SUMMER 2009 WATER MAIN LEAKS
PRELIMINARY INVESTIGATION REPORT
November 3, 2009

This preliminary report of findings has been prepared as the "internal report" by the Los Angeles Department of Water and Power (LADWP) in response to the City Council motion of Councilmember Greig Smith on September 22, 2009 and related discussion on this motion from the Energy and Environment Committee. Specific issues of focus are:

a.) The cause or causes of the water main breaks in the LADWP Water Distribution System during the summer of 2009:

- **Main breaks occurred on corroded pipe**
- **Operational changes, routine and in part due to changes necessitated by prior leaks, may have triggered other leaks in pipes that were on the verge of failing**

b.) The potential cause or causes of the higher percentage of street blowouts:

- **The percentage of breaks occurring on cast iron pipe increased in comparison with past years**
- **Cast iron breaks tend to cause greater street damage than do breaks on other types of pipe**

c.) Effects of 2-days per week watering restrictions:

- **No evidence that pressures increased as a result of watering restrictions**
- **No clear correlation between watering days and the occurrence of main breaks**
- **Awaiting the conclusions of the independent experts' report and open to recommendations**

d.) How past rate increases for LADWP Water System infrastructure programs have been spent and what future steps for the infrastructure and asset management program will be taken:

- **Cumulative investments in our infrastructure replacement program for FY 07/08 - FY 09/10 have increased a total of $190M above FY06/07 levels**
- **Formalized asset management program recently created to effectively focus infrastructure replacement efforts**
- **Expenditure graphs**

Cause of Leaks this past Summer:

- Physical examination of pipe samples removed by leak repair crews and review of available pipe condition data revealed that the failed pipe sections were corroded and deteriorated. *Physical examination of the pipe samples showed rust, corrosion pits, microfractures, and graphitization. A lot of this pipe was installed 70-90 years ago and in "very severe" or "severe" corrosive soil environment. It was a common construction practice in that era to use native material for pipe bedding and backfill. In some instances, local corrosion was accelerated due to stray current from impressed current systems on nearby substructures, the presence of degradable material in the pipe trench, and minor leaking joints.*
- Corroded and deteriorated pipe is susceptible to breaks when subjected to minor increases in pressure. *In the 579-ft service zone (the service zone with the most leaks this past summer), a cluster of leaks in late-July thru mid-August coincided with an increase in reservoir-elevation at the Lower Franklin Reservoir and an increase in static pressure of about 4 pounds per square inch (psi). The elevation of the reservoir was within the normal operating range, but pipe leaks have occurred in the past when reservoirs elevations are raised after an extended period at a lower elevation.*
- Trunk line breaks might accelerate the number of pipe breaks due to the operational changes required to maintain service and supply. *26 gate valves were operated to isolate the City Trunk Line and allow repairs to be made. Numerous changes were also made to maintain pressure and flow in areas supplied by the City Trunk Line.*

Cause of Higher Percentage of Blowouts this past Summer:

- The higher percentage of blowouts appears to be the result of a higher percentage of breaks on cast iron pipe this past summer. *Approximately 77% of pipe leaks in our sample study (July 1 – September 9) occurred on cast iron pipe. This compares to ~68% of leaks in Summer 2008 and ~54% of leaks in Summer 2007.*
- Cast iron pipe breaks often take the form of longitudinal splits or ruptures which result in larger leaks. *Local weak spots will also fail longitudinally--perpendicular to the axis of major stress (circumferential hoop stress).*

Other Factors Studied:

- Other factors studied with no apparent correlation to the leaks and blowouts of this past summer include: pipe age, age/condition of the street surface, water temperature, imported water supplies from the Metropolitan Water District, and soil temperature.
- Field investigations were also performed on service zone divide gates and interconnections, and these were found to be in proper operating condition.
- The two, well-publicized pipe breaks on the City Trunk Line at Coldwater/Dickens on 9/5/09 and on a 6-inch main at Hartsook/Bellingham on 9/8/09, had this in common: both pipes are located in the 1000-ft service zone and both pipes had undergone significant corrosion over time. The City Trunk Line had external corrosion pits throughout the circumference of the pipe in the failed portion. The Hartsook pipe had localized corrosion that coincided with a tree root growing along the pipe. It cannot be stated definitively that the breaks were related, but there is a possibility that they were.

Impact of 2-days per week (M/Th) watering restrictions:

- Review of pressure and flow data failed to show any relationship between the occurrence of water main breaks and the M/Th watering restrictions.
- The M/Th watering restrictions have not caused pressure increases but distinct pressure drops during peak demand periods on Monday and Thursday are evident. *For these days of the week, there is a wider range in operating pressure (the difference between the daily high and low pressure). Theoretically, this could place additional operating stress on the pipe; but, this is less likely to cause a pipe failure or leak as an increase in operating pressure or a transient pressure wave (a relatively quick and temporary pressure increase).*
- Currently, the LADWP does not have the capability to monitor or detect transients in a subsection or small region of a service zone. Therefore, data loggers were installed in October 2009 to help check if the M/Th watering restrictions are resulting in transient pressures. This data will continue to be carefully reviewed. Unfortunately, there is no baseline from this past summer or previous years to compare this logger data.
- The LADWP has conferred with other utilities (*Long Beach, Anaheim, and San Diego*) that have implemented similar watering restrictions and these others utilities have not observed subsequent increases in leak rates.

Infrastructure Program Expenditures

- Past water rate increases for LADWP Water System infrastructure programs have allowed a ramping up of efforts focused on water main replacement, trunk line construction, corrosion protection, and pressure regulation facilities.
- A cumulative amount of $190 million has increased infrastructure investments above the Fiscal Year 06/07 levels.

Recommendations & Next Steps for Leak Analysis:

- LADWP looks forward to hearing the findings from independent experts and suggested areas for further study.
- LADWP will work with industry experts and peer utilities to try to determine the cause of a "secondary peak" in cast iron pipe leaks during the summer months.
- LADWP will redeploy data loggers next summer to provide a more detailed investigation of potential transient pressures and flow conditions during periods of peak demand.

Recommendations for Pipe Condition Assessment and Infrastructure Programs:

- Annual water main infrastructure replacement footage has doubled since 2006-2007. However, the current plan to attain annual replacement footage of 200,000 feet should be followed. (*Target Date: 4 years*)

- Ensure focused water main infrastructure replacement not only addresses pipes with the greatest amount of historical leaks but also targets cast iron pipe in severely corrosive soils. (*Target Date: ongoing*)
- Continue expansion of the corrosion protection program for steel pipe to 400 anode stations per year. (*Target Date: 18 months*)
- Incorporate the findings of the independent-experts report as appropriate.
- Update records for as-built construction drawings and leak repair reports, and "System's Leakiest Pipeline" report. (*Target Date: 3 months*)
- Refresh and revise the Asset Management Program's pipeline condition and criticality assessment methods and models, and provide an updated priority list for pipeline replacements projects. (*Target Date: 6 months*)
- Continue development of LADWP's geographical information system, geospatial analytical tools, and web-based leak reporting system to facilitate more comprehensive and robust pipeline condition assessment. (*Target Date: ongoing*)

Where do we go from here?

Presently, the primary drivers for water main infrastructure replacements have been the failure modes of repeated leaks or insufficient capacity (and a few others to a lesser extent). To a large extent, this has been a reactive strategy that has served the LADWP well to maintain leak rates and service levels. However, the replacement rate in 2006 corresponded to a replacement cycle for water main of well over 400 years. This means it would take over 400 years to replace all the pipe in the LADWP water system. Because it is not likely that water mains in the system will last this long, the decision was made in 2007 to significantly increase the water main infrastructure replacement rate each year to achieve 200,000 feet per year by 2012. This effort will reduce the replacement cycle to approximately 180 years. This effort will be accomplished by increasing the number of crews from the 6 in 2006 to 18 by the full build-out in 2012 (one crew consists of 9 employees).

While the LADWP is fully aware that age is not always the best indicator of how long a pipeline will last, records indicate that on average, the water main infrastructure replaced ranges in age from 70 to 100 years. By the year 2020, a significant portion (about 7.5 million feet) of the infrastructure will be in this 70 to 100 year age range. There are a number of factors that contribute to the deterioration of buried pipe such as type of material, soil corrosivity, construction methods, and other internal and external conditions. The influence of these factors can cause the service life of a buried pipe to vary significantly.

As the LADWP transitions from a reactive mode of water main infrastructure replacement to a more proactive program, and more crews and resources are focused on replacement, it is imperative that better methods of targeting and prioritizing the right water mains be developed. The LADWP Water System's Asset Management Group along with the Water Distribution Division are working to develop a predictive model that uses existing data relative to the factors which contribute to water main deterioration to determine a replacement priority for all pipe segments in the system. The results of this model along with criticality assessments and leak history can be used to focus

replacement resources on pipe segments that are more likely to fail and disrupt service levels.

To be as efficient as possible, the LADWP mainline infrastructure replacement program will ramp up to the aforementioned level of 200,000 feet per year and a replacement cycle of approximately 180 years. Recognizing that the 180-year replacement cycle is more than the 70 to 100 year average age of historical replacements, the LADWP is depending on the increased analysis and assessments used in the predictive model to targeted pipe segments with a high probability of failure, allowing for a more efficient deployment of resources. This will ensure that pipe segments that are in good condition will remain in service well past the 70 to 100 year average until the end of their useful life while others are replaced as needed.

Are we moving fast enough?

To maintain service levels and get ahead of these projected failures, the LADWP began ramping up its water main infrastructure replacement program in 2007 while working on methods to better predict where the failures will occur. LADWP has cost effectively staffed up to repair the leaks that occur and replace water mains with a persistent leak history in order to maintain and improve service levels to our customers.

The current rate of water main infrastructure replaced is sufficient to maintain or gradually reduce the overall LADWP leak rates over the next eight to ten years. However, due to the historical methods of water main installation, it expected that pipelines will continue to corrode, deteriorate, and leak over time to a point where further capital investments will be needed in order to maintain an equal level of service to our customers.

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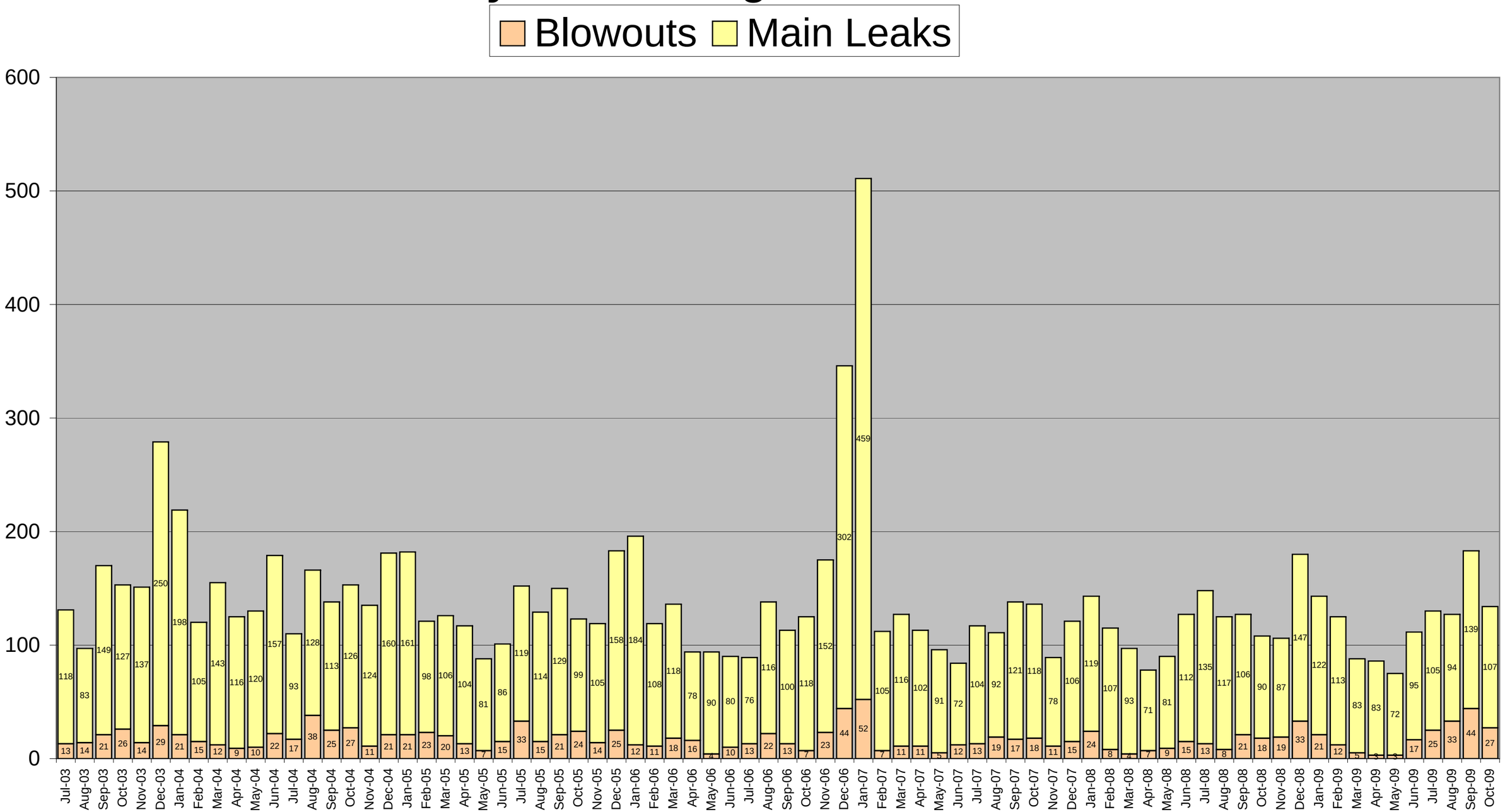
Preliminary Conclusions

I. Main breaks occurred on corroded sections of pipe.

II. A high percentage of main breaks occurring on cast iron pipe accounted for increased number of blowouts.

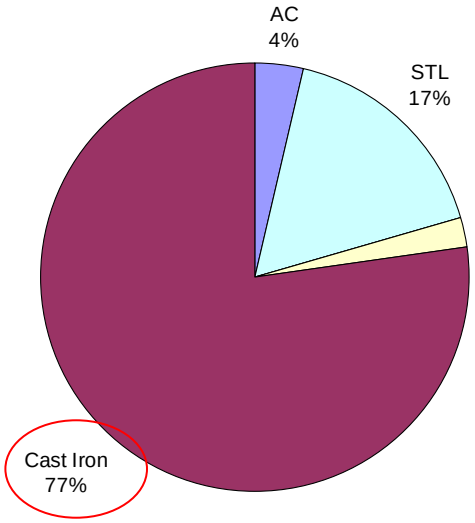
III. Operational changes associated with the Coldwater break may have caused a short term increase in leaks.

July 2003 through October 2009



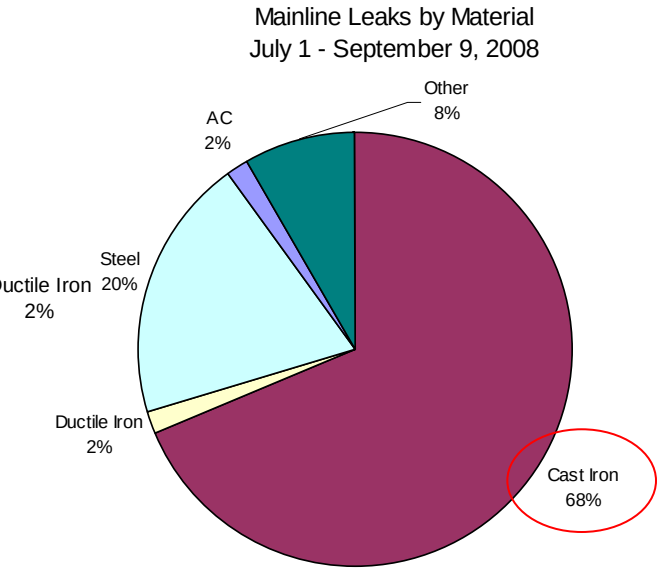
SUMMER 2009 WATER MAIN LEAKS
PRELIMINARY INVESTIGATION REPORT
Comparison of Breaks on CI Pipe to Prior Years

Leaks Summer 2009 (n=189)



Data Source: WDD CPS System

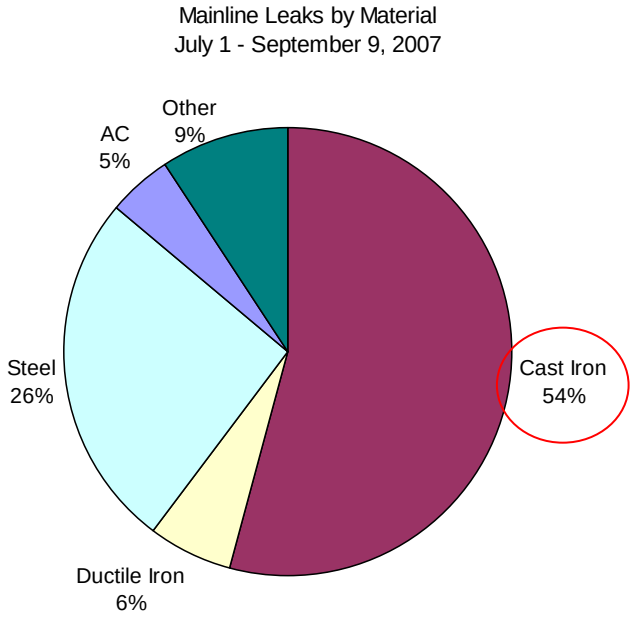
Leaks Summer 2008 (n=166)



Note:
8% Other includes: Copper, Plastic and not listed material

Data Source: GIS Leak Database

Leaks Summer 2007 (n=121)



Note:
9% Other includes: Copper, Plastic and not listed material.

Data Source: GIS Leak Database

- Higher rate of CI pipe failures in Summer 2009 than past 2 summers

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Photos of CI Pipe from Recent Breaks

Hartsook

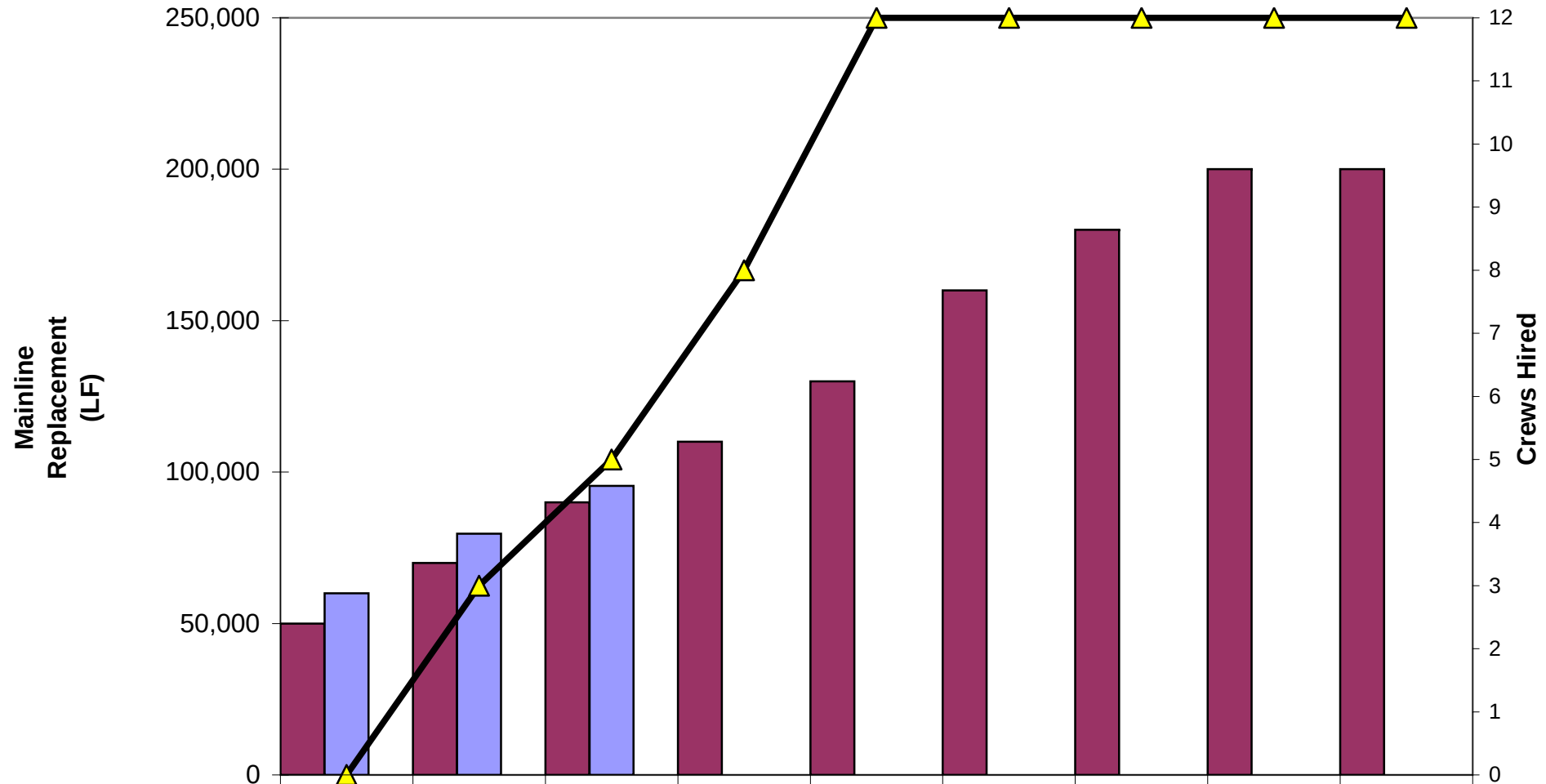
Topanga Canyon

Corbin & Kittridge

Melrose

Burbank Blvd

Mainline Replacement Program Build-out

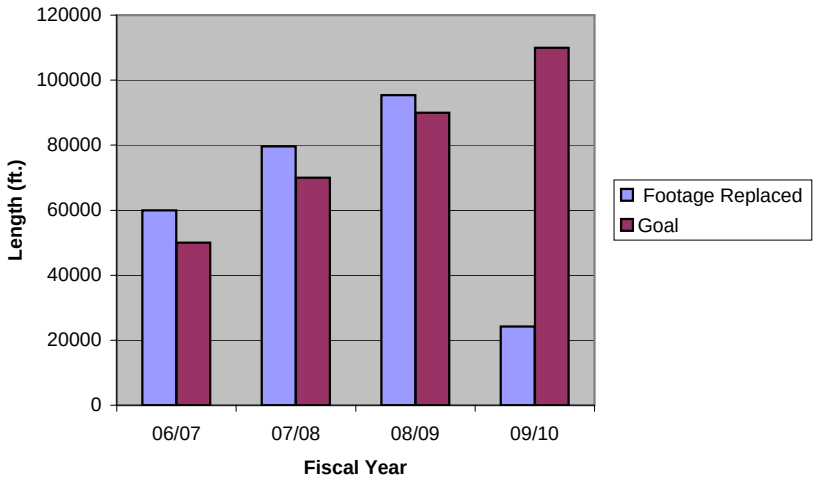


	FY06-07	FY07-08	FY08-09	FY09-10	FY10-11	FY11-12	FY12-13	FY13-14	FY14-15
MLR Goal	50,000	70,000	90,000	110,000	130,000	160,000	180,000	200,000	200,000
Actual Main Replaced	60,000	79,652	95,416						
Cost in Thousands	$24,253	$29,647	$33,357	$38,831	$48,973	$61,672	$65,176	$68,183	$69,670
Cumulative Hiring	0	3	5	8	12	12	12	12	12
Yearly Hiring Plan	0	3	2	3	4	0	0	0	0

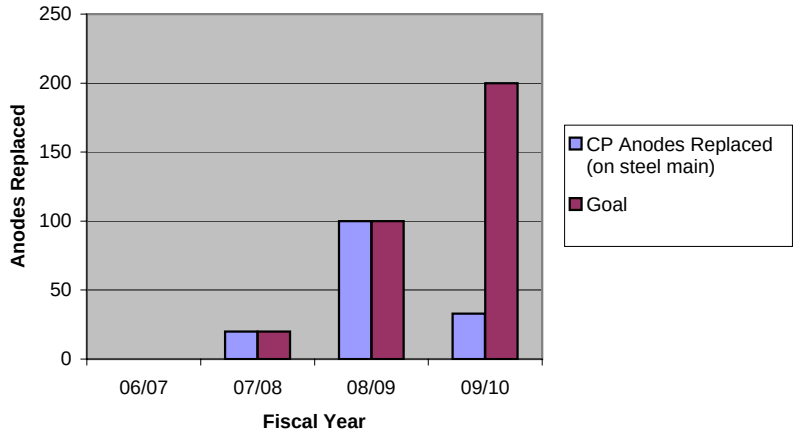
Costs for FY06-07 through FY09-10 net of reimbursements, FY06-07 footage estimated

Key Water Infrastructure Activity
(as of October 2009)

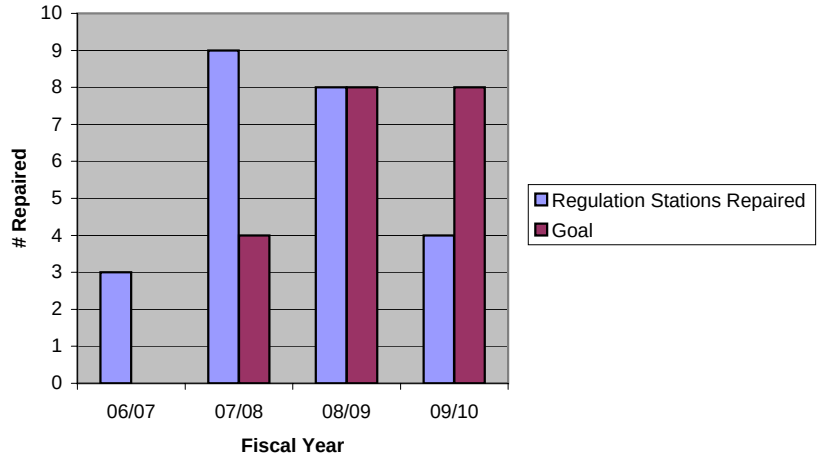
Water Main Replacement



Corrosion Protection System Replacement



Pressure Regulation Stations Repaired



Trunk Line Installation and Rehabilitation Efforts

Past Work

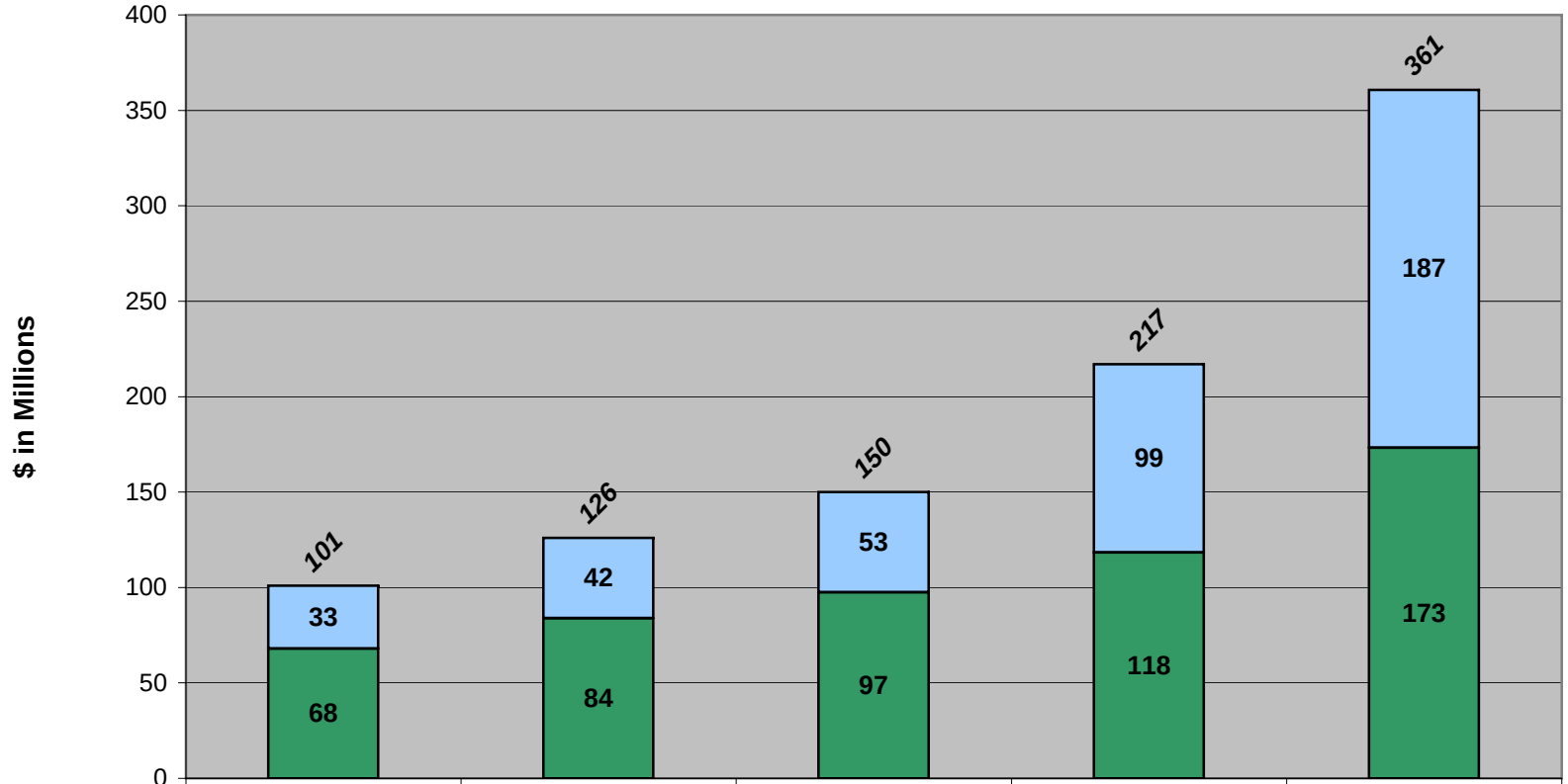
FY04/05 - 08/09:	**58,200 ft. (11 miles) of trunk line**
FY04/05 - 08/09:	**22,800 ft. (4.3 miles) of rehabilitated TL**
Total:	**81,000 ft.**

Projected Work

FY09/10 - 13/14:	**119,995 ft. (22.7 miles) of trunk line**
FY09/10 - 13/14:	**32,100 ft. (6.1 miles) rehabilitated TL**
Total:	**152,095 ft.**

LADWP Water System Infrastructure Capital Expenditures

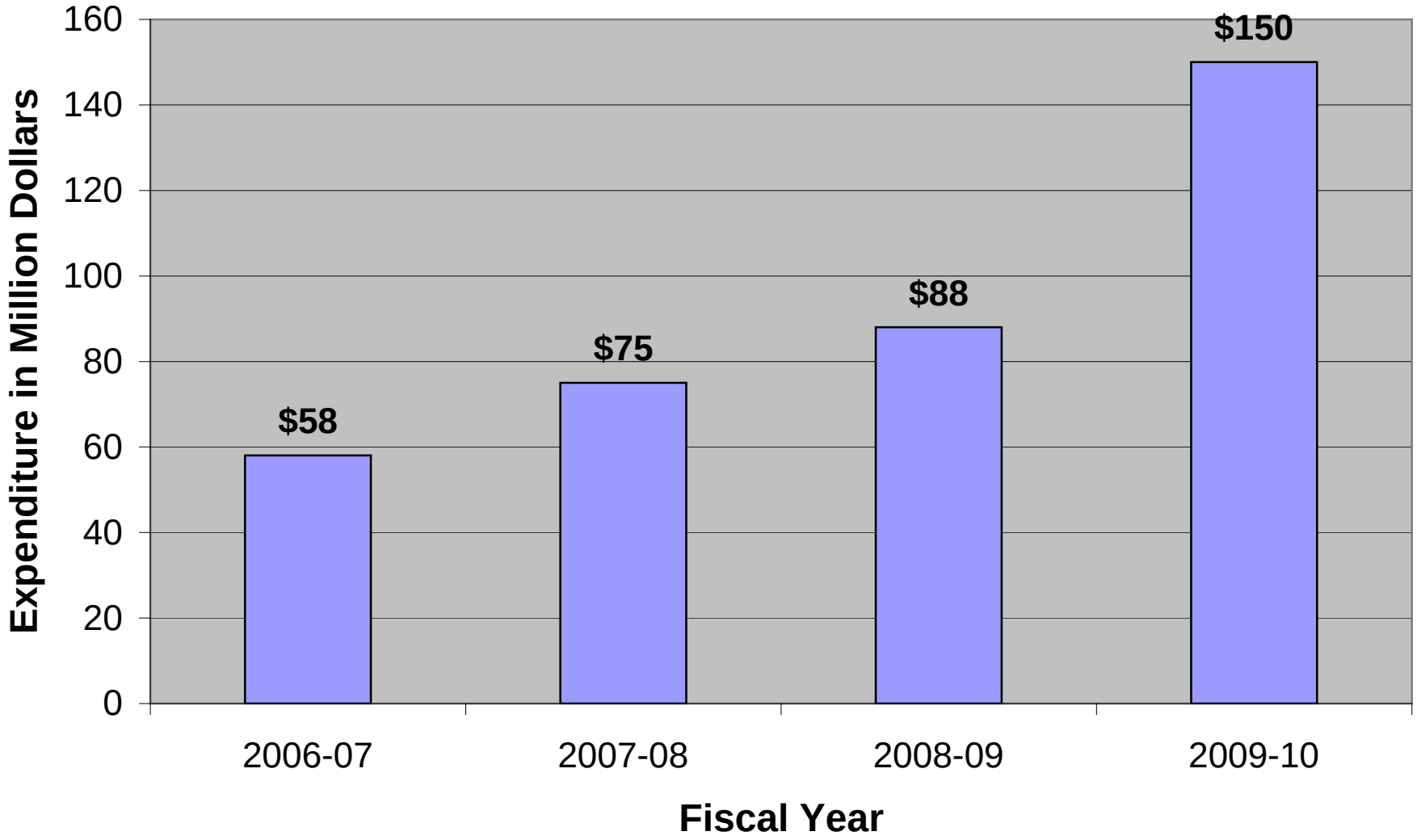
(Data Date 9/9/09)



	2006-07	2007-08	2008-09	2009-10	2010-11
WQ Trunk Lines	33	42	53	99	187
Infrastructure Reliability	68	84	97	118	173
Totals	101	126	150	217	361

Fiscal Year

LADWP Water System Pipeline Expenditures
2006 through 2010



LADWP Water System Pipeline Expenditures
2006 through 2010

($1000s net of reimbursements)

Pipeline Construction Projects			FY 2006-07		FY 2007-08		FY 2008-09		FY 2009-10		Total
26220	TRUNK LINE & MAJ SYS CONN		697		2,699		1,231		12,161		16,788
	23112	De Soto TL		1		0		6		1,155	
	23137	FTHL TL(HUBBARD TO GRN VERDUGO RES)		0		48		105		1,051	
	23212	VENTURA T/L SLIP LINING PROJECT		295		2,207		21		0	
	23219	FORMOSA AVENUE TRUNK LINE		12		8		201		7,666	
		Misc		388		436		899		2,290	
26331	DISTRIBUTION MAINS		24,253		29,647		33,357		38,831		126,088
23222	WQIP TRUNKLINE IMPRVEMNTS		32,905		42,088		52,514		98,577		226,084
	20045	STONE-HOLLYWOOD TRUNK LINE UNIT 4		2,567		536		183		6,694	
	23105	CITY T/L REPLACEMT SOUTH, UNIT 1		3,483		763		736		0	
	23107	PARTHENIA T/L		16,415		22,168		14,351		6,145	
	23116	CITY TRUNK LINE SOUTH UNIT 2		563		1,095		2,669		12,852	
	23118	CITY TRUNK LINE SOUTH UNIT 4		50		869		8,721		12,746	
	23130	MAGNOLIA T/L		3,472		362		244		0	
	23134	SEPUL T/L UNIT 3 EXT		156		2,786		3,374		51	
	23151	FIRST STREET TRUNK LINE.		1,002		8,253		15,303		13,725	
	23190	CITY TRUNK LINE SOUTH UNIT 5		22		30		579		9,186	
	23228	MODIFICATIONS AT LA-29 (SUNSET)		745		301		414		6,687	
	23435	RIVER SUPPLY CONDUIT UPPER REACH 7		215		522		1,643		1,280	
	23456	RIVER SUPPLY CONDUIT LOWER REACH 3		809		293		2,049		16,560	
	23457	RIVER SUPPLY CONDUIT LOWER REACH 4		744		20		83		7,258	
		Misc		2,660		4,091		2,164		5,393	
Total for Pipeline Construction Projects			**57,854**		**74,434**		**87,102**		**149,569**		**368,960**

Completed Projects

Completed Trunk Line Projects (>24" Dia)		Total Expenditures
23212	VENTURA T/L SLIP LINING PROJECT	2,612
23107	PARTHENIA T/L	77,000
23105	CITY T/L REPLACEMT SOUTH, UNIT 1	31,312
23130	MAGNOLIA T/L	37,044
23134	SEPUL T/L UNIT 3 EXT	9,407