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The Link between Water Loss and Energy Consumption – Southern California EDISON's Embedded Energy in Water Pilot

WaterSmart 2010
Las Vegas, NV

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- Background on water supply in California
- What do we know so far about nexus between water supply and energy consumption
- Estimating water loss on a state-wide level
- Components of the Water Loss/Energy Study
- Results of Water Loss/Energy Study
- Roadmap for SCE Water Loss/Energy reduction program

Water-Energy Pilot-
Evaluation, Measurement & Verification Plan of PG&E, SCE, SDG&P

- Determine if water efficiency programs can create sufficient embedded energy savings to warrant inclusion in energy efficiency program portfolios

- Determine if partnerships of energy utilities and water agencies can increase the opportunities for reducing water use and its embedded energy.

Water Supply In California

- Major sources of water in CA:
  - State Water Project
  - Central Valley Project
  - Colorado River Aqueduct
  - Plus smaller conveyance systems
    - Hetch Hetchy Regional Water System (Bay Area)
    - LA-Aqueduct
    - Mokelumne Aqueduct
    - the All-American Canal and the Coachella Canal
  - Plus ground water

Combined delivery of ~43MAF of which 34MAF for agricultural use.

Water Supply In California

State Water Project:

- 700 miles of canals and pipes
- Lift water nearly 2,000 feet up and over the Tehachapi Mountains through 10 miles of tunnels
- Net energy consumer
- Single largest energy user in CA (consumes 2-3% of all electricity consumed in CA)
- Consumes ~5,000GWH/year

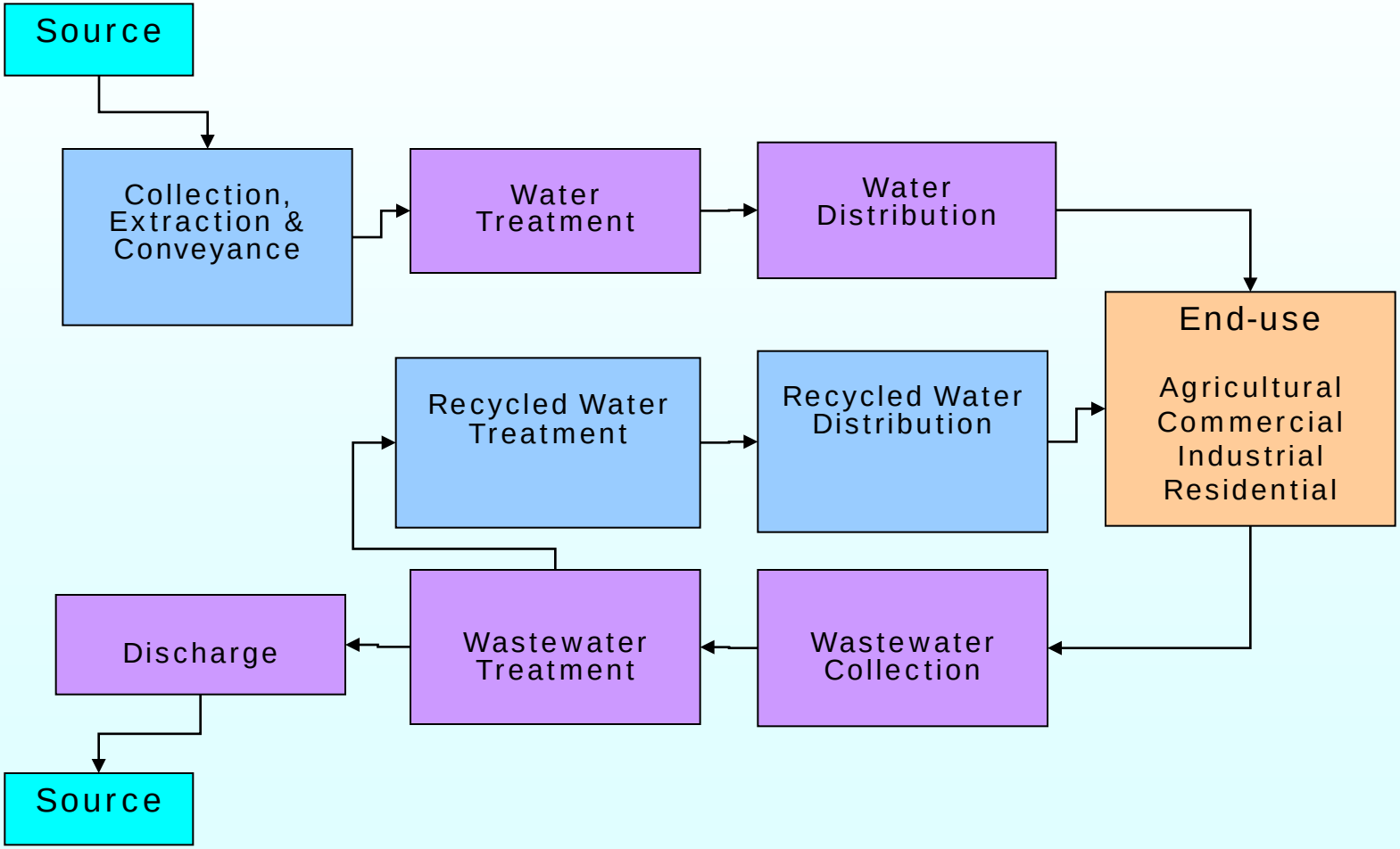
What Do We Know About Water-Energy Nexus

- ~19% (52,000 GWH) of CA energy demand for water related electrical consumption.

- Steps of Water-use Cycle
  - Water Supply and Conveyance
  - Water Treatment
  - Water Distribution
  - End Use
  - Waste Water Treatment

What Do We Know About Water-Energy Nexus

Typical Water Cycle:



Source: Robert Wilkinson, PhD; Dir. of Water Policy Program, UCSB

What Do We Know About Water-Energy Nexus

Energy Intensity/Embedded Energy Break Down

Total Embedded Energy	52,000 GWH	100%
Water Purveyor Energy Use	20,000 GWH	38%
Water Related Energy Use on Customer Side	32,000 GWH	62%

Energy Intensity: Amount of Energy required to use one unit of water in a specific location.

Water Leak Detection Program and Water System Loss Control Study

- Primary Research
  - Three participating water utilities
  - Size ranges between 10,000 and 30,000 service connections
  - Detailed Top-Down Water Audit
  - Bottom-Up DMA measurements
  - Leak detection and repair & pressure management
  - ELL analysis
  - Quantification of savings and conversion into embedded energy
  - Cost benefit analysis

Water Leak Detection Program and Water System Loss Control Study

- Secondary Research
  - Literature review
  - Estimation of state-wide water loss volume
  - Water Loss Control Best Management Practice document

Estimating Water Loss on a State-wide Level

- Water Audit data set of 32 water utilities (6 audits from WSO and 26 from CUWCC)
- Filter ILI<1.5 (11 utilities report ILI below 1)
- Final data set 17 water utilities

Water Loss Characteristics	Average	Min	Max	Units
Infrastructure Leakage Index	3.2	1.6	6.6	[ILI]
Real Losses	63	28	119	gal/service con/day
Real Losses as % of Volume Supplied	9	4	22	%

Estimating Water Loss on a State-wide Level

CA - Annual Urban Water Supply	**8.7 MAF/year**	**2,834,907 Mgall/year**
10% Real Losses	**0.87 MAF/year**	**283,491 Mgall/year**
40% of RL Economically Recoverable	**0.35 MAF/year**	**113,396 Mgall/year**

Enough to provide water for 2 million people with an average daily consumption of 154 gallons per person per day

2020 goal is statewide water demand reduction of 1.76MAF

Estimating Water Loss on a State-wide Level

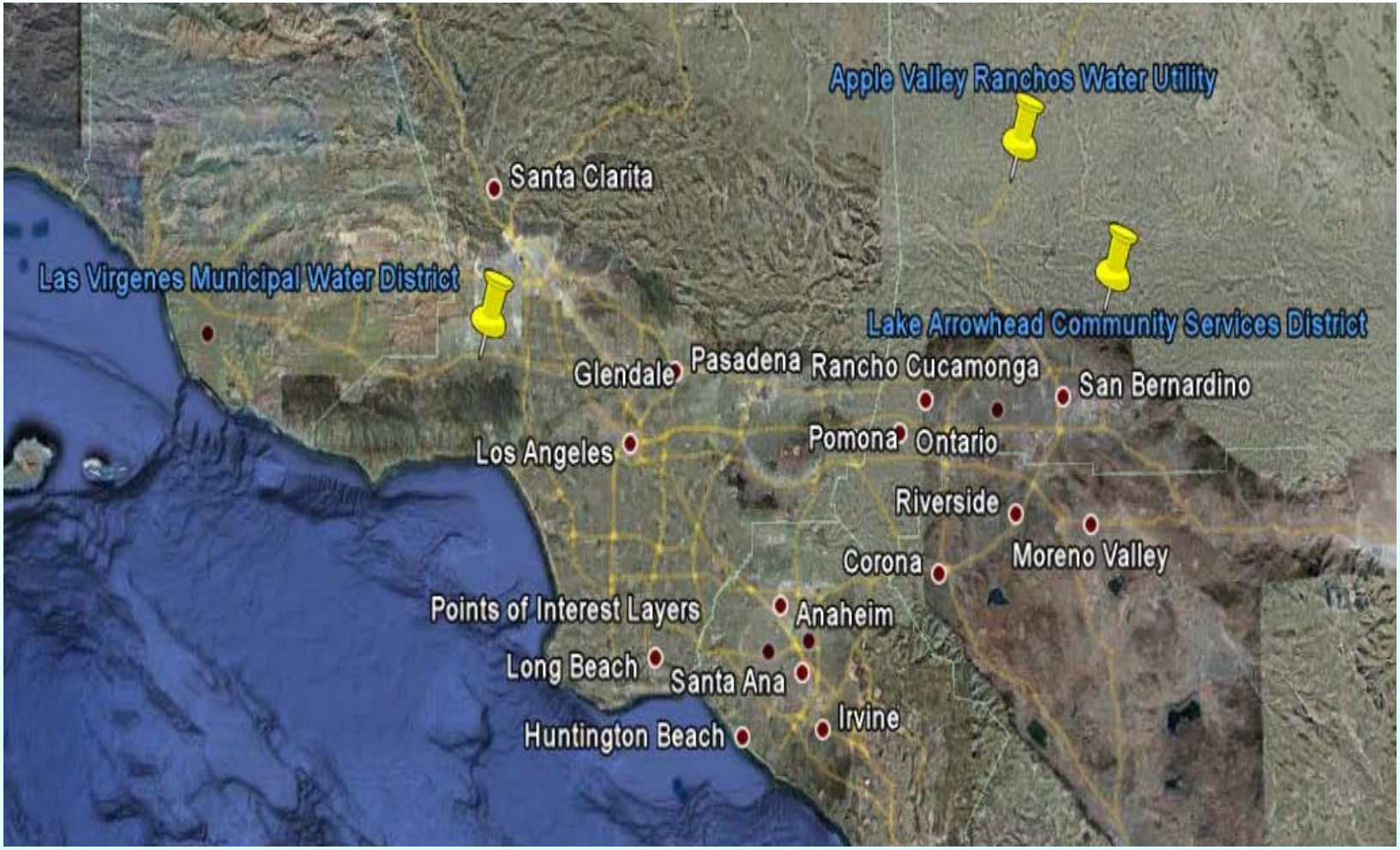
	Northern CA	Southern CA
Water Energy Proxies for Indoor Use		
Water Supply and Conveyance [kWh/MG]	2,117	9,727
Water Treatment [kWh/MG]	111	111
Water Distribution [kWh/MG]	1,272	1,272
Total Energy [kWh/MG]	**3,500**	**11,110**
	KWh/year	**KWh/year**
Embedded Energy in total Real Loss Volumes in North CA and South CA	275,615,976	2,274,698,022
Embedded Energy in recoverable Real Loss Volumes (40%) in North CA and South CA	110,246,390	909,879,209

- 30% of CA urban water demand in Northern CA and 70% in Southern CA

- Estimated energy savings in the range of 1,020,125,599 KWh/year (about 26% of the 2008 California electricity system power generated by coal power plants)

Water Leak Detection Program and Water System Loss Control Study

Primary Research



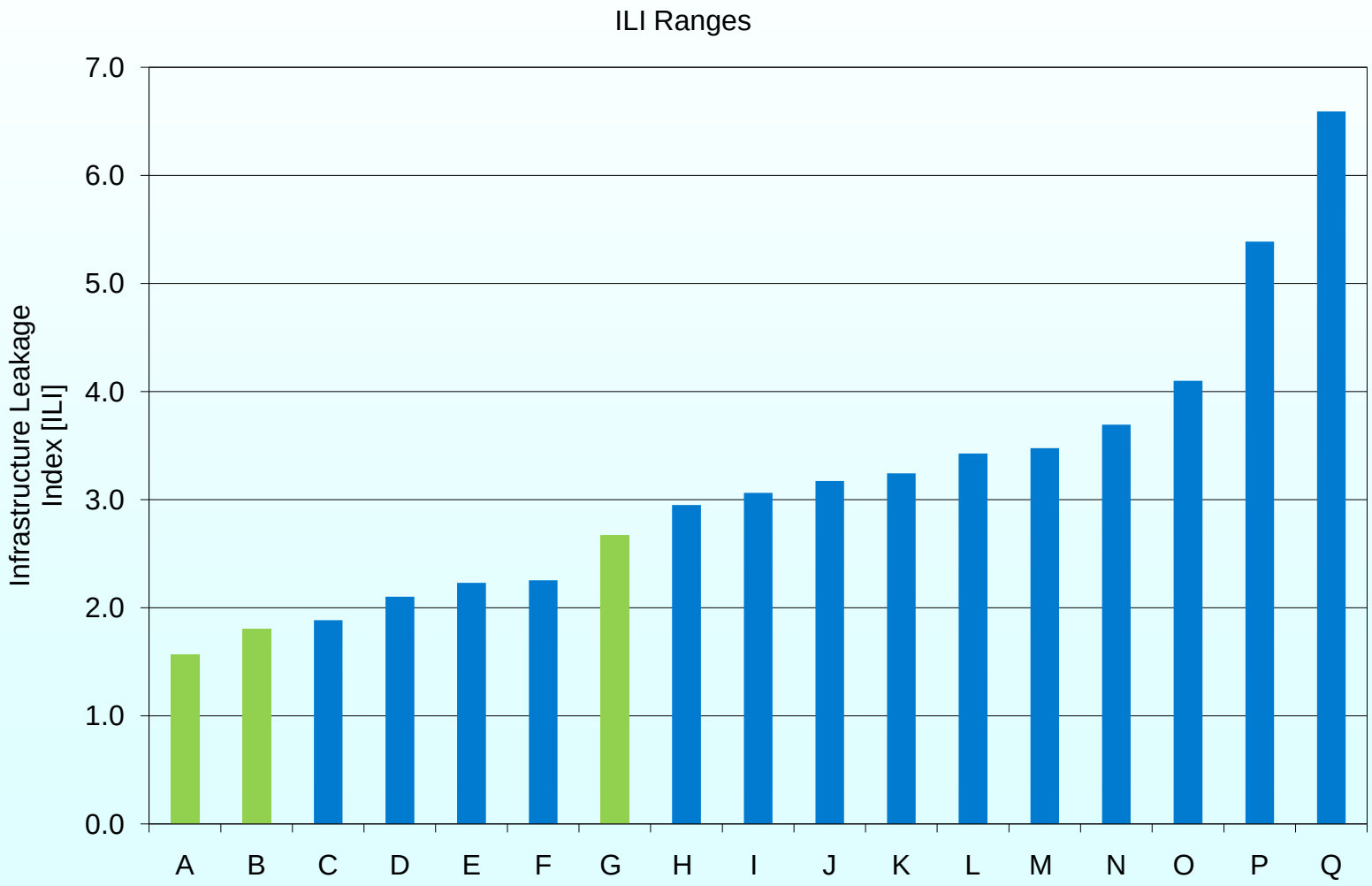
Water Leak Detection Program and Water System Loss Control Study

Primary Research – Water Audit Results

Utility	LVMWD	AVRWC	LACSD
Size	21,000	26,000	8,000
Real Losses [%SIV]	4	6	22
Real Losses [gal/serv con/day]	46	37	56
Infrastructure Leakage Index (ILI)	1.8	1.6	2.7
Apparent Losses [gal/serv con/day]	1	10	2

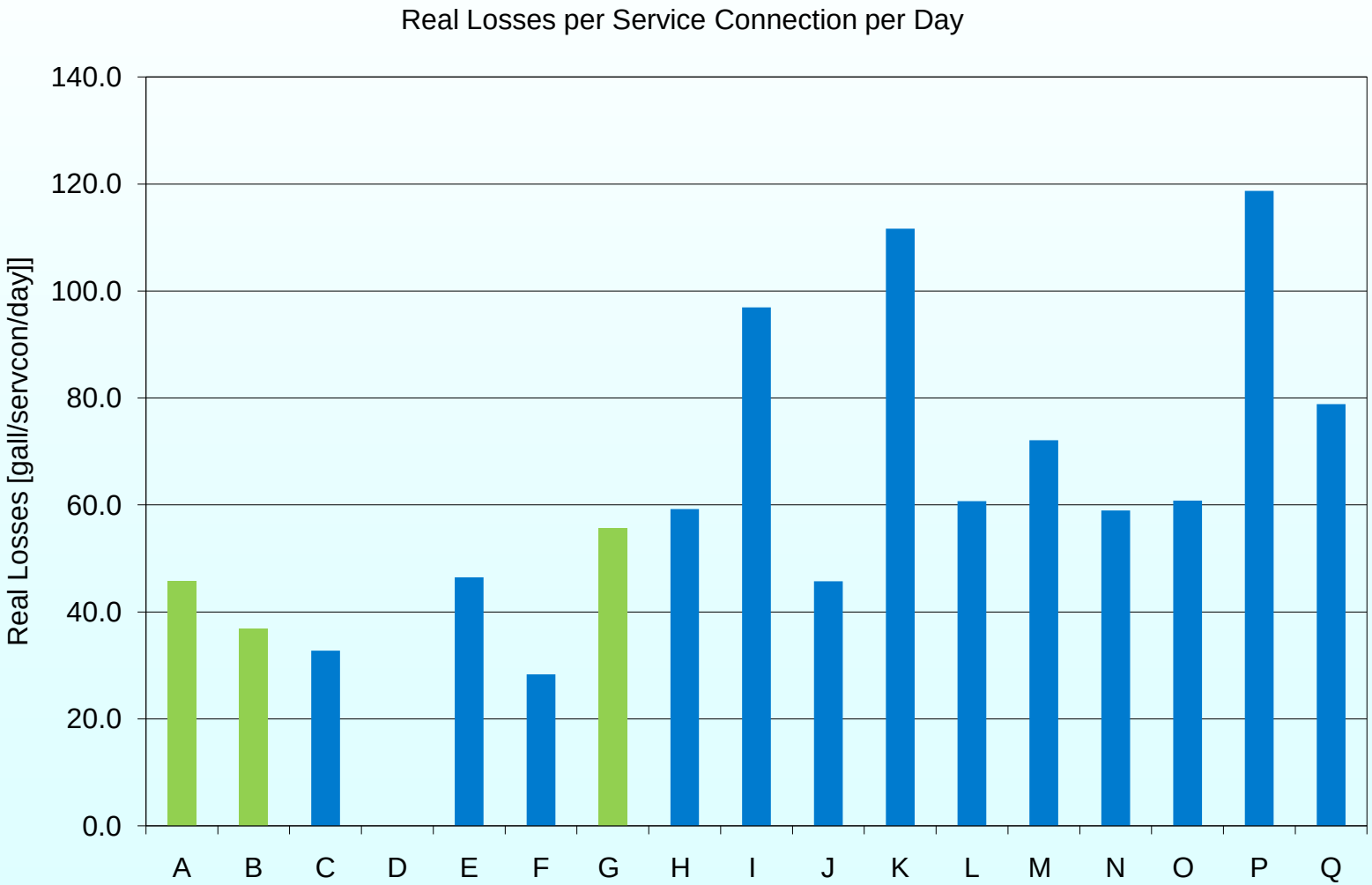
Water Leak Detection Program and Water System Loss Control Study

Performance Indicator– Infrastructure Leakage Index



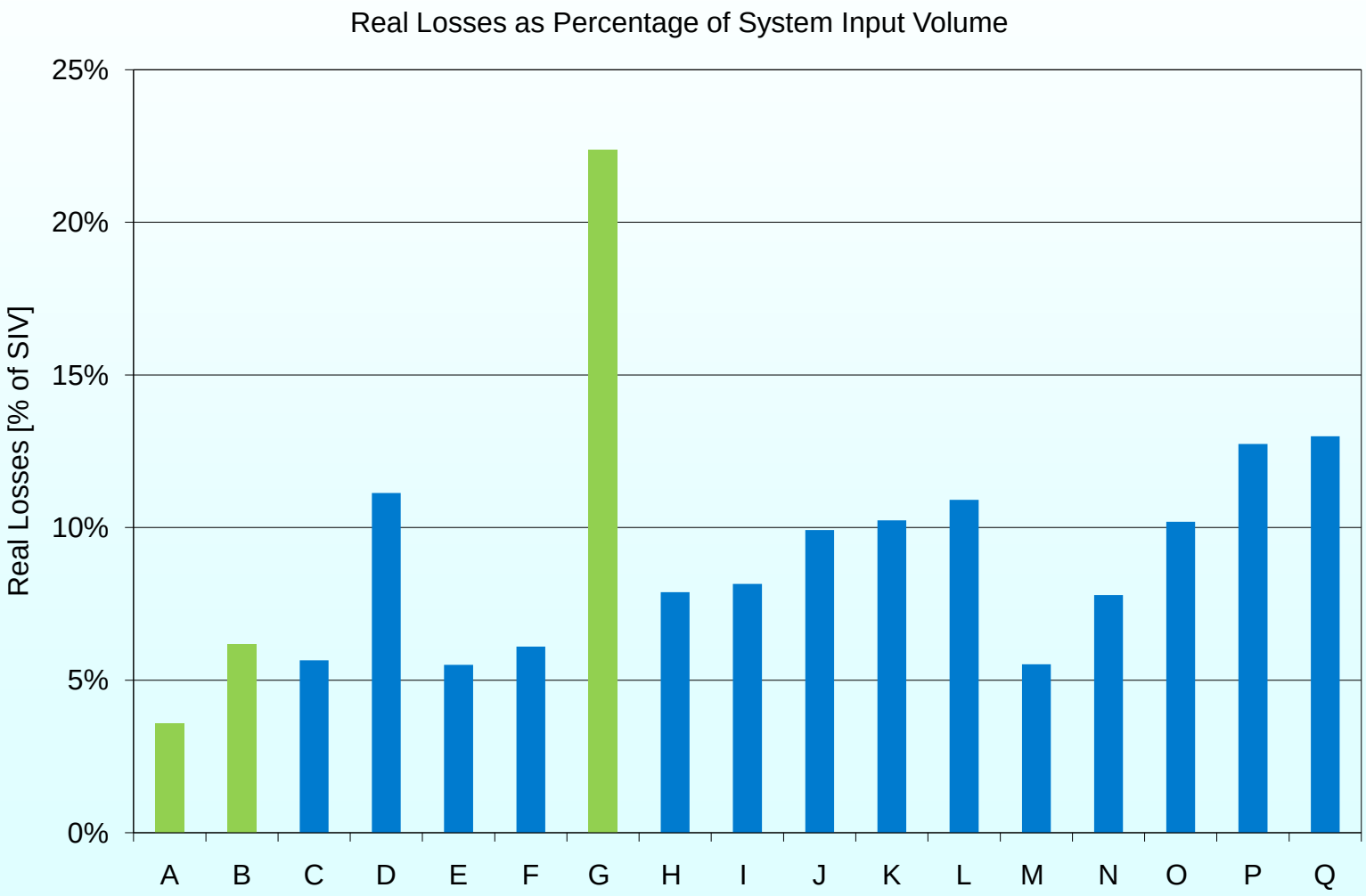
Water Leak Detection Program and Water System Loss Control Study

Performance Indicator – Real Losses/Serv/Day



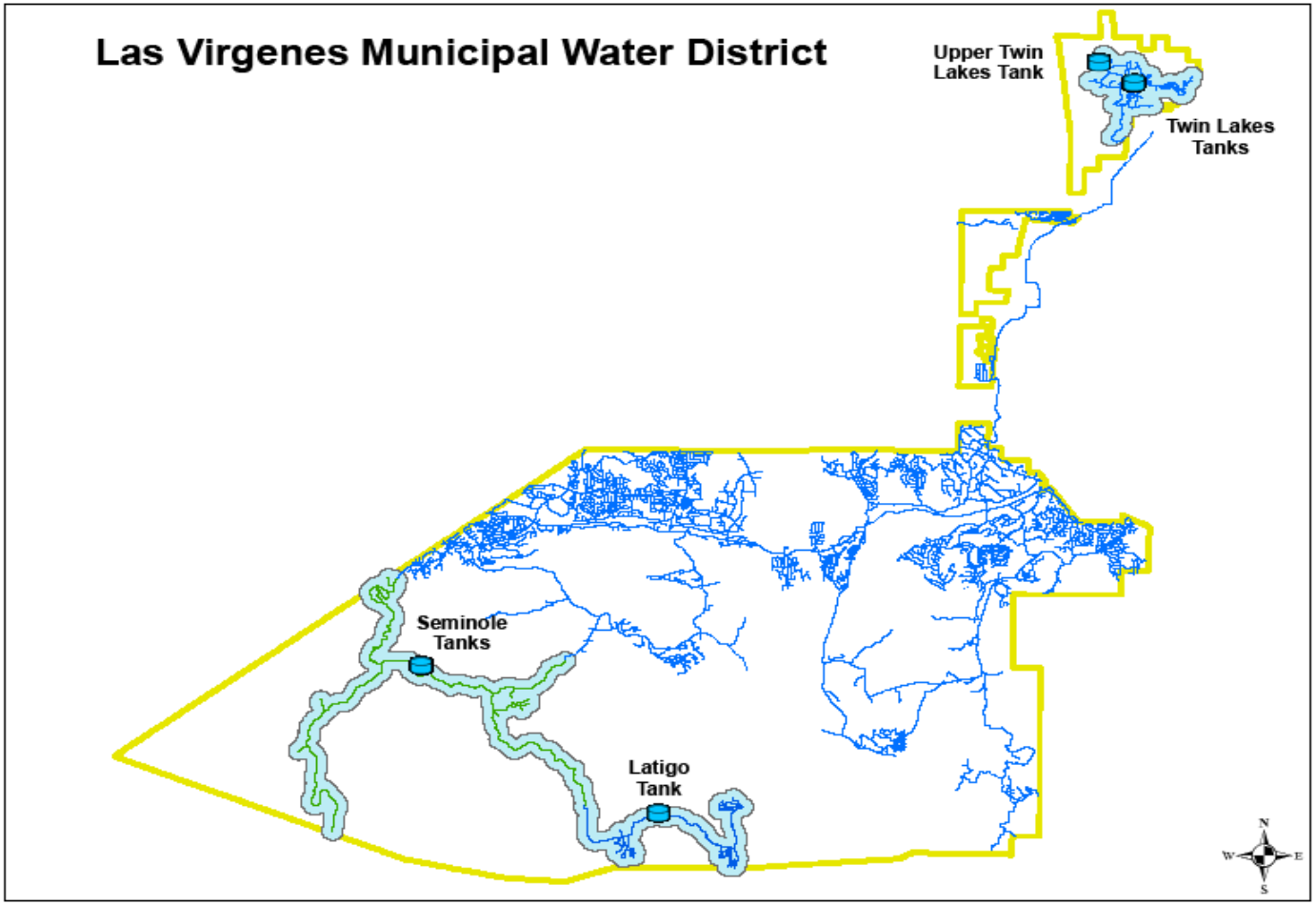
Water Leak Detection Program and Water System Loss Control Study

Performance Indicator - Percentage Real Losses



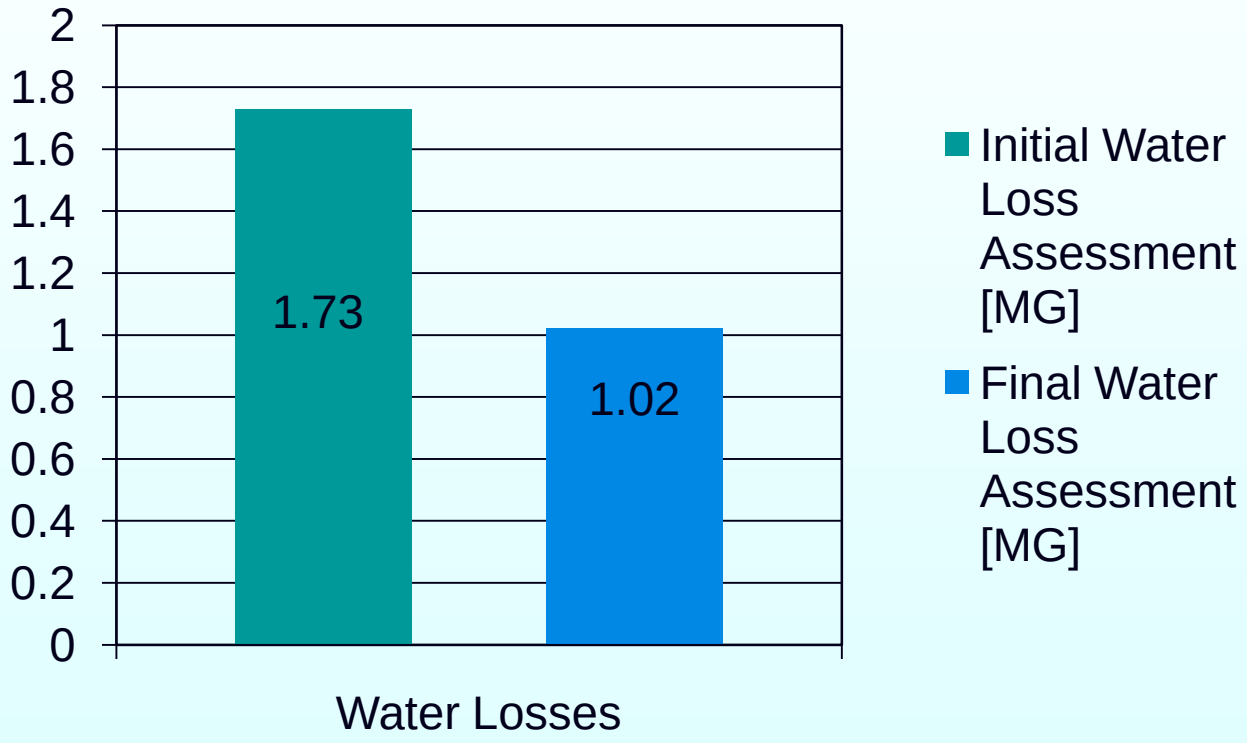
Field Leakage Measurements

- DMAs: Seminole–Latigo-Three Springs and Twin Lakes



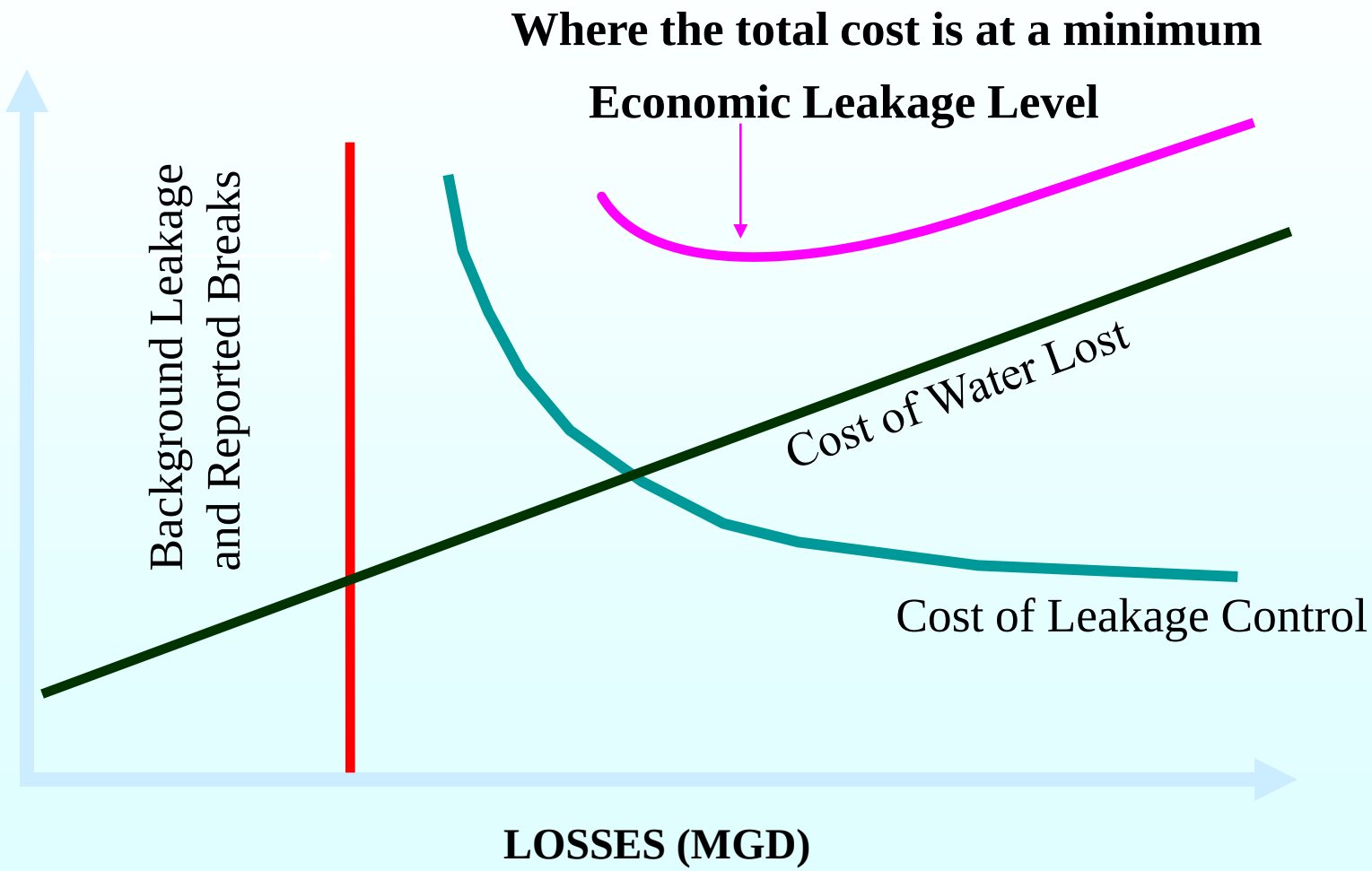
Field Leakage Measurements

- Seminole–Latigo-Three Springs System Final Water Loss Assessment

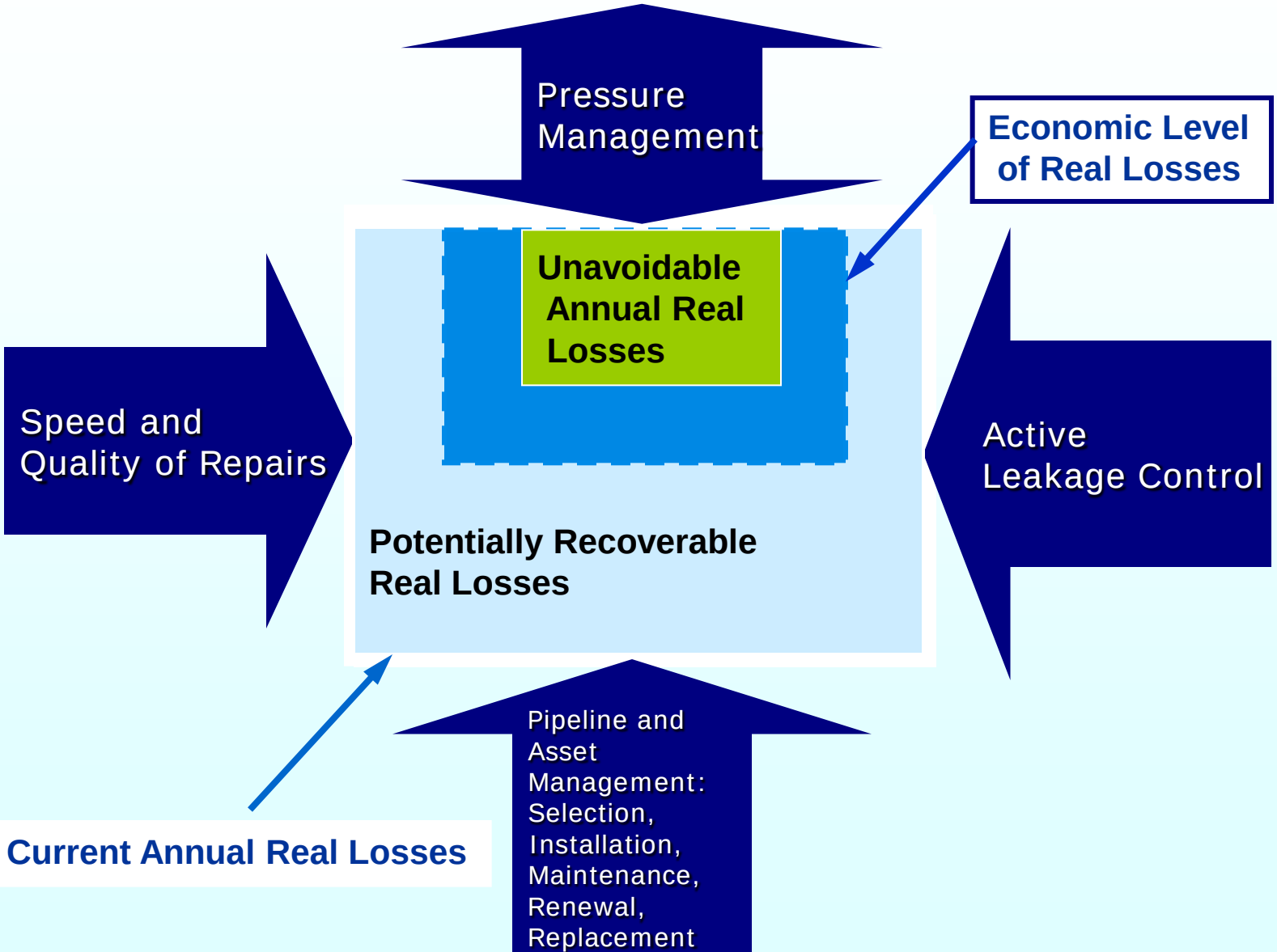


More Pressure - More Losses

What Volume of Real Losses is Economic



Management Tools for Real Loss Reduction



Economic Frequency of Intervention (Rate of Rise Method) - Proactive Leak Detection

- Retail Cost vs. Avoided Cost

	Retail Cost Valuation of Real Losses	**Avoided Cost Valuation of Real Losses**
Economic Intervention Frequency	18.8 month	35.2 month
% of System to be Surveyed Annually	64%	34%
Annual Budget for Intervention	$51,388	$27,439
Economic Unreported Real Losses	24.5 MG/Year	45.9 MG/Year
Potential Recoverable Leakage	137.7 MG/Year	116 MG/Year

Roadmap for SCE Water Loss/Energy Reduction Program

Roadmap for a Water Loss and Energy Reduction Program in the SCE Service Territory

Voluntary Application Process

- For Utilities not sigantory to the CUWCC Memorandum of Understanding that are interested in participating in the program and have reliable water audit results available. Plus for CUWCC signatories who want to fast track their participation in the program .

BMP 1.2 Reports

- Review of all BMP 1.2 reports submitted by SC Edison service territory water utilities.
- First reports for FY09 and FY10 will be available December 2010.
- Can be carried out by SCE internally.

Offer incentive for infrastructure replacement based on assessment of direct and embedded energy savings

Qualifying Matix

- Import information into a ranking sheet.
- Ranking = B x C x $\sqrt{D}$

Ranking	Utility Name	(A) Infrastructure Leakage Index (IUI)	(B) Real Losses (gpl/conn/day)	(C) Avoided Cost of Water ($/AF)	(D) Energy Intensity of Water Delivered (low=1, medium=2, high=3)

Component and ELL Analyses

- Conduct Component Analysis and Economic Level of Leakage Analysis to design adequate intervention strategy for top 10 (or more) water utilities of ranking sheet.
- The final number of utilities selected for component analysis and ELL depends on results of initial ranking sheet.
- This step will guarantee that only cost effective water loss intervention strategeis will be pursued.

Intervention Strategies

- Pursue individual intervention strategies:
  - Pressure Management - Has results on all three Real Loss components. Rule of thumb is 10% reduction in pressure results in 10% reduction in Real Losses. ELL will determine by how much pressure can economically and technically be reduced.
  - Proactive Leak Detection - Reduces backlog of leaks and keeps losses from unreported leaks at economic optimum. ELL will determine the economically optimum leak detection frequency.
  - Infrastructure Replacement

Pressure Management → Savings MG/KWH

Proactive Leak Detection → Savings MG/KWH

Infrastructure Replacement → Savings MG/KWH

Thank You!

Questions?

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LISTENING WITH STETHOSCOPES AND AQUAPHONES ALONG A MAIN SUPPLY PIPE DURING A NIGHT INSPECTION.