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DEPARTMENT OF PUBLIC SERVICE REGULATION
BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MONTANA

IN THE MATTER OF the Joint Application of Liberty Utilities Co., Liberty WWH, Inc., Western Water Holdings, LLC, and Mountain Water Company for Approval of a Sale and Transfer of Stock	)))))	REGULATORY DIVISION Docket No. D2014.12.99

WESTERN WATER'S AND MOUNTAIN WATER'S SUPPLEMENTAL RESPONSES TO THE CITY OF MISSOULA'S DATA REQUEST CITY-011

Western Water Holdings, LLC ("Western Water"), Mountain Water Company ("Mountain Water") provide the attached supplemental response to the City of Missoula's Data Request CITY-011.

Respectfully submitted this 14th day of May, 2015.

Holland & Hart LLP

By: *s/ Thorvald A. Nelson*

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ATTORNEYS FOR MOUNTAIN WATER COMPANY AND WESTERN WATER HOLDINGS

DATA REQUESTS

CITY-011: RE: Project Orchard Confidential Information Memorandum
Witness:

In the Project Orchard Confidential Information Memorandum of June 2014, it was represented, on page 74, that "[w]ater loss due to leakage remains high with non-revenue water production accounting for over 40% of total water production."

a. Did you perform any evaluation, due diligence, or analysis regarding leakage at Mountain Water, including necessary capital expenditures and maintenance to address the problem?

b. If so, please describe, in detail, the evaluation, due diligence, or analysis you performed, including your conclusions.

c. Please produce all documents reviewed, prepared, or relied upon in answering this data request.

Objection:

Mountain Water and Western Water object to this request to the extent it seeks information not relevant to the subject matter of the instant proceeding, information not reasonably calculated to lead to the discovery of evidence admissible in the instant proceeding, and on the grounds the reference to "you" is vague and ambiguous.

Response to CITY-011:

a. Yes.

b. Mountain provided a detailed 5 year financial analysis and action plan in 2010 to the PSC to identify its five year program for addressing leakage in the system. Mountain has continued to spend capital dollars on main replacement at a minimum as was stated in that plan. This plan was part of the Carlyle transaction docket with the PSC and was agreed to by all parties in that proceeding.

At the time of June 2014, Mountain had a draft report it had prepared for its next filing to the PSC with its plan for the next five years. In that plan, Mountain has implemented new studies and procedures to better understand its non-revenue water and provide a comprehensive program for its next five years. Included in that study: 1) An industry accepted statistical analysis of its long term main replacement needs by main type [KANEW]; 2) New prioritization guidelines for prioritizing specific main projects by year; 3) AWWA water audit for non-revenue water in addition to its annual reservoir study; 4) District metering for valve to valve leakage tests; 5) Acoustic sounding for leak investigations; and 6) Proposed DSiC program to assist with long term main replacement revenue requirements in a historical rate making environment.

Mountain's 2015, 5 year capital budget, has been adjusted from its 2010 plan to increase its capital spend associated with mains from an average of $1m per year to closer to $2.4m, with the plan to get to $2.8m on average to match its findings in the KANEW study.

c. N/A.

Supplemental Response to CITY-011(c):

Although these documents were not reviewed, prepared, or relied upon in answering PSC-011(a), the following documents support Mountain Water's and Western Water's response:

- Financial Analysis and Proposed Action Plan for Water Loss Mitigation (WWH001272-WWH001299);
- Mountain Water Company: System Report in Support of the Distribution System Improvement Charge August 2013 (WWH001249-WWH001271);
- AWWA Water Audit Summary 2011-2013 (WWH001247-WWH001248); and
- Mountain Water's 5-year capital budget previously produced in response to PSC-030 (WWH001075-WWH001079).

CERTIFICATE OF SERVICE

I hereby certify that on this, the 13th day of May, 2015, **WESTERN WATER'S AND MOUNTAIN WATER'S SUPPLEMENTAL RESPONSE TO THE CITY OF MISSOULA'S DATA REQUEST CITY-011** were electronically filed with the Commission and served via U.S. mail and e-mail, unless otherwise noted, to the following:

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s/ Adele C. Lee

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COMPARISON OF WATER LOSS DATA

Water Loss Measurements

	2010	2011	2012	2013
Reservoir Fall Studies[1] (MG/YR)	4444	4231	3988	3793
Percentage Change by Year of Total Water Loss Measured	0	- 4.79%	- 5.75%	-4.89%
0.25		49.95%	46.06%	43.36%
0.42				

AWWA Water Audit Summary:
Assuming FLAT RATE Consumption = Metered Consumption Per Account

Million gallons / Year	2010	2011	2012	2013
Total Water Produced[2]	8300	8471	8658	8747
Metered Consumption[3]	3131	3295	3532	3550
Unbilled Metered[4]	0.984	1.349	1.297	1.297
Unbilled Unmetered[5]	103.7	105.9	108.2	109.3
Unauthorized Unmetered[6]	20.75	21.18	21.65	21.86
Flat Rate Consumption	783	750.7	722	674
Number of Flat Rate Customers[3]	4397	4094	3870	3674
Number of Metered Customers[3]	17575	17972	18932	19349
Non-revenue water (%)	52.8%	52.2%	49.4%	51.7%
Real Water Losses	51.6%	51.0%	48.2%	50.2%

AWWA Water Audit Summary:
Assuming FLAT RATE Consumption = 2.0 Times Metered Consumption Per Account

Million gallons / Year	2010	2011	2012	2013
Total Water Produced[2]	8300	8471	8658	8747
Metered Consumption[3]	3131	3295	3532	3550
Unbilled Metered[4]	0.984	1.349	1.297	1.297
Unbilled Unmetered[5]	103.7	105.9	108.2	109.2
Unauthorized Unmetered[6]	20.75	21.18	21.65	21.86
Flat Rate Consumption	1566	1501	1444	1348
Number of Flat Rate Customers[3]	4397	4094	3870	3674
Number of Metered Customers[3]	17575	17972	18932	19349
Non-revenue water (%)	43.4%	43.4%	40.5%	44%
Real Water Losses	42.2%	42.1%	39.3%	42.5%
Real Water Losses	3503	3566	3403	3715

Notes:

G:\Engineering\Water Loss Group\AWWA water audit\AWWA Water Audit Summary TABLE_sma.docx

1. Reservoir fall studies are conducted one day annually by isolating each pressure zone, filling the reservoir, turning off all pumps, and measuring the reservoir drop over a period of time during the early morning hours when demand is lowest. According to AWWA Manual M32, Figure 2 – AWWA Average Day Diurnal Curve, the usage during these studies is assumed to be 25% of average day.
2. Taken from production 'READS'.
3. Data was taken from the CIS Revenue Data Base – 1190 Annual Consumption and Cust Connections
4. Water used by the City of Missoula fire department and by MWC personnel for hydrant testing.
5. Water used for firefighting, flushing of mains and sewers, street cleaning, etc. AWWA default value of 1.25% was used.
6. Water withdrawn from hydrants, bypasses to meter reading equipment, etc. AWWA default value of 0.25% was used.

MOUNTAIN WATER COMPANY: SYSTEM REPORT IN SUPPORT OF THE DISTRIBUTION SYSTEM IMPROVEMENT CHARGE AUGUST 2013

1. Introduction

The purpose of this report is to support Mountain Water Company's (MWC's) proposed Distribution System Improvement Charge (DSIC) tariff filing to the Montana Public Service Commission. This report will briefly describe the steps MWC is taking to identify and quantify leakage in the system, as well as MWC's asset management and main prioritization program which evaluates and prioritizes water main pipes for replacement or rehabilitation. Section 2 provides a detailed description of the types of testing that MWC performs to quantify total leakage in the system and to identify locations of the leaks so they can be repaired or the mains replaced. Section 3 provides a description of an asset management study undertaken by MWC to predict the quantity of water main MWC will need to replace over the next 20-30 years. The analysis utilized a software package called KANEW™, which combines the distribution of MWC's mains by type and age with functions predicting the lifespan of each type of pipe, to forecast the annual main replacement that would be required to avoid failure of those mains. Section 4 provides a discussion of the main replacement prioritization matrix developed by MWC. Section 5 identifies the mains proposed to be replaced over the next 3 years within the DSIC tariff.

2. Non-Revenue Water

This section describes the current techniques used to identify and quantify leakage in the system. There are several factors that contribute to leaks in the system. Missoula has unique geology, including very porous soils with high transmissivity that allows leaks to occur without surfacing, which can make locating leaks very difficult. In addition, after World War II there was a surplus of 6" steel pipe which was used extensively in the system. This pipe is thin walled and is known to be susceptible to pin-hole leaks. As described in this report, this 'steel invasion' pipe is one of our primary targets for replacement, along with pipes that have reached their normal useful life. Customer service lines also contribute to leakage, some estimates put this number at 50% of total leakage coming from customer owned service lines. It's important to note that leaked water costs between 3-6% of MWC's operating expenses, since this water is simply returned to the aquifer; therefore, while it's important to use our resources and technology to identify and quantify leaks, we also target pipes for replacement based upon many other factors as described in Sections 3 and 4.

2.1 Leakage Studies

Mountain Water Company (MWC) utilizes several types of leakage studies and leak detection equipment and techniques. MWC focuses on a macro level of testing by quantifying the leakage in each of its 18 separate storage zones; as well as on a micro level looking for leaks in individual sections of pipe. There

are two different methods for calculating the zone-wide losses:

- Reservoir fall studies
- Water audits

MWC uses "acoustic testing" to pinpoint the location of specific leaks. Starting in 2012, MWC began performing "neighborhood level" leakage tests called "valve-to-valve studies" with the goal of quantifying leakage in individual segments of main. Each of these types of testing is described in detail below.

2.2 Reservoir Fall Studies

The basic concept with a reservoir fall study is to calculate the decrease in volume of water in a reservoir during a low usage time of day and year to estimate the lost water occurring during that period. The study has been conducted once a year in the middle of the night in early spring or late fall when customers are not irrigating. The water levels in all reservoirs are monitored over a several hour period. Where possible, wells are shut down to simplify the test results. The system lost water (including unaccounted for water through private service lines) is estimated as the difference between the decreased storage volume in the reservoir and the calculated customer water usage during the test. It is assumed that customers use 0.25 times their average day consumption, based on literature research conducted by MWC. When comparing data between years, it is important to note that the system size has increased over time; through main extensions, infill, and purchases of neighboring water systems. Major purchases included the Linda Vista system in 1998 and the Missoula Water Works System in 2001. Table 1 summarizes the total lost water measured during these 1 day tests:

Table 1- Reservoir Fall Study Results

Year	Estimated Leakage (gallons per minute, gpm)
1999	7,246
2000	7,660
2001	7,939
2002	8,409
2003	7,983
2004	8,058
2005	8,415
2006	8,420
2007	8.963
2008	8,131
2009	7,799
2010	8,455
2011	8,050
2012	7,590
2013	7,720

Table 2 provides a further breakdown of the 2012 leakage test by storage zone for the 4 zones with an estimated leakage of at least 100 gpm. These 4 zones account for 97% of the total leakage in the system. As shown in Table 3, the South Zone, which is the valley floor south of the Clark Fork River, has the highest amount of leakage with 62% of the total leakage. The North zone, which is the valley north of the river and a portion of the Lower Rattlesnake valley, accounts for an additional 29% of the total leakage.

Table 2-Leakage and Pipe Data for the Highest Leakage Zones

Zone	Estimated 2012 Leakage (gpm)	Miles of main in zone	Miles of "Priority" mains
South	4,715	118	16
North	2,232	81	12
# 2 Reservoir	246	11	0.5
East Missoula	153	10	0
Total	7,346	220	28.5

Table 2 also shows the total quantity of "priority" mains in those zones, which includes Kalamein pipe (steel), Invasion pipe (WWII surplus steel) and other pipe types greater than 75 years of age. As discussed in Section 4 of this report, these are the categories of pipes that have been given the highest priority for main replacement, based on the belief that they have the highest leakage rate and are at or nearing the end of their useful life. Table 3 provides a breakdown by type of pipe for the number of repaired leaks from the period of 2000-2011. As shown, Kalamein and Invasion pipe have a significantly higher frequency of leaks than all other pipe types. Figure 1 shows the locations of the priority mains in the MWC system.

Table 3-Number of Repaired Leaks per Mile by Pipe Type

Type of Pipe	Number of Leaks Per Mile (2000-2011)
Invasion	8.5
Kalamein	5.8
Asbestos cement	2.1
Steel	1.4
Cast Iron	1.1
Galvanized	0.7
PVC	0.1
Ductile Iron	0.1

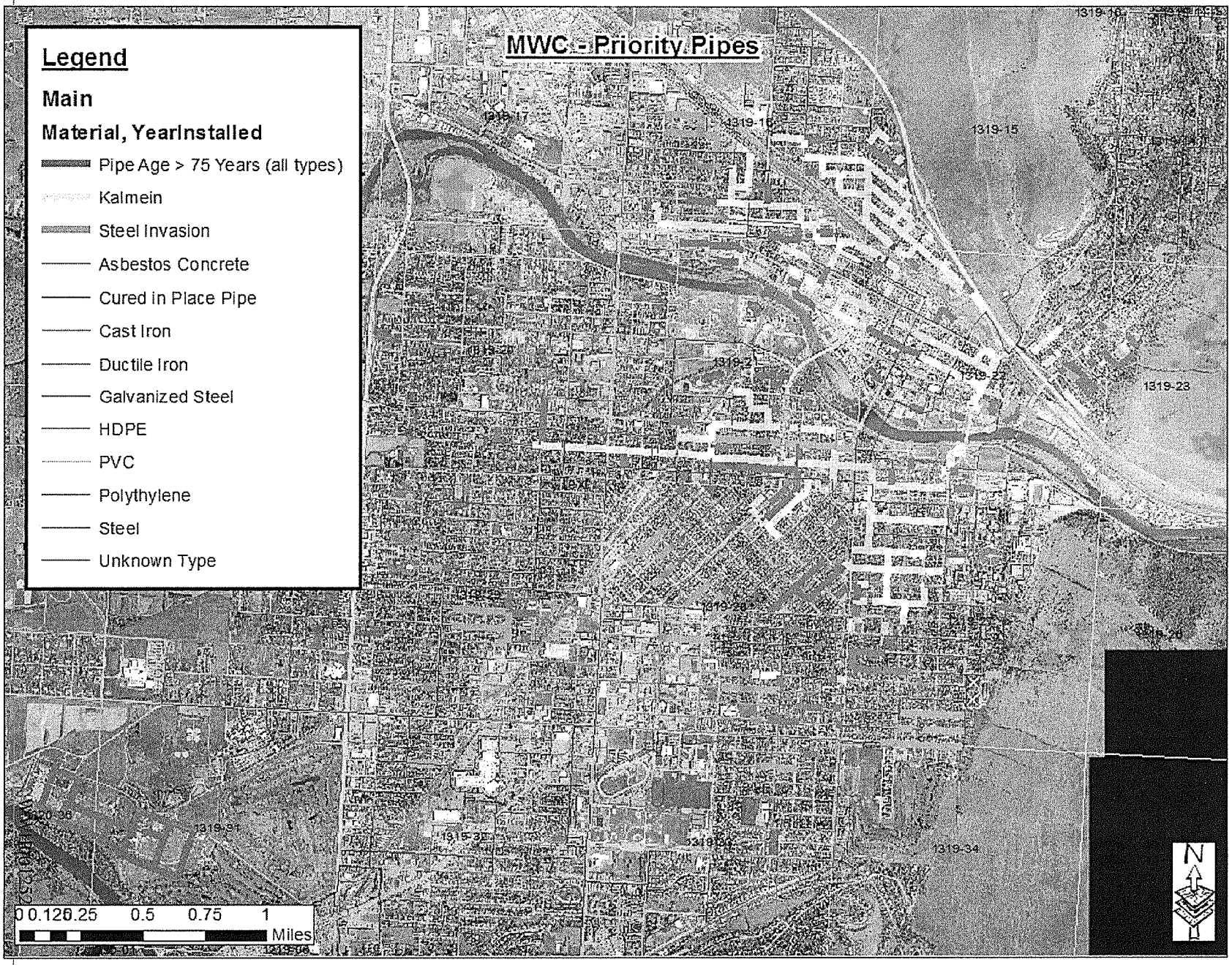

Figure 1 - Map of Priority Water Main Pipes

2.3 Water Audits

A water audit is a water balance that accounts for the total volume of annual production, as compared to the one night snapshot assessed during the reservoir fall studies. The water audit is a more widely used method than the reservoir fall study and theoretically should be a more robust method for determining annual losses in the system. However, the large number of flat rate accounts (17%) in MWC's system introduces a significant level of uncertainty into the results of the water audit. Also as with the reservoir fall studies, there is no practical way to differentiate between service line leakage and water main leakage.

The America Water Works Association's Water Loss Control Committee has designed a spreadsheet-based tool to help quantify and track water losses associated with water distribution systems. The tool is called the "AWWA Water Audit Software Version 4.2 (May, 2010)". MWC has been using this tool for the past few years. The basic function of the model is to separate the total measured volume of water produced by MWC's 37 production wells into the following components of water "usage":

- Billed metered consumption: metered customers
- Billed unmetered consumption: flat rate customers
- Unbilled metered: Includes water used by MWC for system operations, hydrant flow testing, city fire trucks, drinking fountains, etc.
- Unbilled unmetered: includes water used for fire fighting, etc. AWWA recommends a value of 1.25% of water produced.
- Real losses, including main losses, tank overflows and customer service line leakage

In addition, there are apparent losses that include unauthorized consumption (theft, illegal connections, etc.), customer metering inaccuracies, and systematic data handling errors that could also be considered losses or non-revenue water. These were not included in Table 4 in an effort to more accurately reflect what could be considered leakage.

AWWA Water Audit Summary: Because flat rate consumption is unknown, an assumption must be made. The two tables below provide results of the AWWA Water Audit. Table 4 assumes flat rate usage is equal to metered usage and Table 5 assumes that flat rate customers use twice as much water as metered customers.

Table 4. Assuming FLAT RATE Consumption = Metered Consumption Per Account

Million gallons / Year	2010	2011	2012
Total Water Produced	8300	8471	8658
Metered Consumption	3131	3295	3532
Unbilled Metered	0.984	1.349	1.297
Unbilled Unmetered	103.7	105.9	108.2
Unauthorized Unmetered	20.75	21.18	21.65
Flat Rate Consumption	783	750.7	722
Number of Flat Rate Customers	4397	4094	3870
Number of Metered Customers	17575	17972	18932
Water Loss (%)	51.6%	51.0%	48.2%

Table 5. Assuming FLAT RATE Consumption = 2.0 Times Metered Consumption Per Account			
Million gallons / Year	2010	2011	2012
Total Water Produced	8300	8471	8658
Metered Consumption	3131	3295	3532
Unbilled Metered	0.984	1.349	1.297
Unbilled Unmetered	103.7	105.9	108.2
Unauthorized Unmetered	20.75	21.18	21.65
Flat Rate Consumption	1566	1501	1444
Number of Flat Rate Customers	4397	4094	3870
Number of Metered Customers	17575	17972	18932
Water Loss (%)	42.2%	42.1%	39.3%

In 2011, the AWWA water loss control committee completed a water audit data collection initiative to create a dataset of validated water audit data to be used for reliable utility benchmarking. Twenty one utilities participated. Some of the results are summarized below along with MWC data.

Table 5. Comparison with Other Utilities		
Key Performance Indicator	Average	MWC 2012
Non-Revenue Water (% of Volume)	22.6%	40.5%
Real Losses (gals/connection/day)	63.32	310.65
Non-Revenue Water (% by Cost)	10%	6.1%
Infrastructure Leakage Index[1]	3.57	14.01

Notes:

1. The ratio of the Current Annual Real Losses to the Unavoidable Annual Real Losses. The general guideline presented in the AWWA Audit Software states the following for an ILI greater than 8.0. 'Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 – other than as an incremental goal to a smaller long-term target – is discouraged.'

As shown in Tables 4 and 5, the assumption used for the multiplier of average flat rate usage to average metered usage results in a significant change in the estimated volume of annual Total Real Losses (i.e. leakage). MWC believes that flat rate customers do use more water than metered customers; in fact, MWC's tariffs assume flat rate customers use twice as much water as metered customers.

2.4 Valve-to-Valve Leakage Studies

In 2012, MWC began pursuing a new concept of measuring leakage in individual segments of main in areas where leaks are likely to occur. These are short term tests that are typically conducted during the mid-morning hours to avoid nighttime work and to target a relatively low water usage time of day. As with the Reservoir Fall studies, the valve-to-valve studies are conducted at low usage times of the year

(i.e. early spring) to minimize the influence of customer irrigation during the day.

The basic concept is to set up a temporary metered supply of water to a main (referred to here as Main A for simplicity) to be tested for leakage. All other feeds to Main A are then eliminated by closing all other valves connected to it. The flow of water into Main A is then measured for a short period of time until the flow stabilizes. Then, an additional segment of main (Main B) will be added to the test by opening the valve between Mains A and B and closing all other valves connected to Main B. The flow of water to Main B (including customer usage and leakage) is then calculated as the total flow minus the flow measured previously in Main A. Additional segments of main are added sequentially to the test, but the test duration is typically minimized to try to minimize the changes in flow that can occur as customer usage changes during the day.

The temporary metered supply can be set up in a number of different ways. MWC has a few pumping facilities (East Missoula Boosters and Whitaker Boosters for example) that have solenoid operated valves (SOV's) with flow meters that can be utilized to feed the mains directly adjacent to those facilities. All other areas to be tested require an excavation crew to dig down at a valve that can isolate the area to be tested and install a blowoff on both sides of that valve. A blowoff is typically a small diameter (often 2" or 3") tee off a main with a valve and a riser pipe up to the ground surface. Blowoffs are typically used for flushing water out of a main but a blowoff can also be used as a point to discharge water back into a main from another blowoff.

Once the two blowoffs are installed at an isolation valve, MWC's distribution crew can then run a short term flow test by installing temporary piping with a flow meter above ground between the two blowoffs. The valves on both blowoffs are then opened to direct flow from one blowoff into the other and then all other valves feeding that particular main are closed to isolate it from the system. The flow meter can then be read to give a total flow reading into that main (i.e. customer usage plus leakage). Once the two blowoffs are installed, they will be available for future leakage testing as well. One limitation of these tests is that high flows through a single small diameter temporary piping connection will reduce the pressure to the area being tested; thus measured leakage rates could be somewhat lower than leakage at normal system pressures.

It is not practical to measure actual customer usage during these short term tests. Thus, an estimate of customer usage must be applied in order to calculate the leakage component. Most of the valve-to-valve tests have occurred in residential areas where daytime usage is typically fairly low. MWC compared the mid-morning daytime use on March 25, 2013 in several metered zones fed by Pressure Reducing Valves (PRV's.) These zones include a total of 1,320 customers, making a reasonable sample size for comparison of customer usage in other parts of the system. The customers in those PRV zones used an average of 0.22 gpm/customer (about 75% of the annual average usage per metered customer).

The locations of the valve-to-valve leakage tests conducted in 2012 and 2013 are shown in Appendix A. As indicated, the tests were primarily focused on the area north of the Clark Fork River, in the "North" pressure zone. The north zone was the focus of the initial studies because MWC has placed a higher priority on main replacements in the downtown area (as described in Section 4), which lies within the

north zone. This higher priority results from the age and condition of the infrastructure, the pipe types, and a desire to minimize business interruptions during leak repairs and because the City of Missoula tends to focus its street reconstruction projects in the downtown area as well. Table 6 provides a summary of these 2012-2013 leakage tests. As shown in Table 6, MWC crews have leak tested a total of 27 miles of pipe in the system and have identified a total leakage rate of 1,270 gpm. This estimated leakage represents 72% of the total measured flow during these tests, with the estimated customer usage making up the difference. The 27 miles tested include 7 miles (50% of the total) of Kalamein pipe, 1.5 miles (30% of the total) of Invasion pipe and a total of 10.6 miles of "priority" mains (37% of the total). While 1,270 gpm is a substantial amount of leakage, it is dispersed over a significant length of main and the tests have only been able to pinpoint a small number of leaks that would warrant the cost of repair. The 1,270 gpm of leakage represents approximately 17% of the total measured leakage rate in 2012. There are an estimated 2,257 customer service lines connected to the segments of main tested. Assuming an average of 60 feet of pipe for each service line, there is an additional 26 miles of buried service lines which are potential locations for leakage.

Appendix A also contains a detailed map of each leak test area, which show the segments tested and the total flow on the segment.

Table 6- 2012-2013 Valve-to-valve leakage studies

Test Name	Pressure Zone	Date	Number of customers on tested mains	Measured Flow (gpm)	Estimated Leakage (gpm)	Miles tested	Leaks Found and/or repaired
5th St	South	3/14/2013	288	377	314	2.9	84 gpm leak to be repaired near 5th/Russell
East Broadway	North	4/24/2012	207	383	337	3.6	180 gpm leak located and repaired in April, 2013
Lower Snake	North	2/13/2013	210	105	56	1.9	
Main St	North	4/9/2012	175	309	271	3.5	94 gpm on Main St, which was replaced in 2012; An additional service leak has been identified on a pipe segment with a measured leakage of 45 gpm
North Side 1	North	4/4/2013	535	299	181	4.8	
North Side 2	North	4/18/2013	800	287	111	9.9	
Whitaker Crestline	Lower Farviews	1/3/2013	42	0	0	0.5	
		Total	2,257	1,760	1,270	27.0	

Table 7 provides a breakdown of flows and quantities of pipe tested in the North and South pressure zones. The tests to-date have assessed 70% of the "priority" mains in the North Zone but only approximately 15% of the priority mains in the South zone. MWC's crews intend to focus more effort in 2014 in the South zone. The nature of these tests doesn't allow them to focus solely on the priority mains. As valves are opened to add segments of pipe to the test section, some of these segments may be old pipe while others may have been replaced in recent years.

Table 7- Summary of valve-to-valve tests for North and South zones

Zone	Total Miles of main	Total miles of main tested	Total miles of "Priority" Mains	Total Miles of "Priority" Mains Tested	Total Leakage in 2012 Reservoir Fall Study (gpm)	Total Flow in Valve-to-Valve Tests (gpm)
North	81	24	12	8.3	2,232	1,383
South	118	3	16	2.4	4,715	377

MWC normalized the estimated flow on all 92 segments tested to the length of the segment in order to identify possible leaks. The highest normalized flow of any pipe segment is 17 gpm/100 ft and only 10 pipe segments have greater than 4 gpm/100 ft of measured flow. For comparison purposes, MWC has previously calculated that a cost effective main replacement (i.e. one where the savings in leakage reduction equals the amortized capital cost of replacing the main) requires approximately 27 gpm of leakage per 100 feet of pipe. It is important to note that MWC believes it needs to plan for replacement of its aging buried infrastructure prior to catastrophic failure. Therefore, most main replacement projects will not be economical solely from the savings in reduced leakage but from the avoided future cost associated with catastrophic failure.

Table 8 provides further detail on the 21 segments of main with the highest leakage rate per 100 ft and identifies whether there are any specific plans for replacement in the capital budget. For some projects, it is noted that MWC "will consider in 2014-2018 CIP". These projects will be weighed against projects tested in future years to determine the replacement priorities in those years

Table 8- Segments with highest flows per 100 ft

Test Name	Location	Measured Flow	Length (ft)	Flow (gpm/100 ft)	Comments
5th St	5th St - Prince to Russell	84	489	17.2	Planned leak repair s replacement 2015
E Broadway	Eastgate Shopping Center	176	1237	14.2	Customer has repaire correlation study
Main St	Main-Higgins to Ryman	37	321	11.5	Main Replaced 2012
5th St	4th St - Orange to Myrtle	80	1083	7.4	Will correlate 2013; I
Lower Snake	Van Buren-Poplar to Locust	55	832	6.6	High asphalt penaltie
North Side 1	Cooper-Burton to Hawthorne	49	796	6.2	Will consider for elir CIP
Main St	Main-Pattee to Adams	46	840	5.5	Main Replaced 2012
Lower Snake	Cherry Locust alley Monroe	3	71	4.2	No plans at this time
5th St	Ash-4th to 5th	32	767	4.1	Will consider for elir CIP
E Broadway	E Broadway-Jackson to east of Van Buren	74	1843	4.0	Planned for replacen
Main St	Broadway-Pattee to Madison	45	1122	4.0	Planned for replacen
Main St	Madison-Front to Spruce	43	1177	3.7	Replacement starting
North Side 1	Cooper-Waverly to Milton	29	806	3.6	Will consider for elir 2014-2018 CIP
Main St	Pine-Higgins to Washington	28	800	3.5	Planned for eliminati
North Side 1	Cooper/Toole alley from Bulwer to Hawthorne	36	1086	3.3	Will consider in 2014
Lower Snake	Monroe-Vine to Poplar	10	320	3.1	Will consider in 2014
5th St	5th St - Russell to Washburn	12	389	3.1	Will consider in 2014
North Side 1	Cooper/Toole alley from Bulwer to Burns	27	886	3.0	Will consider in 2014
North Side 2	N 1st	20	658	3.0	Will consider in 2014
5th St	5th St - California to Ash	32	1061	3.0	Planned replacemen
5th St	5th St - Myrtle to Orange,	42	1508	2.8	Planned replacemen

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2.5 Acoustic Studies

Acoustic testing is based on the concept that water moving in a piping system (or leaking out of the piping system) generates noise which is then transmitted along the pipe. Data logging devices can then be placed at access points to that pipe (typically at valves) to monitor, analyze and record the noise signal. Acoustic testing is more effective in steel and ductile or cast iron pipes than it is in plastic pipes because the speed of sound in plastic is much lower than in metallic pipes.

MWC's distribution staff use ZoneScan™ acoustic dataloggers that sit on top of valves and detect noise associated with water leakage. MWC owns approximately 70 of these devices and deploys them at various locations around the system to listen for leaks. The devices are set to turn on in the hours of 2 AM- 4 AM and store noise levels on intervals set by the operator. When the noise data is downloaded, the software package gives a "leak value" which indicates the likelihood that the acoustic signal is caused by leaking water. Since the acoustic signal is caused by moving water, it could also indicate customer water usage at that time.

The dataloggers are typically deployed in areas where MWC suspects leakage may be occurring or in response to customer requests for leakage investigations. Leakage may be suspected in a particular area for a number of reasons including:

- Valve-to-valve study indicated a leak in area,
- Customers in an area are complaining about noise on their service line, or
- An area of a street surface is observed to be settling

As of 4/22/2013, dataloggers have been deployed on 91 valves in 10 different areas of the system in 2013. These datalogger installations result in conducting acoustic testing on approximately 16 miles of main, only 0.5 miles of which overlaps with the valve-to-valve studies. Thus, between the dataloggers and valve-to-valve studies, MWC crews have conducted leakage assessments on nearly 43 miles of main in 2012-2013.

The datalogger readings at 30 of the 91 valves tested were either "Leak Indicated" or "Possible Leak", while the remaining readings did not indicate a leak. Four of the 10 areas investigated did not show any indication of a leak. Leaks were indicated but have not been pinpointed in 3 of the 10 areas investigated. Future work will attempt to pinpoint possible leaks in those areas. Leaks were pinpointed at 3 of the 10 areas, including one water main break on Pattee Creek Drive that was repaired. The other 2 pinpointed leaks were service line leaks on West Broadway that were further investigated using MWC's "correlator" as described below.

MWC's distribution staff also utilize a Tri-Corr Touch™ leak correlator by Fluid Conservation Systems. The correlator is often utilized after dataloggers indicate the presence of a leak in an area. This system incorporates two acoustic sensors that are installed on either end of a pipe segment where there is a suspected leak. The acoustic signals from both sensors are processed by the correlator to pinpoint the actual location of a leak on the segment.

As of 4/22/2013, the correlator has been used in 6 areas of the system totaling 1.8 miles. Four of those

investigations have identified leaks as follows:

- A significant service line leak was found and repaired near the Eastgate Shopping Center. That service line had a measured leakage of 180 gpm during the 2012 Main Street valve-to-valve study.
- A leak at 5th/Russell has been identified; this leak is on a segment of main with a total flow of 84 gpm in the 5th St. valve-to-valve study. This leak is scheduled for repair in 2013.
- A service line leak in the 200 block of West Broadway has been identified; the 1,100 lineal foot segment of main it is connected to had a measured leakage of 45 gpm in the 2012 Main Street valve-to-valve test. The Owner has scheduled the service line to be repaired.
- A service line leak has been identified on a 2-inch main crossing Broadway at Hawthorne. That main has been cut off from the system and the service line abandoned.

2.6 Leakage Testing Summary

Quantifying, locating, and repairing leakage in MWC's system is a very complicated process. MWC has developed and refined processes for quantifying the leakage starting from the "high level" system-wide reservoir fall studies, to the neighborhood level valve-to-valve leakage studies, and finally to the block level acoustic studies that attempt to pinpoint actual locations of leaks. While overall, the valve-to-valve tests to date have studied 37% of the oldest pipe in the system and quantified 17% of the total estimated leakage, they have identified only a few sizeable leaks. The leakage identified in most of these tests tends to be widespread throughout the system and present in small volumes on many segments of main. MWC will need to replace significant lengths of main in order to make a measurable difference in the total leakage rate. MWC crews will continue to refine their methods for quantifying leakage and pinpointing leaks, as well as to widen the scope of testing.

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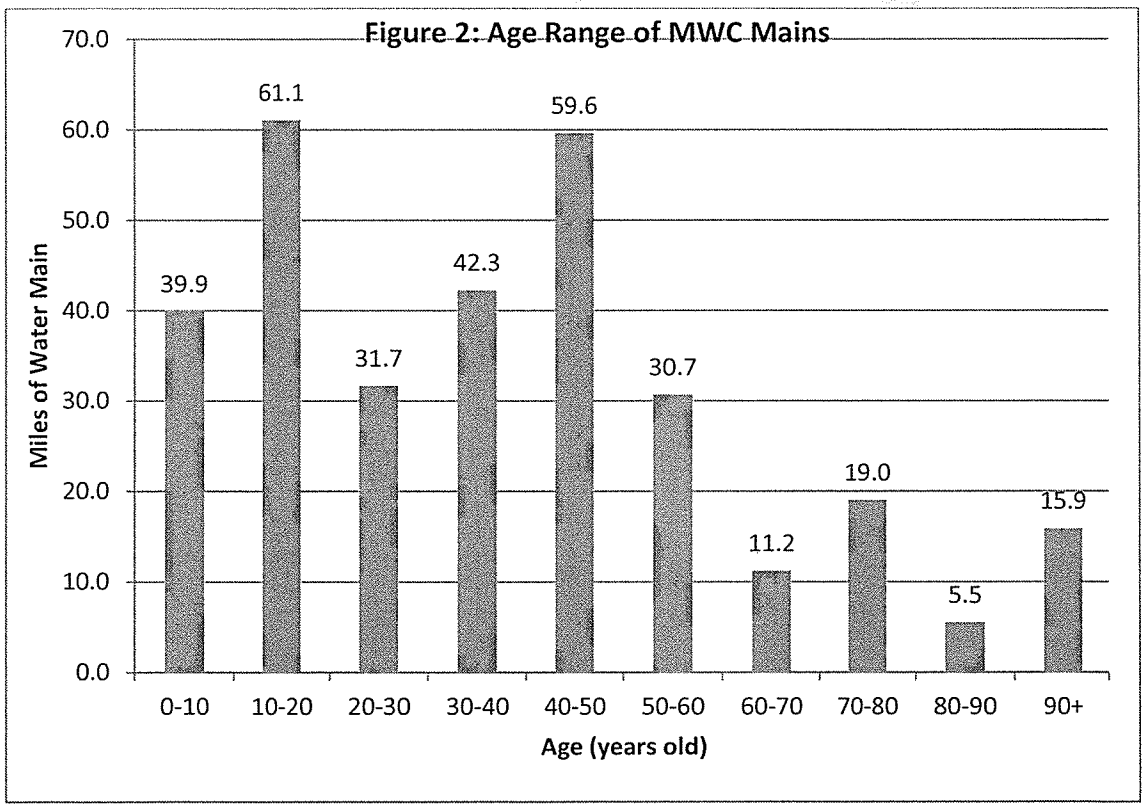
3. Asset Management Study for Water Mains

MWC owns approximately 320 miles of buried water mains. The age range of these mains is summarized in Figure 2. Like most communities in the United States, MWC believes it has not been replacing water mains at a sustainable rate. The lack of adequate funding for infrastructure replacement in the U.S. has been well documented by organizations such as the American Society for Civil Engineers (ASCE), the American Water Works Association (AWWA) as well as the US Environmental Protection Agency (USEPA). AWWA's 2012 Report titled "Buried No Longer: Confronting America's Water Infrastructure Challenge" (AWWA, 2012) estimated a need for $1 trillion for repairing and expanding U.S. drinking water infrastructure in the next 25 years. The ASCE 2013 Report Card for America's Infrastructure gives drinking water a "D" and also calls for more than $1 trillion dollars for infrastructure replacement.

> **Aging Infrastructure:**
> Average pipe age in the MWC system is 36 years. According to the EPA website, about 40% of the national drinking water pipes are greater than 40 years



In the last few years, MWC has ramped up its annual main replacement budget from a very small percentage of its capital budget to approximately $1 million/year. Depending on the size and location, main replacements typically cost anywhere from slightly less than $1 million/mile for 8" diameter mains in neighborhood streets to nearly $3 million per mile for large diameter mains in major arterials. Thus, at the best case in current conditions, MWC is replacing approximately 1 mile of main per year. To date, the budgeted amount for main replacements has not been tied to any reasonable estimate of a sustainable rate of replacement.

In 2013, MWC identified a need to quantify a sustainable rate of main replacements, with the knowledge that any increase in required capital budget would also need to be sustainable with respect to affordability for MWC's customers. After conducting literature research into the available methodologies for determining main replacement frequencies, MWC became aware of a statistical package called "KANEW"™ that was developed and tested in AWWA-Research Foundation Project No. 265 "Quantifying Future Rehabilitation and Replacement Needs of Water Mains" (Deb, A.K., Y.J. Hasit, F.M. Grablutz, and R. K. Herz, 1998). KANEW software is based on a cohort survival model and allows the calculation of residual service lives and annual rehabilitation needs on the basis of service life distributions. KANEW forecasts the length of main that needs to be replaced or rehabilitated annually for a given forecast horizon. The calculation is based on the current inventory of assets classified by installation years and asset types with specific service lives.

A Larger Context:
ASCE released its 2013 Report Card for America's Infrastructure, giving drinking water a D – Poor: At Risk. "Delaying the investment can result in degrading water service, increasing water service disruptions, and increasing expenditures to emergency repairs."

MWC stores system data in several ways including GIS, AutoCAD, and Fixed Assets (accounting). This inventory data was imported into KANEW for all years available, 1910 to 2012.

3.1 Determining Pipe Life Expectancies

KANEW uses three data points to create a service life curve, these data points correspond to the anticipated average years of pipe life remaining, by percentage. For example, in Table 1 below, 100% of the AC pipe should last for 60 years, 50% of the AC pipe will have reached its useful life at 80 years old, and 10% is expected to last 100 years or more.

Steel Pipe with a History:
MWC currently has about 5 miles of Steel 'Invasion' pipe. This pipe was reportedly used during WWII as a way to transport oil and gas – chosen because it was light, easy to handle and inexpensive. After the war, there was a surplus and it was commonly used in temporary facilities; however, it was never intended for permanent infrastructure.

MWC conducted a literature search, specifically using the Deb, et. al (1998) study that developed the KANEW software. That study provides pipe life expectancies used in KANEW models for various water systems around the U.S. The age ranges given in this document were averaged and a standard deviation was calculated.

AWWA (2012) also provided typical life expectancies for various pipe types with "short life expectancies (i.e. due to poor soils, installation practices, etc.) and "long life expectancies". MWC"s selected values for pipe materials were also compared to those values.

MWC examined our inventory data that shows when pipes were installed and when they were removed or replaced. The 100% values (100% of a particular pipe cohort is still in the ground, fully functional) came directly from MWC actual data that shows when a particular pipe cohort started to be removed or replaced. The 50% and 10% values are based on institutional knowledge, literature reviews, and were shown to be within one standard deviation of the values from other communities described in Deb et. al (1998).

It should be noted that each system is unique in terms of pipe type, construction methods (proper

bedding, corrosion protection, etc.), soils (corrosive vs. non-corrosive), etc., therefore, specific system knowledge is helpful in determining pipe life expectancies and they will vary from system to system. For the most part MWC's mains (and in particular our oldest mains) are installed in soils that not highly corrosive.

Table 9 summarizes the life expectancies for each pipe type in the MWC system and compares them with assumptions used for several other municipalities (Deb et. al, 1998).

Table 9. Pipe Life Expectancies (in years) for MWC and Other Water Systems

	% of pipe life remaining	MWC	Philadelphia WS	Los Angelos DWP	Boston WSC	Fort Worth	Nottinghamshire
Asbestos Concrete	100%	60	50 to 70	40 to 60	- - -	85	50 to 55
	50%	80	110 to 130	60 to 90	- - -	100	60 to 70
	10%	100	150 to 180	90 to 110	- - -	120	70 to 90
Cast Iron	100%	70	45 to 65	20 to 30	60 to 90	50	70 to 75
	50%	90	110 to 130	30 to 50	70 to 100	80	80 to 90
	10%	115	140 to 160	50 to 75	80 to 120	120	90 to 110
Ductile Iron	100%	70	60 to 80	40 to 50	100 to 120	60	15 to 15
	50%	100	120 to 140	60 to 85	110 to 130	90	25 to 30
	10%	130	160 to 190	85 to 100	120 to 150	130	35 to 50
Galvanized	100%	80	- - -	- - -	- - -	-	- - -
	50%	90	- - -	- - -	- - -	-	- - -
	10%	110	- - -	- - -	- - -	-	- - -
Steel 'Kalmein'	100%	75	- - -	- - -	- - -	-	- - -
	50%	90	- - -	- - -	- - -	-	- - -
	10%	110	- - -	- - -	- - -	-	- - -
PVC	100%	70	- - -	- - -	- - -	100	20 to 25
	50%	90	- - -	- - -	- - -	130	30 to 40
	10%	115	- - -	- - -	- - -	150	40 to 60
Steel	100%	65	50 to 70	50 to 60	70 to 100	-	30 to 35
	50%	80	115 to 135	60 to 80	80 to 120	-	40 to 50
	10%	100	150 to 170	80 to 110	100 to 150	-	50 to 70

Steel 'Invasion'	100%	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	50%	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10%	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-

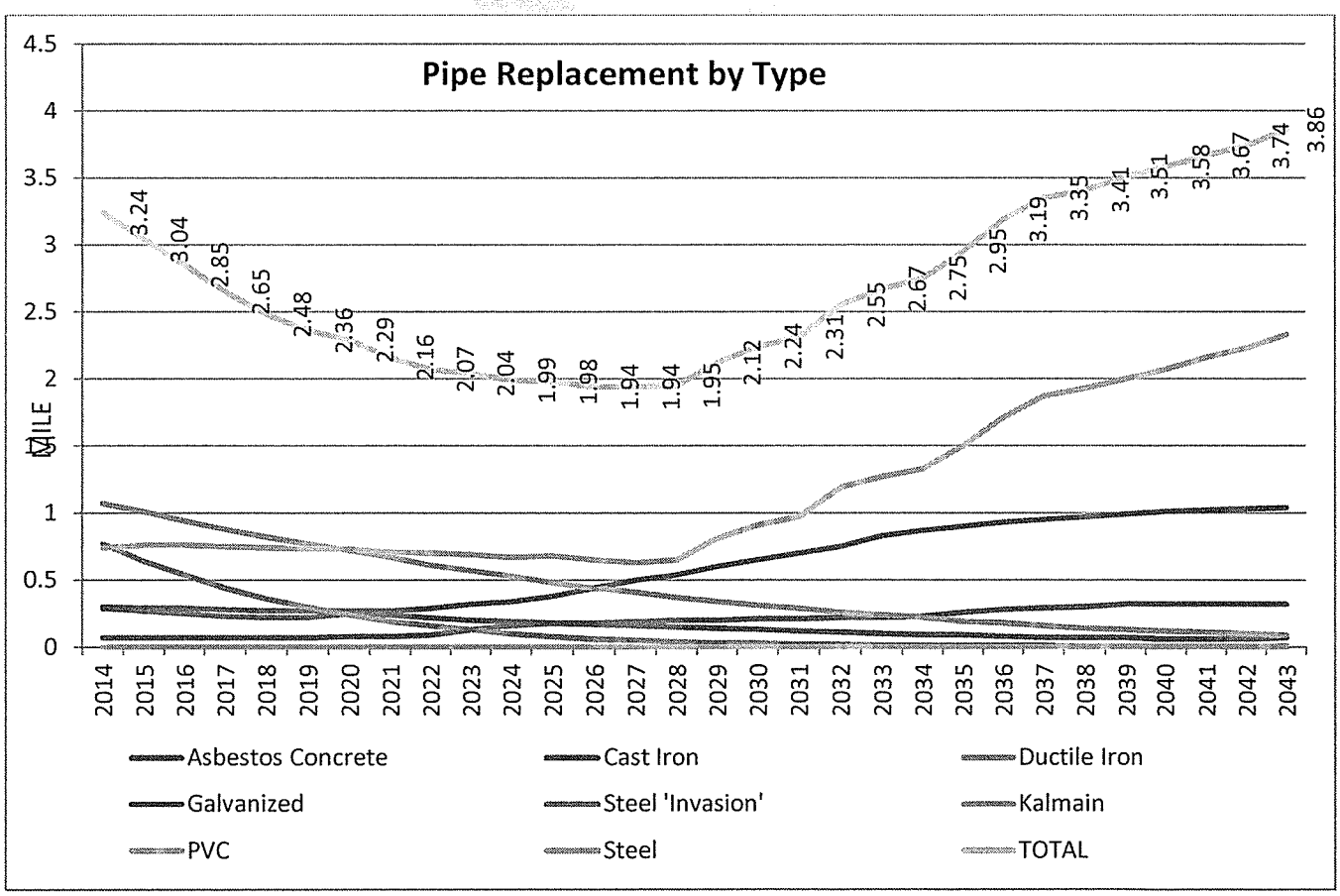
3.2 KANEW Results

The results indicate that a replacement cycle of 2.48 to 3.24 miles per year is required to keep pace with the life expectancies for pipe in the MWC system over the next 5 years, as shown in Table 10.

Table 10. Length of Water Mains to be Replaced

Year	Total Miles
2014	3.24
2015	3.04
2016	2.85
2017	2.65
2018	2.48

Figure 3 shows a 30-year projection of the required main replacements by type of pipe as well as the total annual replacement frequency.



4. Project Prioritization

MWC uses a project matrix as an initial tool in evaluating our water mains. The project matrix includes several criteria and weighting factors that help prioritize the water mains. These criteria are described below;

- Number and cost of leak repairs: priority is given to pipes that have had leaks in the past, and pipes that are located in areas where leak repairs are costly due to difficult construction, expensive traffic control, or disruption to the residents, businesses, or community facilities.
- Pipe type & pipe age: As described in Section 2, greater priority is given to pipes greater than 75 years of age and pipe types (Kalemain and Invasion) that are prone to leaks or pipe failure.
- Soil conditions: priority is given to pipes built in areas of poor soils conditions, as this can speed pipe deterioration.
- Community impacts: priority is given to water mains that serve critical community facilities (such as hospitals, elder care facilities, schools, etc.) and to water mains in areas that would have a large impact to the community if the water main was to leak or fail.
- Transmission mains – priority is given to larger, more critical infrastructure such as large water mains.

The project matrix is included in Table 11.

In addition to these criteria, we work closely with the City of Missoula to coordinate our projects with work on their public works projects. Each year, the city releases a list of anticipated projects, and MWC will determine whether or not it's appropriate to complete a water main replacement project ahead of or in conjunction with a city streets project. This can minimize the impacts to a neighborhood by having utility and road repair work occur at once. MWC also attempts to group together projects by neighborhood where practical in order to avoid impacts to residents and businesses in successive years.

Table 11. Project Matrix

Criteria Description	Criteria 1					Criteria 2 (multiply by criteria 1 for total score)			Max Score
Number and Cost of Leak Repairs	≥	5	per 1000 ft =	3	points	Arterial (or critical infrastructure or hilly) =	3	points	
	≥	2	per 1000 ft =	2	points	Collector =	2	points	
	≥	0	per 1000 ft =	1	points	Local =	1	points	9
Coordination with Street Projects / Other Infrastructure (railroads, etc)			Yes =	6	points				
			No =	0	points				6
Pipe Type, Age and soil conditions			INV =	6	points				
			KAL =	6	points				
	≥	75	years =	4	points				
			Bad soils =	2	points				
			Other =	0	points				6
Transmission/Distribution	≥	10	inches =	6	points				
	≤	10	inches =	0	points				6
Community Impacts			Critical =	3	points				
			Commercial =	2	points				
			Residential =	0	points				3
								Total	36

5. Project Selection

After analyzing data currently available from the sources described above, MWC put together a list of water main replacement projects for 2014-2016, included in Table 13. The project list closely matches the number of miles of main identified for replacement in the KANEW study.

MWC tracks bid tabulations and actual project costs for all water main replacement projects. Using these numbers, we estimate the cost of future projects. These costs are further refined as project details are determined. Current project cost estimates are shown in Table 12. In addition, the ENR construction cost index was averaged for the past 10 years, and the resulting +3.69% was applied to each future year.

Table 12: Project Cost Estimates ($/LF)

Residential		Downtown / Commercial	
6	$150	6	$210
6" CIPP	$175	6" CIPP	$245
8	$175	8	$300
12	$225	12	$350
16	$275	16	$385
24	$350	24	$490

Table 13: Water Main Replacement Projects 2014-2016

PROJECT NAME	RATING		PIPE SIZE	PIPE TYPE	LENGTH	PROPOSED SIZE	COST
Spruce-Nora to May	★★★	1/2	12	KAL	677	12	$253,064.00
*Pine - McCormick, two blocks west; McCormick - Pine to Spruce			6	kal	1165	8	$362,397.00
Hawthorne - Pine to Broadway	★★★		4	KAL	312	8	$58,005.00
Pine-Higgins to Adams (flop services, 12 to 24")	★★	1/2	12	KAL	1100	12	$192,241.00
Helen-Keith to Beckwith (eliminate main)	★★		12	KAL	360	NA	$21,360.00
Front-Madison to Jackson, Jackson-Front to Broadway, Broadway-Jackson to W. of Vanburen	★★	1/2	6	INV	1268	8	$459,670.00
*Monroe - Front to Broadway, Front - Jackson to 90 to Broadway, Broadway - Jackson to 12" tie in, abandon 4" Kal in Broadway		-	2	gal	1074	8	$354,827.00
Pine-Adams to Madison	★★	1/2	12	KAL	750	12	$280,352.00
3rd St. - Darlene to 10" E (just past Davis St.)	★★		6	ST	370	12	$88,912.00
N 2nd St. @ A St.	★	1/2	6	INV	182	-	$53,400.00
Crestline-High Park to 39th	★★		6	ST	655.601	8	$122,533.00
Crestline-39th to Whitaker		-	6	AC	1430	8	$259,484.00
Jefferson - Spruce to Pine	★	1/2	12	KAL	325	8	$101,098.00
5th St. - Russell to Orange	★★		6	KAL	3740	8	$678,651.00
5th St. - Orange to Higgins	★	1/2	6	KAL	1450	8	$263,113.00
S. 5th- Russell to Grant	★	1/2	6	KAL	1920	8	$597,254.00
Pine - Higgins to Ryman	★	1/2	6	KAL	310	8	$56,252.00
			3.24	miles	17088.6	**TOTAL**	**$4,454,783.00**

PROJECT NAME	RATING	-	PIPE SIZE	PIPE TYPE	LENGTH	PROPOSED SIZE	COST
Broadway-Pattee to Madison	★★★	1/2	12	KAL	1534	12	$593,819.00
MADISON STREET/RIVER-S 5TH E (replace both 16", plus pipe from well)	★★	1/2	16	KAL	1415.22	16	$430,444.00
WORDEN AVENUE-Sherwood to Defoe	★		6	KAL	923	8	$173,446.00
Howell-Worden to Milton	★	1/2	4	KAL	985	8	$185,096.00
RONALD AVENUE-University to BECKWITH	★		6	KAL	1051	8	$197,499.00
Pine - Woody to Owen	★	1/2	6	KAL	745	8	$239,994.00
S 1ST W/HICKORY-WALNUT	★	1/2	6	KAL	347	8	$65,171.00
S. 4th-Higgins to Orange	★	1/2	6	INV	1400	8	$450,996.00
4th St. - Orange to Ivy	★		6	KAL	2219	8	$416,983.00
Burns St - Cooper alley to Sherwood alley & sherwood alley	★	1/2	6	KAL	683	8	$128,346.00
Railroad - Orange to McCormick, flop services on Alder - McCormick to Owen	★	1/2	6	KAL	933	8	$175,325.00
Kensington-Grant to W of Grant	★	1/2	6	INV	257	8	$48,294.00
Philips-Worden to Holmes	★	1/2	6	KAL	726	8	$136,426.00
Woodworth-Mansfield to Madeline	★	1/2	6	INV	340	8	$63,891.00
Fairview-Eaton to E of Schilling	★	1/2	6	INV	663	8	$124,588.00
Spruce-Higgins to Adams	★	1/2	12	ST	1200	12	$450,996.00
ASH STREET-S 3rd-S to Oak	★		6	KAL	670	8	$125,903.00
			3.05	miles	16091.2	**TOTAL**	**$4,312,617.00**

PROJECT NAME	RATING	-	PIPE SIZE	PIPE TYPE	LENGTH	PROPOSED SIZE	-
Strand-Grant to W of Kemp	★		6	INV	1231	8	$239,273.00
BECKWITH AVENUE/RONALD TO Higgins	★		6	KAL	1249	8	$242,771.00
WORDEN AVENUE/DEFOE-1st	★		6	KAL	1083	8	$210,505.00

DEFOE STREET/DICKENS-Worden	★		6	KAL	1400	8	$272,122.00
Artemos	★		6	AC	2520	8	$489,819.00
ALLEY BTWN SHERWOOD & COOPER-	★	-	2	GVST	95	8	$18,513.00
Overlook/High Park-39th	★	-	6	ST	748	8	$145,449.00
MCLEOD AVENUE/RONALD-HIGGINS	★	-	6	KAL	651	8	$126,503.00
PACIFIC AVENUE & N 6TH/WORDEN-	★	-	6	KAL	682	8	$132,608.00
Strand-Grant to W of Kemp	★	-	6	INV	1231	8	$239,273.00
Kent- Bancroft to Park	★	-	6	INV	1270	8	$246,853.00
Central-Hilda to Maurice	★	-	6	INV	1400	8	$272,122.00
Burlington-Grant to Schilling	★	-	6	INV	1440	8	$279,896.00
			2.84	miles	15000.6	**Total**	**$2,915,707.00**

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6. Conclusion

The current rate of water main replacement is not adequate to avoid main failures. Because resources are limited, MWC leverages all available technology to identity and quantity leaks in the system. In addition, MWC uses the best available information to evaluate water mains and prioritize them for replacement. In addition, MWC is continually evaluating new technologies for pipe replacement or rehabilitation such as trenchless technologies (MWC has completed pipe bursting, directional drilling, and pipe lining projects in recent years) in an effort to replace water mains in an economical manner without compromising the ultimate longevity of the system.

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FINANCIAL ANALYSIS AND PROPOSED ACTION PLAN FOR WATER LOSS MITIGATION

Mountain Water Company

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I. Executive Summary

In resolution of the general rate application processed under docket D.2009.9.119, PSC Order 6954c prescribed the following in paragraph 26:

"The Commission directs Mountain to include in its future general rate cases, commencing with the general rate case anticipated to be filed in 2010, an action plan that includes projected dates for starting and completing projects to mitigate water supply losses in a cost effective manner."

This document was developed to respond to this order. System characteristics and environment are described, with extensive supplementary detail provided in the Appendix. Factors contributing to water loss are then examined, and a cost analysis is performed to estimate costs to eliminate water loss and the subsequent effect on customer rates. Finally, an action plan is presented that addresses water loss on both Company-owned mains and customer-owned service lines.

Company-owned transmission and distribution main totaled 315.4 miles at the end of 2009. The average age of that pipe is 34.06 years. There are approximately 22,000 active customer-owned services. Total water loss on the system, including both mains and services, is assumed to be 40%, split equally between Company-owned and customer-owned facilities. The leakage rate, as measured in annual "reservoir fall" studies, has been little changed over time.

There are four primary factors that affect leakage:

1. Pipe age
2. Pipe type
3. Soil composition
4. Pressure fluctuations

Steel "invasion" pipe, along with kalamein, are the two materials that have the greatest number of leaks per mile of main. A higher-than expected leakage rate appears in the South Hills area of the system, where the soil composition is the most corrosive.

Water loss costs on a nominal dollar basis in 2009 totaled about $588,000. The share of costs on Company-owned totaled $366,000 and included electricity for pumping, chlorine for disinfection, pump maintenance and leak repair. The remaining $196,000 is attributable to water loss from customer-owned service lines and included electricity for pumping, chlorine for disinfection, and pump maintenance. Service line repair costs are borne by the individual property owners. While the total loss for both Company- and customer-owned facilities seems large, it represents in total only about 3.4% of 2009 operating revenues. Since it costs approximately $1 million per mile distribution main, replacing all of the Company-owned main 40 years old and older would result in a ratepayer increase of 107.3% and still would not address water loss on customer services.

There are a number of activities that are in-process or planned to address the water loss issue. Most prominently, main totaling about 5.6 miles is targeted for replacement over the next five year. In addition, the Company will further research alternative funding sources and mechanisms for both main replacement and service line replacements.

II. Introduction

To develop a strategy for water loss mitigation, this financial analysis utilized information about several factors:

a. The total quantity of water loss to be mitigated;
b. The current cost of that water loss;
c. The quantity and size of Company-owned main and customer services that may be leaking;
d. The cost of replacing pipe and services; and
e. How much a dollar of new plant costs the customers in water rates

This information is summarized in two different ways:

1. Total rate impact to replace all of the potentially leaking main; or
2. The quantity of pipe that could be replaced in a cost-neutral fashion to the customers

This analysis will provide an overview of Mountain's distribution system characteristics and environment and then present data relating to each of the five factors above. The report concludes with a proposed action plan to address water loss on both Mountain's mains and customer-owned service lines.

III. Distribution System Characteristics and Environment

a. Quantity and Size of System Mains

As of the end of 2009, Mountain's transmission and distribution main footage totaled 1,665,556 , or 315.4 miles. The average age of Company-owned main was 34.06 years. The following two charts summarize the footage by pipe type, and average age by pipe type.

Exhibit 1

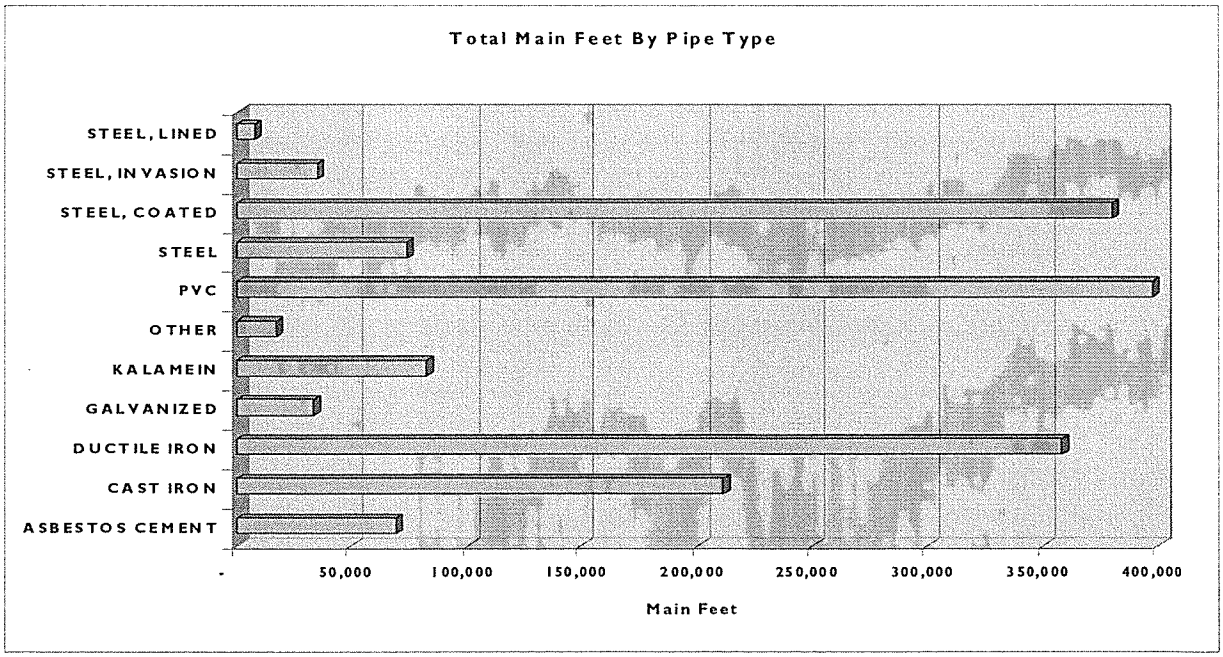
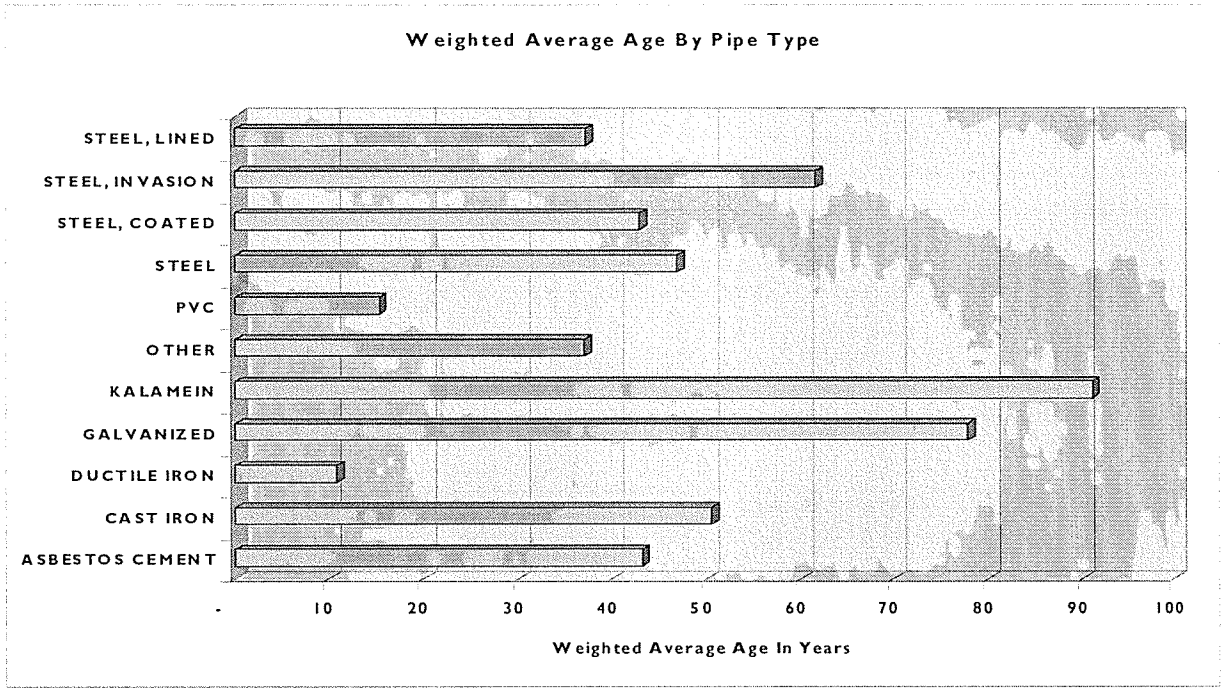


Exhibit 2



Of the total main in service at the end of 2009, about 40%, or 674,282 feet was installed in 1970 or earlier. Exhibit 3 summarizes this older main by size and type.

Exhibit 3

Sum of Main Feet	Description										
Main Size	ASBESTOS CEMENT	CAST IRON	DUCTILE IRON	GALVANIZED	KALAMEIN	OTHER	STEEL	STEEL, COATED	STEEL, INVASION	PVC	Grand Total
1"				330							330
1.5"							70				70
2"		1,763		28,369	287		4,729	2,897			38,045
3"				2,468	946						3,414
4"	10,296	8,359		380	2,213		576	5,353			27,177
5"					498						498
6"	31,856	188,745	691	165	61,434	47	11,574	133,390	35,326		463,228
8"	2,791	6,805	36		2,371		7,756	23,797		635	44,191
10"		2,621			2,285		4,648	26,770			36,324
12"	997	658			7,366		2,386	12,153			23,560
14"							2,776	687			3,463
16"		637			4,734		439	1,535			7,345
20"							6,283				6,283
24"								4,157			4,157
30"						16,197					16,197
Grand Total	**45,940**	**209,588**	**727**	**31,712**	**82,134**	**16,244**	**41,237**	**210,739**	**35,326**	**635**	**674,282**

Exhibit 4 displays the same data summarized by main type and period installed. (Detail by year is available in Appendix A.)

Exhibit 4

Main Older Than 40 Years

Sum of Main Fe	Description										
Period Installed	ASBESTOS CEMENT	CAST IRON	DUCTILE IRON	GALVANIZED	KALAMEIN	OTHER	STEEL	STEEL, COATED	STEEL, INVASION	PVC	Grand Total
1910 -1914		9,974		16,876	51,802	47	362				79,061
1915 -1919				686			709				1,395
1920 -1924		324		1,011	19,374		453				21,162
1925 -1929		313		774	10,462						11,549
1930 -1934		8,066		340	424						8,830
1935 -1939	2,947	12,297		1,145	46		477	41			16,953
1940 -1944		1,122		5,564			20,722	56,883			84,291
1945 -1949	2,791	2,596		779	26		400	1,945	33,652		42,189
1950 -1954	3,703	29,194					5,642	1,914	1,674		42,127
1955 -1959	3,300	69,854	147	352			2,358	6,235			82,246
1960 -1964	17,941	68,427	352	1,637			124	17,406			105,887
1965 -1969	15,258	7,421	228	905		16,197	9,692	115,577		635	165,913
1970 -1974				1,643			298	10,738			12,679
Grand Total	**45,940**	**209,588**	**727**	**31,712**	**82,134**	**16,244**	**41,237**	**210,739**	**35,326**	**635**	**674,282**

b. Quantity and Size of Customer Service Lines

Service lines are owned by the customers from the main to residence (ARM 38.5.2502). Most service lines installed up through about 1983 were galvanized iron pipe. Since 1983, most newly-installed service lines have been polyethylene (PE). The following exhibit summarizes the available information on customer connections by type of material.

Exhibit 5

Total Service Line Counts	
Material listed	**# of services**
Unknown	12,105
Copper	283
Galvanized	7,940
"Plastic" or "poly"	4,559
Total	**24,887**

The services listed as "Unknown" are most likely galvanized. "Plastic" or "poly" typically refers to polyethylene pipe in smaller sizes. Plastic service lines larger than 3" would typically be polyvinyl chloride (PVC). The terms "plastic" or "poly" could also refer to a type of pipe used in some areas called "Clear-Core", which had a black polyethylene layer on the outside and a clear polyethylene layer on the inside.

MWC's records do not necessarily differentiate service lines which may have been abandoned or which have been replaced in recent years with polyethylene pipe if the contractor didn't notify MWC. The records also do not include service lines for some of the acquired systems (Missoula Water Works, etc.) that did not maintain data on service lines. Therefore, for purposes of this analysis, the PSC annual report total of 22,155 services will be used. If it's assumed that 40% of those lines are also older than 40 years, that would calculate to 8,862 service lines.

IV. Detail of Factors Relating to Water Loss

a. Mechanism of Water Loss by Main Type

Exhibit 6 lists the various types of main that exist in Mountain's system, and explains the typical leakage mechanism for each type.

Exhibit 6

Pipe Material	Location of Main Failure	Most Likely Cause of Leak	Type/Outcome of Main Failure	Affected By Aggressive ("Hot:") Soil Type
Asbestos cement Cast iron Ductile iron PVC	Main	Pipe has been previously exposed and not backfilled correctly.	Shear break—can instantly leak thousands of gallons a minute depending on the size of main	No
Galvanized	At pipe thread	Electrolysis weakens pipe where pipe lengths are threaded together, allowing pressure fluctuations to create leaks.	About 90% of galvanized pipe is 2-inch in diameter. Leaks tend to be small and increase gradually over time	Yes
Kalamein	Lead hubs	Pressure fluctuations slowly force the lead out of the hubs.	Leaks start small but gradually increase over time, depending on pipe size and soil. Three-quarters of kalamein pipe is 6-inch diameter.	Yes
Steel, coated	Main or dressers	Electrolysis weakens pipe where coating integrity has been affected, typically at dressers where main is joined and where the services are connected. This allows pressure fluctuations to create leaks.	Leaks start small but gradually increase over time, depending on pipe size and soil. Approximately 2/3 of the coated steel main is 6-inch diameter, and the remainder is 8-, 10- or 12-inch .	Yes
Steel, invasion	Main	Pipe is very thin-walled as it was designed for above-ground installation by Allied forces during WWII. As pipe corrodes, it can lose structural integrity, so any pressure fluctuation can create a leak.	Leaks start small but can increase rapidly. All steel invasion pipe is 6-inch diameter.	Yes
Steel, lined Steel	Main	Electrolysis weakens pipe, allowing pressure fluctuations to create leaks.	Leaks start small but gradually increase over time, depending on pipe size, soil and pressure fluctuations. About 70% of steel-lined main is 6-, 8- or 10-inch, and almost 90% of line steel main is 20-inch in diameter.	Yes

b. Mechanism of Water Loss For Service Lines

Galvanized pipe itself was often covered with a pipe wrap consisting of tape with a layer of tar. These wrapped service lines can last a long time, depending on certain factors. Soil type is one of the main factors leading to leaks on service lines. Soils in the bulk of the MWC service area on the valley floor are sands and gravels, which don't tend to be highly corrosive to metallic pipes. However, areas of predominantly silty soils, such as those found in the South Hills, tend to be quite corrosive to metallic pipes.

The most common mode of failure for galvanized pipe is at places where it was threaded and the galvanizing material removed. This typically occurred at taps and swing joints near the taps.

Service lines are believed to comprise a significant portion of the total water loss in the Mountain Water system. In reviewing the data on known water service line leaks in the last 10 years, there are an average of 216 "leak investigation" service orders per year. These service orders are most commonly initiated when a customer complains about noise emanating from the service line caused by moving water. Service orders can also be initiated if water is surfacing through curb boxes or other locations, particularly if the water is causing damage. MWC does not actively search for service line leaks by listening for noise on the line unless requested to by the owner.

Of the 123 service line leak investigation service orders through the middle of November, 2009, 55 (45%) have been determined to be actual leaks on the service line. The owners of those service lines were encouraged to repair the leaks, and of 30 locations recently re-surveyed by MWC personnel, 22 leaks have been repaired. MWC is limited in its authority to shut customers off in this circumstance. In instances where the leakage is causing property damage, MWC will enlist the help of the City of Missoula to apply additional pressure on the owner to make the repairs. Exhibit 7 is a map of service lines leak investigations 2004-2009.

Exhibit 7

Legend

- Customer Leak Investigations ('04-'09)
- ServiceBoundary

Reservoir Pressure Zones

Name

- #1 Reservoir
- #2 Reservoir
- 3 Million Reservoir
- Crestline Tanks
- East Missoula Tank
- Elk Ridge Tank
- Gharrett Tank
- Highpark Reservoir
- Hillview Tank
- Lincoln 6 Tank
- Lincoln Hills Tank
- Mansion Heights Tank
- Skyview Reservoir
- Twite 500K Reservoir
- Twite 85K Reservoir
- Upper Elk Ridge Tank
- Upper Prospect
- Whitaker 400K Tank

N

1 inch = 6,000 feet

c. Effects of Soil Composition on Main and Service Line Integrity

Soil type is one of the key factors determining the rate of corrosion of piping systems, according to the "10-point system" described in Appendix A of ANSI/AWWA C105/A21.5-99, Standard for Polyethylene Encasement for Ductile Iron Pipe Systems. Electrical Resistivity is the main soil property determining the likelihood for a particular soil to be corrosive, although other properties such as moisture content, pH and sulfide content are also important. Soils with low resistivity act as electrolytes and increase the rate of corrosion. Generally speaking with all other factors equal, sandy soils are less corrosive than silty soils, which are less corrosive than clay soils.

There are a wide range of soils types found within the Mountain Water Company service area, as illustrated in the soils map delineated by the Natural Resource Conservation Service (NRCS) shown in Appendix A. The majority of the MWC distribution system lies within the area mapped as "Urban land", where the soils have not been characterized. The valley floor soils are generally very coarse grained sands and gravels with very little silt or clay particles and low water tables. These soils would generally be considered to have low corrosion potential.

There are a number of areas with silty clay loams such as near the Missoula International Airport where the corrosion potential would be somewhat higher than other areas of the valley floor. Many of the hillsides surrounding the valley floor are mapped as "Argixerolls-Haploxerolls", which are a complex mix of soils ranging from those with high clay content (Argixerolls) to those with low clay content (Haploxerolls) (per Barry Dutton, Soils Scientist with PBS&J, Inc.). The water table is relatively high in some of these areas such as the South Hills, which would contribute to increased corrosion potential.

As discussed above, there are many variables which can determine the severity of piping corrosion in a particular area, including the soils, depth of water table, and type and age of pipe, and whether the pipe has any type of cathodic protection (such as sacrificial anodes or polyethylene encasement). Due to the wide range of variables, it is very difficult to predict where leaks are most likely to occur and to focus main replacement programs in those areas.

d. Factors Most Highly Correlated With Water Loss

This analysis indicates that there is no single factor that is most predictive of main or service line water loss. Pipe age, pipe type, pressure fluctuation and soil composition all play a role, and sometimes interact, to create conditions conducive to leakage.

Analysis of the detailed leak data from 2000-2009 indicates that steel invasion pipe has the highest prevalence of leaks per mile of any main type, followed by Kalamein. Exhibit 8 details the results of this analysis.

Exhibit 8

Pipe Type	# of leaks from 2000-2009	# Leaks Per Mile
Asbestos Concrete	16	1.94
Cast Iron	35	0.99
Ductile Iron	3	0.06
Invasion	53	7.44
Kalamein	69	4.35
PVC	12	0.15
Steel	106	1.26
Unknown Type	39	N/A

Kalamein is Mountain's oldest main and has been in service on average over 90 years. As explained in Exhibit 6, steel invasion pipe was never really designed for the use to which it was put, and is the third-oldest pipe after Kalamein and galvanized. Appendix A contains additional detail on main footage by type in each reservoir pressure zone.

Pressure fluctuations are a potential cause of main breaks or even smaller leaks at lead hub joints. These fluctuations can be caused by a variety of factors such as improper operation of fire hydrants or sudden loss of power at production facilities. These types of incidents can cause water hammer, which results in alternating waves of high and low pressure. Pressure cycles can cause fatigue in piping materials which can eventually cause them to rupture or to displace leaded hub joint material in older piping systems.

The next factor to consider is the interaction of soil composition and pipe type. From 2000-2009, there were 333 main leaks documented and repaired. Exhibit 9 provides a map of these leaks.

Exhibit 9

Legend

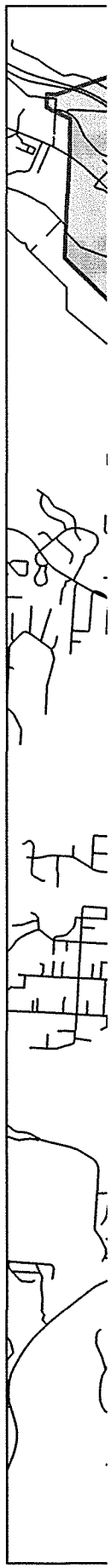
- Water Main Leaks ('00-'09)

——— ServiceBoundary

Reservoir Pressure Zones

Name

- #1 Reservoir
- #2 Reservoir
- 3 Million Reservoir
- Crestline Tanks
- East Missoula Tank
- Elk Ridge Tank
- Gharrett Tank
- Highpark Reservoir
- Hillview Tank
- Lincoln 6 Tank
- Lincoln Hills Tank
- Mansion Heights Tank
- Skyview Reservoir
- Twite 500K Reservoir
- Twite 85K Reservoir
- Upper Elk Ridge Tank
- Upper Prospect
- Whitaker 400K Tank



N

1 inch = 6,000 feet

Exhibit 10 summarizes the number of main leaks and customer service line leak investigations by reservoir pressure zone.

Exhibit 10

Reservoir Zone	Footage of All Main		Number of Water Main Leaks From 2000-2009		Number of Customers	% Customers By Zone	Number of Customer Leak Investigations From 2004-2009*		Leak Investigations per 1,000 customers
#1 Reservoir--East of Russell	181,219	10.9%	80	24.0%	2,135	9.46%	107	12.7%	50
3 Million Gallon Reservoir	640,453	38.5%	145	43.5%	10,859	48.11%	370	43.8%	34
#2 Reservoir	76,167	4.6%	16	4.8%	1,053	4.67%	44	5.2%	42
Whitaker 400K Tank	36,649	2.2%	17	5.1%	419	1.86%	32	3.8%	76
Crestline Tanks	30,662	1.8%	6	1.8%	368	1.63%	22	2.6%	60
Upper Elk Ridge Tank	4,547	0.3%	-	0.0%	30	0.13%	2	0.2%	67
Gharrett Tank	12,662	0.8%	-	0.0%	207	0.92%	7	0.8%	34
Lincoln 6 Tank	15,416	0.9%	2	0.6%	150	0.66%	11	1.3%	73
Highpark Reservoir	31,087	1.9%	17	5.1%	345	1.53%	30	3.6%	87
Elk Ridge Tank	35,614	2.1%	-	0.0%	388	1.72%	11	1.3%	28
Hillview Tank	55,483	3.3%	10	3.0%	626	2.77%	50	5.9%	80
Skyview Reservoir	113,700	6.8%	17	5.1%	1,180	5.23%	44	5.2%	37
Lincoln Hills Tank	25,710	1.5%	1	0.3%	351	1.56%	14	1.7%	40
Upper Prospect	35,036	2.1%	1	0.3%	265	1.17%	7	0.8%	26
East Missoula Tank	48,572	2.9%	7	2.1%	667	2.96%	29	3.4%	43
Twite 85K Reservoir	24,446	1.5%	1	0.3%	198	0.88%	3	0.4%	15
#1 Reservoir--West of Russell	241,435	14.5%	13	3.9%	2,815	12.47%	49	5.8%	17
Twite 500K Reservoir	35,489	2.1%	-	0.0%	414	1.83%	9	1.1%	22
Mansion Heights Tank	21,209	1.3%	-	0.0%	101	0.45%	3	0.4%	30
Total	**1,665,556**		**333**		**22,571**		**844**		**37**

Examining the frequency of both main and service line leaks as compared with the percentage of main by reservoir zone reveals that two zones, the Highpark Reservoir and the Whitaker 400K Tank, both have a history of leaks disproportionate to the amount of main in each zone. The Highpark zone comprises 1.9% of the total main in the system, 5.1% of the total main leaks and 3.6% of the service line leak investigations. The Whitaker 400K Tank zone comprises 2.2% of the total main, 5.1% of the total main leaks and 3.8% of the service line leak investigations. While natural springs in the South Hills would be expected to result in a higher number of leak investigations as customers mistake the spring water for leakage, corrosive soils are still a likely contributor to the higher number of leaks in this part of the system.

Soils in the Highpark and Whitaker 400K zones are mapped entirely as the "Argixerolls-Haploxerolls" unit described previously. Approximately 65% of the main in the Highpark and 21% of the main in the Whitaker 400K zone are coated steel with an average age of 39 and 40 years, respectively. The coating on the steel pipe typically provides adequate cathodic protection, but the coating on the dresser couplings used to join the pipe is vulnerable to breakdown and corrosion.

In summary, it can be concluded that pipe type, pressure fluctuations, and the interaction of pipe type, and soil composition are the most relevant factors in predicting leakage and developing a plan to address system water loss. Kalamein and steel invasion pipe have the greatest density of leaks. Steel pipe joined with dresser couplings and bedded in the corrosive soil found in the South Hills area of Missoula leads to a higher rate of corrosion and pipe leaks than in other areas of the system.

e. Cost of Water Loss

For 2009, the following table summarizes the variable costs incurred that either related directly to water production or leak repair, assuming a 20% water loss through Mountain's mains. Using Mountain's share of the estimated water loss rate, applied to purchased power, chemicals and pump maintenance, and assuming that leak repair expense would be entirely eliminated if all leakage was stopped, the 2009 cost of water loss from Mountain's mains was $366,252 . The cost of service line leaks similarly uses the assumed system leakage attributed to service lines of 20% applied to purchased power, chemicals and pump maintenance and totals $196,042 . To put these totals in context, the expense of main leakage represents 2.2% of 2009 operating revenues, and service line leaks an additional 1.2%.

			Allocation of Leakage Costs	
	Total	Delivered to Customers	Mains	Service Lines
Purchased power--KWH	$ 871,325	$ 522,795	$ 174,265	$ 174,265
Chemicals--chlorine	81,059	48,636	16,212	16,212
Pump maintenance	27,824	16,694	5,565	5,565
Leak repair	170,210		170,210	
Total	$ 1,150,418	$ 588,125	$ 366,252	$ 196,042

f. Cost of Leak Repair

The cost of an individual leak repair is highly variable, from a low of perhaps $3,000 to upwards of $12,000. Mountain's practice is to limit leak repairs to those leaks that surface. Once that happens, the leak is typically of sufficient volume that it is cost-effective to repair. The process of repairing a leak involves locating the exact spot where the leak is occurring, cutting the pavement above the leak, excavating down a minimum of six feet to the main, placing a repair band on the pipe, filling the hole back in and re-paving. Safety considerations include location of other in-street utilities, traffic control, trench boxes and weather conditions. Customer considerations include the need to stop service while the leak is being repaired, and provision of bottled water for customers during the outage. Depending of the timing, size and location of the leak, the disruption can range from minimal to severe.

The average number of leaks repaired since 2002, when Mountain started keeping detailed statistics, is 33 per year. While Mountain could expend additional efforts to locate leaks before they surface, this can be a very time consuming and expensive process. Even when the correlating equipment signals that a leak is present, until excavation is performed, the magnitude of the leak cannot be determined. It is possible that there are hundred of small leaks throughout the system that could cost millions to repair, with a consequent and immediate impact on customer rates. This expense could be ongoing as well, since simply disturbing pipe as is done during a repair can promote further leaks. Systematic replacement of main, with repairs performed on an as-needed basis, is the most cost-effective in the long term.

g. Cost of Main Replacement

Main replacement cost is largely dependent on main size and material used. The cost is generally expressed as a cost per foot and includes both the cost to excavate and abandon the old pipe, and disconnect and re-connect customer services. Exhibit 11 develops an estimate to replace all 674,000 feet of main 40 years old or older.

Exhibit 11

Main Size	Main Feet	2009 Cost Per Foot	Cost of Replacing Main
1"	330	175.00	$ 57,750.00
1.5"	70	175.00	12,250.00
2"	38,045	175.00	6,657,875.00
3"	3,414	175.00	597,450.00
4"	27,177	175.00	4,755,975.00
5"	498	175.00	87,150.00
6"	463,228	175.00	81,064,900.00
8"	44,191	175.00	7,733,425.00
10"	36,324	215.00	7,809,660.00
12"	23,560	250.00	5,890,000.00
14"	3,463	275.00	952,325.00
16"	7,345	300.00	2,203,500.00
20"	6,283	350.00	2,199,050.00
24"	4,157	400.00	1,662,800.00
30"	16,197	425.00	6,883,725.00
Grand Total	674,282		$ 128,567,835.00

This works out to just over $1,000,000 per mile of main replacement.

h. Cost of Service Line Replacement

Service line replacement cost can be quite variable, depending on the configuration of the entity served, whether excavation involves only a lawn or requires digging up a driveway, need for traffic control, penalties for digging up a recently-renovated street surface, etc. This analysis will use an average of $5,000 per stand-alone service line replacement. At that amount, to replace 8,862 service lines 40 years old or older would cost $44,310,000 . Each property owner bears the cost of replacing the line serving the owner's premises.

Significant costs can also incurred in re-connecting service lines for existing customers during main replacement projects. MWC decided to replace the portion of the service line in the street as part of its 2007 West Central water main replacement project. The service line "reconnection" to the new main cost $800 for each service. Replacing the portion of service line under the street cost an additional $1,675 per service. The overall cost of installing the water main was $100/ lineal foot, which included the main, appurtenances and water service reconnections. When the cost of replacing the portion of the service line in the street was added, the total cost per foot of main increased to $133/LF. Thus, replacing just a portion the service line added approximately 33% to the cost of the project.

i. Cost of a Dollar of New Plant in Water Rates

Exhibit 12 illustrates the calculation of the additional revenue requirement resulting from a $100,000 increase to rate base. It starts with the net income and builds up to the amount required in water rates to cover the new plant.

Exhibit 12

			Revenue Requirement
Rate Base Increase		100,000	
Test Year 2007 Adopted Rate of Return	x	8.966%	
Net Income Required From Rate Base Increase			$ 8,966.00
Calculation of Income Taxes:			
Embedded Interest Rate		7.80%	
Debt Proportion in Capital Structure	x	47.09%	
Weighted Debt Cost		3.68%	
Rate Base Increase	x	$ 100,000.00	
Imputed Interest Expense		$ 3,675.23	
Net Income After Interest Expense		$ 5,290.77	
Income Taxes--State @ 6.75%			580.27
Income Taxes--Federal @ 34.00%			2,725.55
Sub-Total Net Revenue Before Taxes			$ 12,271.82
PSC and Consumer Consel Revenue Taxes		0.34%	41.72
Uncollectible Rate		0.1682%	20.65
Property Tax Rate		1.57%	192.67
Depreciation --1.95%		1.95%	1,945.31
Total Revenue Requirement Increase			$ 14,472.17

Thus, the net increase per dollar of new plant is 14.47217%.

V. Cost Analysis of Water Loss Factors

a. Rate Impact From Replacing All Main 40 Years Old and Older

The following calculation shows the impact to water rates of replacing all pipe 40 years old and older.

Increase in rate base (Exhibit 11)		$128,567,835
Impact on revenue requirement of rate base increase (Exhibit 12)	X	0.144721665
Required rate change to cover this increase to plant		$18,606,551

The adopted revenue requirement from Mountain's test year 2007 general rate case is $17,348,288 . The increase shown about would raise customer rates 107.3% from current levels.

b. Total Main That Could Be Replaced With No Rate Impact

The following calculation shows the total amount of main that could be replaced with no impact to the rate payers, assuming for illustrative purposes that this main replacement stopped all leakage.

Cost of leakage from Mountain's main leaks (Section IV.f)		$366,252
Impact on revenue requirement of rate base increase (Exhibit 12)	÷	0.144721665
Rate-neutral increase in rate base		$2,530,731

The next step is to determine how many feet of main could be replaced with this amount of spending.

Rate-neutral increase in rate base	$2,530,731
Average pro-forma cost per foot to replace main (Exhibit 11)	÷ $190.67
Feet of main replacement that is revenue-neutral	13,272.58

This amounts to about 2.51 miles, or about 1.97% of Mountain's main that is 40 years old or older.

VI. Action Plan For Mitigation of Water Loss

a. Currently In Progress/Ongoing

System-Wide:

- MWC has an internal team studying the water loss issue. The group is examining the various components that relate to real and apparent system water loss and trying to quantify those factors that are measureable. The significant number of flat rate accounts in Mountain's system limits the accuracy of any estimate made with usage assumptions that are substituted for actual consumption measurements.

- MWC has experimented with the concept of pressure management. The basic concept is to lower system pressures during low demand periods of the day in order to reduce the quantity of leakage from the mains. MWC experimented with lowering the level in one reservoir by approximately 12 feet (5 psi) and there was no measurable decrease in water loss during its annual "reservoir fall" leakage study. While pressure management may be worth further investigation, the fact is that more of MWC's system is served by reservoirs that have very little flexibility in lowering water levels. Reducing water levels at times of the day will also reduce the available volume for fire fighting. MWC does have numerous Pressure Reducing Valve (PRV) zones which do have some flexibility for reducing pressures, but those zones comprise a relatively small percentage of the total water main in the system.

- Pressure Monitoring devices are deployed at various locations throughout the water system. Pressure transducers are installed at all 60 sites where SCADA is available. The SCADA system obtains a pressure reading for that site each time it polls the site, approximately on a 1-minute interval. The SCADA software automatically triggers alarms for pressures higher or lower than preset limits. An additional 10 sites that don't have SCADA available have pressure recorders installed which have to be manually downloaded and recorded on approximately 2 week intervals. The recorders read the pressure every 0.25 seconds and record the minimum, maximum and average readings every minute. Thus, the pressure recorders provide a very detailed history of pressures at that location. MWC also has four "Cello" monitors which record pressures (and flows if installed at a metered location) and use cell phone technology to transmit the data back to the main office at whatever frequency is desired. The Cello units can be programmed to alarm at high or low pressure readings.

- Valve leak sounding devices are deployed at various locations through out the water system. They are installed on the operating nuts of the system valves and record the decibel levels of the system at specific time increments. The units are outfitted with a transmitter so that a properly-equipped

computer can retrieve the information from each data logger on a drive-by. If the decibel level is high enough, the logger notifies the system operator of a possible leak. The system's software can also correlate between two or more loggers to pinpoint the location of the leak.

Company-Owned Mains:

- Continue current practices for leak repair. Leaks that surface or have the potential to cause damage are repaired. If the leak is determined to be on a customer service line, the property owner is notified of the leak. Where the service line leak is damaging the street, the City assists Mountain in getting the property owner to repair or replace the line.

- Mountain is taking steps to better understand the carbon equivalency emissions of an asset's life cycle to help in its decision making process. The current decision process includes financial and operational considerations. Mountain believes the financial impacts correlate closely with the energy consumption used throughout any alternative. However, a better understanding of any of the alternatives' life cycle carbon equivalency emissions may provide additional guidance for exploring this issue into the future and evaluating the alternative solutions.

- Selected sections of main have been targeted for replacement, with an emphasis on replacing steel invasion pipe. There are a total of 56 separate segments of invasion pipe in the MWC system, of which 15 segments have had at least one leak.

  Over the next five years, Mountain capital planning has identified 4.5 miles of mostly steel invasion main that would cost an estimated cost of $4.7 million to replace. Exhibit 13 outlines the potential replacements by year and cost. (The specific replacements could change depending on the City's plans for street reconstruction and the resulting penalties for disturbing newly-laid asphalt.)

Exhibit 13

Main replacements	Size of Pipe	2010	2011	2012	2013	2014	Totals	
Repl Cherry/Poplar alley-Harrison to Filmore	8			175,098				
Repl Livingston Ave-Bancroft to Park	8		147,451					
Repl Madison 24"	24				495,222			
Repl S 4th/Orange-Ash main	8		270,019					
Repl S 5th W-Orange to Higgins	8				239,607			
Repl S 5th W-Russell to Orange	8			609,156				
Repl Worden St/N 5th to N 4th main replacement	8					46,078		
General Main Replacements		92,157	149,294		684,724	1,548,232		
Total Main Replacement Budget		$ 92,157	$ 566,764	$ 784,253	$ 1,419,554	$ 1,594,310	$ 4,457,038	
Assumed unit price for 8" main replacements($/LF) (including engineering, MWC costs and contingencies)*		$157	$163	$170	$176	$183		
Estimated Lineal Footage of Main Replacement**		588	3,475	4,625	6,496	8,693	23,877	lineal feet
							4.5	miles

*Inflation assumed to be 4%/year based on 2006-2008 CCI
**All quantities based on the assumed price for 8" main, except Madison 24" pipe assumed to cost $360/LF

In addition to the Company-funded main replacement program, Mountain has also received $750,000 in ARRA funding. The following main replacements will be completed in 2010 with that funding:

Exhibit 14

Main Replacements	Size of Pipe (inches)	Quantity (LF)	Quantity (miles)	Engineering and Construction Cost ($)
River/Inez/1st/2nd	8	2460	0.5	$333,000
Cooper-Sherwood	8 & 12	730	0.1	$127,000
Fairview	8	1050	0.2	$161,000
Mary	8	1070	0.2	$145,000
Livingston	8	570	0.1	$97,000
Total		**5,880**	**1.1**	**$863,000**

The ARRA funding alone will allow for replacement of 18% of the remaining steel invasion pipe. The ARRA bids were unusually competitive and not reflective of recent historical experience. If these per-foot rates were to continue, MWC would see reduced costs for its Company-funded projects such as those detailed in Exhibit 18.

- Carry out more targeted leak studies, isolating areas that contain primarily older, steel or kalamein pipe. Those two pipe types are the most prone to leakage. These types of studies can be labor-intensive, and so must be carefully evaluated in terms of costs and potential savings.

- The Pennsylvania PUC implemented a program about 10 years ago that created a Distribution System Improvement Charge, and it has substantially accelerated infrastructure remediation by Pennsylvania utilities. Mountain is researching this type of program for applicability and suitability to assist in financing main replacements.

Customer-Owned Service Lines:

- Research funding sources that would pay customers to replace leaking service lines. A rough estimate indicates that where service line leaks are two gallons per minute or more, the present value of the leakage over a 40-year period can run about $1,600 , depending on the cost of funds used in the calculation.

- Continue to work with the City on effective means of encouraging customers to repair leaking services. The relatively new means that contractors use to hydrovac down to the corp stop (the connection at the main and the service) allows the customer a more cost effective method of investigating the condition of their service lines and is facilitating the overall process of service line repair. This is also helping Mountain investigate suspected leaks on distribution mains to identify if a possible leak is on a main or a service line.

b. Future Activities—Three to Five Years

Company-Owned Mains:

- Investigate pipe lining or pipe bursting techniques. There are new technologies being developed that may allow MWC to rehabilitate pipe by lining the interior of existing main with a structural liner, or replace old main by inserting new main inside the pipe. These methods typically still require an excavation to reconnect each service line. Because a typical city block might have an

average of one service line per 30-40 feet of water main, a "trenchless" project will still end up with a significant amount of disruption to the street. Also, these technologies are still in development, and would need to be tested in Mountain's system and environment to determine if they are viable alternatives to actual pipe replacement.

- The first phase of an accelerated main replacement program is targeting 4.5 miles of kalamein and steel invasion pipe. Mountain will identify and prioritize the remaining 18 miles of kalamein and invasion pipe still in service and determine a timetable for replacing those distribution lines.

Appendix A

Detail of Main Footage Installed by Year and Type Through 1970

Year Installed	1"	1.5"	2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	20"	24"	30"	Grand Total
1910					5,889		3,317	1,058								10,264
1914	330		16,288	946	1,553	498	41,870	457	2,239	2,713		1,903				68,797
1916			451	394												845
1917			196													196
1918			258													258
1919			96													96
1920							213									213
1921					1,040											1,040
1922			550													550
1923			647				5,141					324				6,112
1924			267				8,704	1,914		2,362						13,247
1925							767			1,534		3,144				5,445
1926			63				866									929
1927			423				338			757						1,518
1928							830									830
1929			288				2,539									2,827
1930							5,927									5,927
1931			340				705			257						1,302
1932							48									48
1934							1,152			401						1,553
1935			219				1,107		87							1,413
1936			733				2,720									3,453
1937							3,312									3,312
1938			932		18		5,148			42						6,140
1939			351				2,284									2,635
1940			1,649				9,212		594				5,235			16,690
1941			2,395	2,074			37,585			2,741	2,328		1,048			48,171
1942			976		268		10,315		966	6,242						18,767
1944			663													663
1945							2,596	2,791								5,387
1946			535				7,956									8,491
1947			76				13,513									13,589
1948			155				8,083									8,238
1949			226				5,362		896							6,484
1950							6,372		626	1,005	448					8,451
1951		70					2,826		1,669	1,554						6,119
1952							1,337			360						1,697
1953							7,656		1,362							9,018
1954							16,325	517								16,842
1955			223		570		9,547	970	205							11,515
1956			272		771		14,492		680	1,140						17,355
1957			1,589				16,332	1,051	1,259		687					20,918
1958			202				16,524	2,462		361		439				19,988
1959			466		624		9,908		1,472							12,470
1960			48		1,378		15,892		2,929							20,247
1961			336		2,241		11,193	1,982	10			1,535				17,297
1962			44				10,741									10,785
1963			309				15,384									15,693
1964			2,632		6,613		30,779	1,111		730						41,865
1965			884		3,688		30,684	10,497	1,043					4,157		50,953
1966			210		263		22,811	2,905		1,361						27,550
1967			194				8,982	3,590								12,766
1968					2,261		21,306	10,245	9,219						16,197	59,228
1969							7,484	1,899	6,033							15,416
1970			1,859				5,043	742	5,035							12,679
Grand Total	**330**	**70**	**38,045**	**3,414**	**27,177**	**498**	**463,228**	**44,191**	**36,324**	**23,560**	**3,463**	**7,345**	**6,283**	**4,157**	**16,197**	**674,282**

Detail of Main Footage Installed by Year and Size – Asbestos Cement

Year Installed	4"	6"	8"	12"	Grand Total
1938		2,947			2,947
1945			2,791		2,791
1954		3,703			3,703
1955		3,300			3,300
1961		1,709			1,709
1963		3,771			3,771
1964	6,613	5,848			12,461
1965	3,683	7,388			11,071
1966		3,190		997	4,187
Grand Total	**10,296**	**31,856**	**2,791**	**997**	**45,940**

Detail of Main Footage Installed by Year and Size – Cast Iron

Year Installed	2"	4"	6"	8"	10"	12"	16"	Grand Total
1910		5,599	3,317	1,058				9,974
1923							324	324
1925							313	313
1930			5,503					5,503
1931			705			257		962
1932			48					48
1934			1,152			401		1,553
1935			1,107					1,107
1936	733		2,720					3,453
1937			3,312					3,312
1938			2,141					2,141
1939			2,284					2,284
1940			1,122					1,122
1945			2,596					2,596
1950			2,874					2,874
1951			2,826					2,826
1952			1,337					1,337
1953			7,656		1,362			9,018
1954			12,622	517				13,139
1955			6,247	928				7,175
1956		771	13,555					14,326
1957	1,030		16,332	991	1,259			19,612
1958			16,524	2,462				18,986
1959			9,755					9,755
1960		1,105	15,525					16,630
1961		884	9,484	849				11,217
1962			10,741					10,741
1963			10,314					10,314
1964			19,525					19,525
1965			6,284					6,284
1966			1,137					1,137
Grand Total	**1,763**	**8,359**	**188,745**	**6,805**	**2,621**	**658**	**637**	**209,588**

Detail of Main Footage Installed by Year and Size – Ductile Iron

Year Installed	6"	8"	Grand Total
1959	147		147
1963	352		352
1965	192		192
1968		36	36
Grand Total	**691**	**36**	**727**

Detail of Main Footage Installed by Year and Size – Galvanized

Year Installed	1"	2"	3"	4"	6"	Grand Total
1914	330	16,001		380	165	16,876
1916			394			394
1917		196				196
1919		96				96
1922		252				252
1923		492				492
1924		267				267
1926		63				63
1927		423				423
1929		288				288
1931		340				340
1935		219				219
1938		575				575
1939		351				351
1940		1,370				1,370
1941		1,961	2,074			4,035
1942		159				159
1946		535				535
1947		76				76
1949		168				168
1958		202				202
1959		150				150
1961		321				321
1962		44				44
1963		140				140
1964		1,132				1,132
1965		711				711
1967		194				194
1970		1,643				1,643
Grand Total	**330**	**28,369**	**2,468**	**380**	**165**	**31,712**

Detail of Main Footage Installed by Year and Size – Kalamein

Sum of Main Fe	Main Size									
Year Installed	2"	3"	4"	5"	6"	8"	10"	12"	16"	Grand Total
1914	287	946	1,173	498	41,586	457	2,239	2,713	1,903	51,802
1920					213					213
1921			1,040							1,040
1923					5,141					5,141
1924					8,704	1,914		2,362		12,980
1925					767			1,534	2,831	5,132
1926					866					866
1927					338			757		1,095
1928					830					830
1929					2,539					2,539
1930					424					424
1935							46			46
1949					26					26
Grand Total	**287**	**946**	**2,213**	**498**	**61,434**	**2,371**	**2,285**	**7,366**	**4,734**	**82,134**

Detail of Main Footage Installed by Year and Size – Steel

Year Installed	1.5"	2"	4"	6"	8"	10"	12"	14"	16"	20"	Grand Total
1910			290								290
1914				72							72
1916		451									451
1918		258									258
1922		298									298
1923		155									155
1938		357	18	60			42				477
1940		279		1,018						5,235	6,532
1941		434						2,328		1,048	3,810
1942		817	268	7,534		120	978				9,717
1944		663									663
1948		155									155
1949		58		187							245
1950				1,824		626	1,005	448			3,903
1951	70					1,669					1,739
1955					42	205					247
1956		272		663							935
1957					60						60
1958							361		439		800
1959		316									316
1963				80							80
1964					44						44
1966				136	1,992						2,128
1968					3,807	1,651					5,458
1969					1,729	377					2,106
1970		216			82						298
Grand Total	**70**	**4,729**	**576**	**11,574**	**7,756**	**4,648**	**2,386**	**2,776**	**439**	**6,283**	**41,237**

Detail of Main Footage Installed by Year and Size – Steel, Invasion

Year Installed	6"	Grand Total
1946	7,956	7,956
1947	13,513	13,513
1948	8,026	8,026
1949	4,157	4,157
1950	1,674	1,674
Grand Total	**35,326**	**35,326**

Detail of Main Footage Installed by Year and Size – Steel, Coated

Year Installed	2"	4"	6"	8"	10"	12"	14"	16"	24"	Grand Total
1935					41					41
1940			7,072		594					7,666
1941			37,585			2,741				40,326
1942			2,781		846	5,264				8,891
1948			57							57
1949			992		896					1,888
1951						1,554				1,554
1952						360				360
1955	223	570								793
1956			274		680	1,140				2,094
1957	559						687			1,246
1959		624	6		1,472					2,102
1960	48	273	367		2,929					3,617
1961	15	1,357		1,133	10			1,535		4,050
1963	169		867							1,036
1964	1,500		5,406	1,067		730				8,703
1965	173	5	16,820	10,497	1,043				4,157	32,695
1966	210	263	18,348	913		364				20,098
1967			8,982	3,590						12,572
1968		2,261	21,306	5,767	7,568					36,902
1969			7,484	170	5,656					13,310
1970			5,043	660	5,035					10,738
Grand Total	**2,897**	**5,353**	**133,390**	**23,797**	**26,770**	**12,153**	**687**	**1,535**	**4,157**	**210,739**

Detail of Main Footage Installed by Year and Size – PVC

Sum of Main Fe	Main Size	
Year Installed	**8"**	**Grand Total**
1968	635	635
Grand Total	**635**	**635**

Detail of Main Footage Installed by Year and Size – Other

Year Installed	6"	30"	Grand Total
1914	47		47
1968		16,197	16,197
Grand Total	**47**	**16,197**	**16,244**

PIPE FOOTAGE BY TYPE WITHIN EACH RESERVOIR ZONE

	Pipe Type									
Reservoir Zone	ASBESTOS CEMENT	CAST IRON	DUCTILE IRON	GALVANIZED	KALAMEIN	OTHER	PVC	STEEL	STEEL, COATED	II
3 Million Gallon Reservoir	4,918	162,809	117,397	18,215	35,423	273	56,983	33,590	181,119	
#2 Reservoir	-	21,485	4,856	3,302	267	16,107	5,563	4,311	19,569	
#1 Reservoir - East of Russell	-	17,197	35,583	9,705	46,444	230	17,910	11,058	37,700	
#1 Reservoir - West of Russell	-	2,873	122,263	50	-	43	102,452	6,020	7,284	
Whitaker 400K Tank	23,568	-	1,600	510	-	-	3,079	134	7,758	
Highpark Reservoir	814	-	3,070	-	-	-	6,835	-	20,368	
East Missoula Tank	-	2,993	24,230	938	-	352	5,393	2,439	12,227	
Mansion Heights Tank	-	-	10,106	-	-	8	11,095	-	-	
Twite 85K Reservoir	-	-	775	-	-	-	23,671	-	-	
Twite 500K Reservoir	-	-	2,628	-	-	-	32,861	-	-	
Upper Elk Ridge Tank	-	-	66	-	-	-	-	-	4,481	
Elk Ridge Tank	-	-	4,648	201	-	-	9,517	547	20,701	
Lincoln 6 Tank	-	-	30	-	-	246	2,360	-	12,780	
Lincoln Hills Tank	-	-	4,113	-	-	-	9,622	1,958	10,017	
Crestline Tanks	17,173	1,137	4,607	-	-	40	2,704	736	4,265	
Hillview Tank	20,017	-	2,388	227	-	-	26,056	-	6,472	
Skyview Reservoir	2,309	-	11,686	468	-	-	53,690	12,576	26,113	
Gharrett Tank	-	2,337	-	-	-	-	856	372	9,097	
Upper Prospect	-	-	8,204	23	-	34	26,775	-	-	
Total	**68,799**	**210,831**	**358,250**	**33,639**	**82,134**	**17,333**	**397,422**	**73,741**	**379,951**	

PERCENT OF EACH TYPE OF PIPE FOOTAGE WITHIN EACH RESERVOIR ZONE

	Pipe Type								
Reservoir Zone	ASBESTOS CEMENT	CAST IRON	DUCTILE IRON	GALVANIZED	KALAMEIN	OTHER	PVC	STEEL	STEEL, COATED
3 Million Gallon Reservoir	0.8%	25.4%	18.3%	2.8%	5.5%	0.0%	8.9%	5.2%	28.3%
#2 Reservoir	0.0%	28.2%	6.4%	4.3%	0.4%	21.1%	7.3%	5.7%	25.7%
#1 Reservoir - East of Russell	0.0%	9.5%	19.6%	5.4%	25.6%	0.1%	9.9%	6.1%	20.8%
#1 Reservoir - West of Russell	0.0%	1.2%	50.6%	0.0%	0.0%	0.0%	42.4%	2.5%	3.0%
Whitaker 400K Tank	64.3%	0.0%	4.4%	1.4%	0.0%	0.0%	8.4%	0.4%	21.2%
Highpark Reservoir	2.6%	0.0%	9.9%	0.0%	0.0%	0.0%	22.0%	0.0%	65.5%
East Missoula Tank	0.0%	6.2%	49.9%	1.9%	0.0%	0.7%	11.1%	5.0%	25.2%
Mansion Heights Tank	0.0%	0.0%	47.6%	0.0%	0.0%	0.0%	52.3%	0.0%	0.0%
Twite 85K Reservoir	0.0%	0.0%	3.2%	0.0%	0.0%	0.0%	96.8%	0.0%	0.0%
Twite 500K Reservoir	0.0%	0.0%	7.4%	0.0%	0.0%	0.0%	92.6%	0.0%	0.0%
Upper Elk Ridge Tank	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	98.5%
Elk Ridge Tank	0.0%	0.0%	13.1%	0.6%	0.0%	0.0%	26.7%	1.5%	58.1%
Lincoln 6 Tank	0.0%	0.0%	0.2%	0.0%	0.0%	1.6%	15.3%	0.0%	82.9%
Lincoln Hills Tank	0.0%	0.0%	16.0%	0.0%	0.0%	0.0%	37.4%	7.6%	39.0%
Crestline Tanks	56.0%	3.7%	15.0%	0.0%	0.0%	0.1%	8.8%	2.4%	13.9%
Hillview Tank	36.1%	0.0%	4.3%	0.4%	0.0%	0.0%	47.0%	0.0%	11.7%
Skyview Reservoir	2.0%	0.0%	10.3%	0.4%	0.0%	0.0%	47.2%	11.1%	23.0%
Gharrett Tank	0.0%	18.5%	0.0%	0.0%	0.0%	0.0%	6.8%	2.9%	71.8%
Upper Prospect	0.0%	0.0%	23.4%	0.1%	0.0%	0.1%	76.4%	0.0%	0.0%

AVERAGE AGE BY PIPE TYPE BY RESERVOIR ZONE

	Pipe Type								
Reservoir Zone	ASBESTOS CEMENT	CAST IRON	DUCTILE IRON	GALVANIZED	KALAMEIN	OTHER	PVC	STEEL	S C
3 Million Gallon Reservoir	63.37	56.78	14.38	78.99	90.36	27.79	14.72	56.61	
#2 Reservoir	-	50.59	14.20	72.37	90.70	42.00	15.33	55.45	
#1 Reservoir - East of Russell	-	61.80	16.04	89.53	93.36	27.57	14.28	48.26	
#1 Reservoir - West of Russell	-	52.29	8.74	38.00	-	5.19	13.67	38.26	
Whitaker 400K Tank	48.33	-	5.02	45.00	-	-	16.02	26.00	
Highpark Reservoir	56.00	-	17.06	-	-	-	14.10	-	
East Missoula Tank	-	48.14	6.24	44.83	-	6.00	15.35	33.42	
Mansion Heights Tank	-	-	5.73	-	-	5.00	10.21	-	
Twite 85K Reservoir	-	-	5.18	-	-	-	17.80	-	
Twite 500K Reservoir	-	-	8.47	-	-	-	14.16	-	
Upper Elk Ridge Tank	-	-	21.00	-	-	-	-	-	
Elk Ridge Tank	-	-	15.09	45.00	-	-	15.96	36.25	
Lincoln 6 Tank	-	-	19.00	-	-	3.00	16.66	-	
Lincoln Hills Tank	-	-	10.98	-	-	-	17.40	37.25	
Crestline Tanks	47.75	44.00	31.78	-	-	7.00	18.04	39.00	
Hillview Tank	32.45	-	5.39	36.22	-	-	22.50	-	
Skyview Reservoir	34.00	-	7.47	37.00	-	-	21.82	37.89	
Gharrett Tank	-	48.62	-	-	-	-	15.00	44.32	
Upper Prospect	-	-	23.82	10.35	-	18.00	19.70	-	
Weighted Average Age	**43.25**	**50.53**	**10.90**	**77.81**	**91.09**	**37.04**	**15.39**	**46.94**	