS

Table 3-4: Summary of the Field Verified Leaks Identified by FCS and Hughes

Grid Zones	E-11		G-18		J-22		K-11		Total	
	FCS	Hughes	FCS	Hughes	FCS	Hughes	FCS	Hughes	FCS	Hughes
Main Line	0	0	0	0	0	3	0	0	0	3
FH Leak	0	0	0	2	0	2	0	0	0	4
Service Line	0	4	0	0	0	1	1	0	1	5
Service Conn.	0	0	0	0	0	2	0	0	0	2
Meter Leak	0	4	0	1	1	3	0	0	1	8
Valve Leak	0	0	1	2	0	0	0	1	1	3
Total	0	8	1	5	1	11	1	1	3	25

Source: Maximo Database, 2006; FCS data was obtained from the Permalog® Summary Report, Leak Detection Log, 2006; the Hughes data was obtained from the Leak Detection and Repair Project Final Report, 2006.

FCS COMP. OF SURVEY AND PINPOINTING RESULTS

Table 3-5: Comparison of the FCS Suspected Leaks and the Field Investigation

Grid Zones	FCS		Description of the Changes to Leak Types
	Suspected	Field Verified	
Main Line	6	0	All of main leaks detected by FCS turned out to be "no leaks." Five of the six leaks were in reference to WO#267377.
FH Leak	2	0	One of the fire hydrant leaks was a "no leak;" however the other turned out to be a main valve leak as indicated below.
Service Line	3	1	Only one of the three service line leaks detected was determined to be a leak.
Service Conn.	0	0	No service connection leaks were detected during the survey.
Meter Leak	2	1	Only one of the two meter leaks detected was an actual leak.
Valve Leak	0	1	Initially, no valve leaks were detected. However, one of the detected fire hydrant leaks turned out to be a valve leak.
Total	13	3	The greatest loss in FCS detection results was in main line leaks. In particular, WO#267377. There was a 77 percent reduction in the number of leaks detected using the passive method following the field investigation.

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

HUGHES COMP. OF SURVEY AND PINPOINTING RESULTS

Table 3-6: Comparison of the Hughes Suspected Leaks and the Field Investigation

Grid Zones	Hughes		Description of the Changes to Leak Types
	Suspected	Field Verified	
Main Line	5	3	The two main leaks detected in grid zone E-11 turned out for be "no leaks" following the field investigation. The three detected in grid zone J-22 were confirmed.
FH Leak	15	4	The majority of fire hydrant leaks were initially detected in grid zones G-18, J-22 and K-11. However, after the field investigations nine were "no leaks," one was a meter leak, and one was a fire hydrant left running.
Service Line	5	5	The number of service line leaks held after the field investigations. Only one was a "no leak," but another was found as a result of a reclassified main line leak.
Service Conn.	3	2	Two service connection leaks were found to be "no leak," but an additional one was found from a reclassified meter leak.
Meter Leak	13	8	Five meter leaks were determined to be "no leak" after field investigation. Seven of the 13 meter leaks were meter leaks. One meter leak was a service connection (as discussed above), but one fire hydrant mentioned earlier was found to be a meter leak.
Valve Leak	0	3	The three valve leaks here were a result of reclassified fire hydrant leaks.
Total	41	25	The greatest loss in the Hughes detection results was in fire hydrant leaks. Overall, there as was a 41 percent reduction from the number of leaks detected using the active method to the field verified number of leaks.

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

COMPARISON OF SURVEY AND PINPOINTING TIMES BETWEEN FCS AND HUGHES

Table 4.1: Summary of Pinpointing and Patrolling Times to Complete the Surveys

Grid Zones	FCS (hours)			Hughes (hours)		
	Pin-pointing	Patrolling	Ratio	Pin-pointing	Patrolling	Ratio
E-11	0.25	2.33	0.11	8.00	35.50	0.23
G-18	1.92	3.87	0.50	3.58	20.00	0.18
J-22	1.17	2.58	0.45	7.42	16.00	0.46
K-11	2.20	2.42	0.91	1.00	30.00	0.03
Total	5.54	11.20	0.49	20.00	101.50	0.20

Source: FCS data was obtained from the Permalog® Summary Report, Leak Detection Log, 2006. Hughes data was obtained from the Leak Detection and Repair Project Final Report, 2006.

SUMMARY OF SURVEYING TO PINPOINTING RATIO

Table 4.2: Summary of Patrolling to Pinpointing Ratio and Number of Suspected Leaks Reported.

Grid Zones	Miles of Pipe	FCS		Hughes	
		Survey Ratio	Suspected Number of Leaks	Survey Ratio	Suspected Number of Leaks
E-11	22.6	0.11	0	0.23	12
G-18	25.7	0.50	3	0.18	3
J-22	23.5	0.45	0	0.46	11
K-11	25.5	0.91	8	0.03	0
Total			11		26

Fire hydrants were excluded in this table.

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

SUMMARY OF SURVEYING/PINPOINTING TO ACTUAL LEAKS PINPOINTED

Table 4.3: Summary of Patrolling to Pinpointing Ratio and Number of Actual Leaks Found.

Grid Zones	Miles of Pipe	FCS		Hughes	
		Survey Ratio	Actual Number of Leaks	Survey Ratio	Actual Number of Leaks
E-11	22.6	0.11	0	0.23	8
G-18	25.7	0.50	1	0.18	3
J-22	23.5	0.45	1	0.46	9
K-11	25.5	0.91	1	0.03	1
Total			3		21

Fire hydrants were excluded in this table.

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

COMPARISON OF COST PER SECTION SURVEYED

Table 4.4: Summary of Cost Per Grid Zones for Each Method.

Grid Zones	Miles of Pipe	FCS		Hughes	
		Cost/grid zone[1]	Patrol Time (hours)	Cost/grid zone[2]	Patrol Time (hours)
E-11	22.6	$7,386.78	2.33	$6,922.25	35.50
G-18	25.7	$7,386.78	3.87	$5,160.06	20.00
J-22	23.5	$7,386.78	2.58	$7,166.92	16.00
K-11	25.5	$7,386.78	2.42	$7,901.07	30.00

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

COST TO REDUCE WATER TO THE LOWEST LEVEL USING BOTH METHODS

Table 6.1 Present Worth Analysis – Reduce Water Loss to Lowest Level Possible

Present Worth Analysis	Accessories	Permalogs	Authority Labor for Passive Survey	Active Survey 50% system, once per year	Authority Labor for Active Survey	Total
15 Year Total	$108,386	$11,376,590	$1,879,003	$2,466,863	$20,132	$15,850,974
Miles of Pipe	162,273	162,273	162,273	18,750	18,750	N/A
Cost per Mile	$0.67	$70.11	$11.58	$131.57	$1.07	$215.00

*See Appendix D for detailed Present Worth Analysis

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

PASSIVE COST FOR CRITICAL AND LEAK PRONE AREAS

Table 6.2 Present Worth Analysis – Use Leak Detection on Critical Infrastructure

Present Worth Analysis	Accessories	Permalogs	Authority Labor for Passive Survey	Total
15 Year Total	$26,443	$743,909	$482,489	$1,252,841
Miles of Pipe	45,000	45,000	45,000	45,000
Cost per Mile	$0.59	$16.53	$10.72	$27.84

*See Appendix D for detailed Present Worth Analysis

Table 6.3 Present Worth Analysis – Use Leak Detection on Critical Most Leak Prone Portions of the System

Present Worth Analysis	Accessories	Permalogs	Authority Labor for Passive Survey	Total
15 Year Total	$26,443	$743,909	$482,489	$1,252,841
Miles of Pipe	45,000	45,000	45,000	45,000
Cost per Mile	$0.59	$16.53	$10.72	$27.84

*See Appendix D for detailed Present Worth Analysis

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

COMPARISON OF COST TO DETERMINE TROUBLED AREAS

Table 6.4 Present Worth Analysis – Use Leak Detection as a Screening Tool for Determining Troubled Areas

Present Worth Analysis	Accessories	Permalogs	Authority Labor for Passive Survey	Active Survey 10% system, once per year	Authority Labor for Active Survey	Total
15 Year Total	$26,443	$743,909	$1,051,519	$493,373	$4,026	$2,319,240
Miles of Pipe	58,636	58,636	58,636	3,750	3,750	N/A
Cost per Mile	$0.45	$12.69	$17.93	$131.57	$1.07	$163.71

*See Appendix D for detailed Present Worth Analysis

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

ANALYSIS OF PASSIVE TO REDUCE LOSS DURING SUMMER AND ACTIVE TO DETERMINE PIPE REPLACEMENT

Table 6.5 Present Worth Analysis – Use Leak Detection to Reduce Summer Peak for Repairs

Present Worth Analysis	Accessories	Permalogs	Authority Labor for Passive Survey	Total
15 Year Total	$26,443	$743,909	$1,051,519	$1,821,871
Miles of Pipe	58,636	58,636	58,636	58,636
Cost per Mile	$0.45	$12.69	$17.93	$31.07

*See Appendix D for detailed Present Worth Analysis

Table 6.6 Present Worth Analysis – Use Leak Detection to Help Determine Replacement Priority in a Given Area

Present Worth Analysis	Active Survey – 10% of System, Once Per Year	Authority Labor for Active Survey	Total
15 Year Total	$493,373	$4,026	$497,399
Miles of Pipe	3,750	3,750	3,750
Cost per Mile	$131.57	$1.07	$132.64

*See Appendix D for detailed Present Worth Analysis

Source: Phase III Report Head to Head Evaluation Active versus Passive Leak Detection Methods

KEY CONCLUSIONS

1. There is not one size fits all solutions to leak detection.
2. Active vs. Passive can have dramatic result differences and costs.
3. Know your limitations based on system characteristics (pipe type, valve spacing, & access points.
4. Have resources available to address suspected leaks (repair crews and materials).
5. The benefits of leak detection (real loss reduction) are only realized if the leaks found can be repaired in a timely manner.
6. All “leaks” are suspected leaks until they are excavated and verified.

QUESTIONS

RESOURCES

- AWWA M36 – Water Audits and Loss Control Programs
- Fluid Conservations Systems
- Gutermann Leak Detection, LTD
- Sewerin Leak Detection Technologies
- SubSurface Leak Detection
- Pollard Water
- Hughes
- International Water Association

NEW MEXICO ENVIRONMENTAL FINANCE CENTER

Albuquerque Bernalillo County Water Utility Authority

THANK YOU!!!

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