
BNL's Site Water Distribution Model:
What It Is Telling Us
September 13, 2004

Michael Kretschmann, PE



FIRE PROTECTION
ENGINEERING GROUP

Brookhaven Science Associates
U.S. Department of Energy

BROOKHAVEN
NATIONAL LABORATORY

Acknowledgements

- Alan Kochinsky: Fire Protection Engineering Summer Student
- Sean Vaz: Fire Protection Engineering Summer Student
- Robert Lee
- Plant Engineering
- Fire Fighters

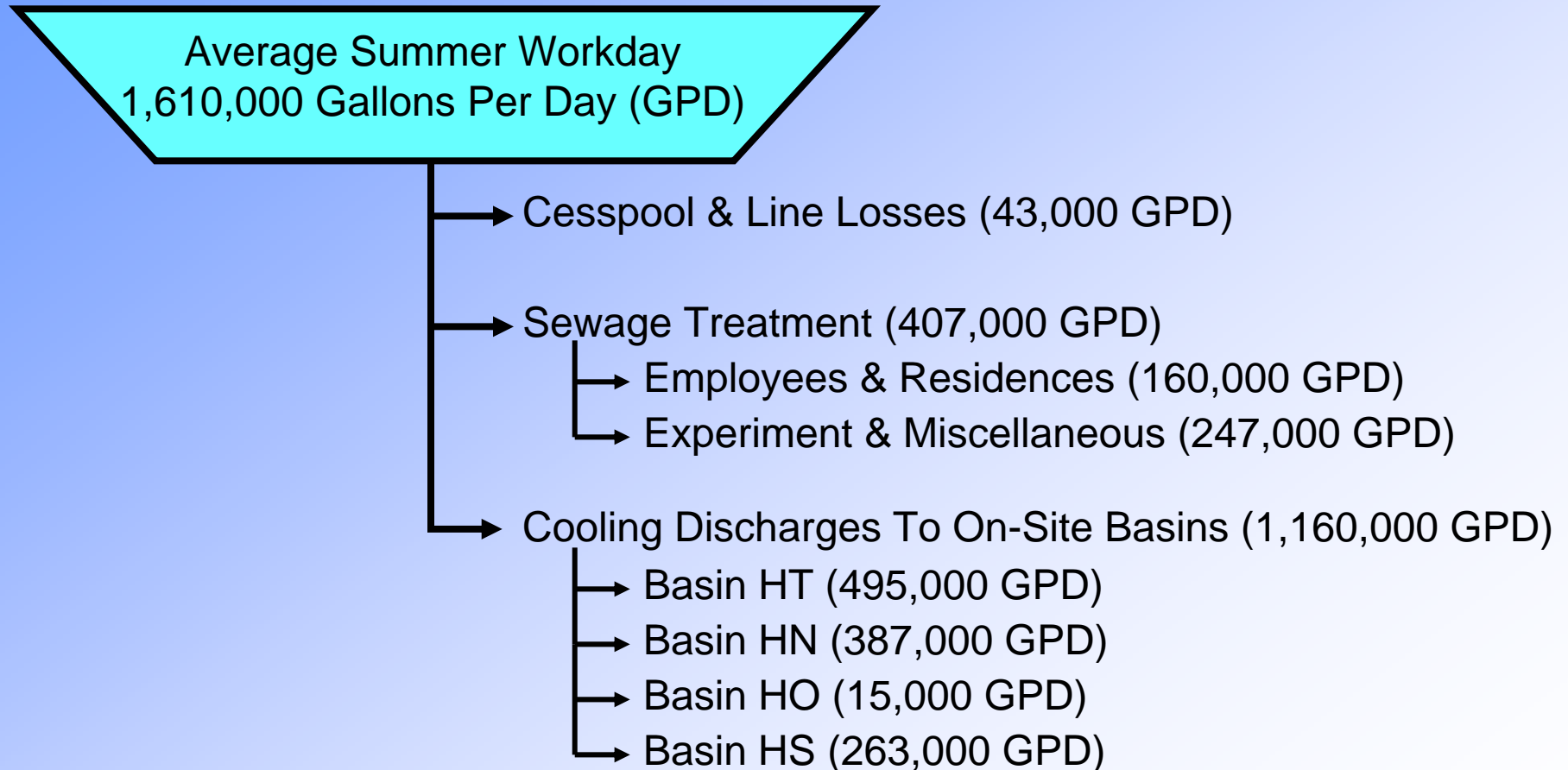
Agenda

- Model Development Overview
- BNL's Model Output: What The Model Is Telling Us
- Fire Protection Recommendations
- Comments/Discussions

Model Development Overview

- Water Demand for 239 Buildings
- BNL's Aging Pipe: Actual Pipe Roughness By Testing

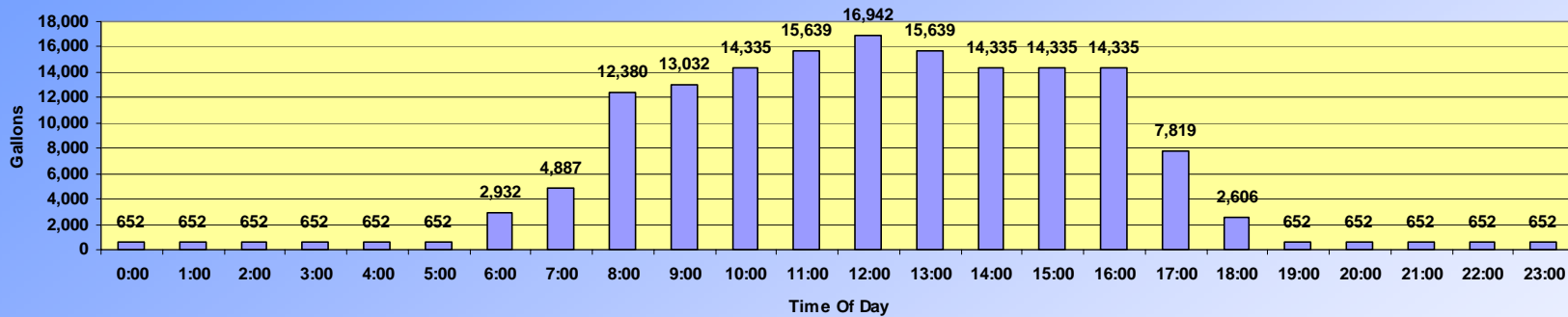
BNL Water Demand: Determining Site Users



Derived From 2002 Annual Water Report

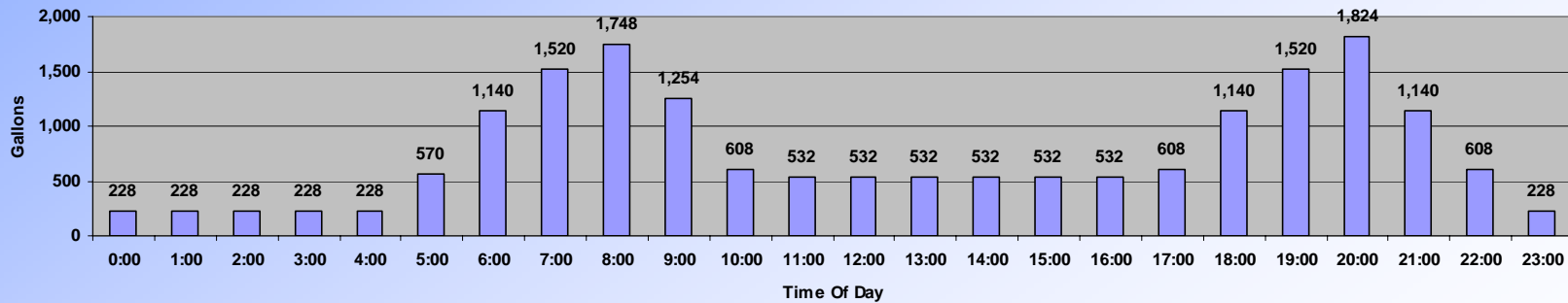
BNL Water Demand: Domestic & Residences

BNL Workers Domestic Water Usage - Average Business Day: Summer



Industry Average of 35 GPD PER Worker

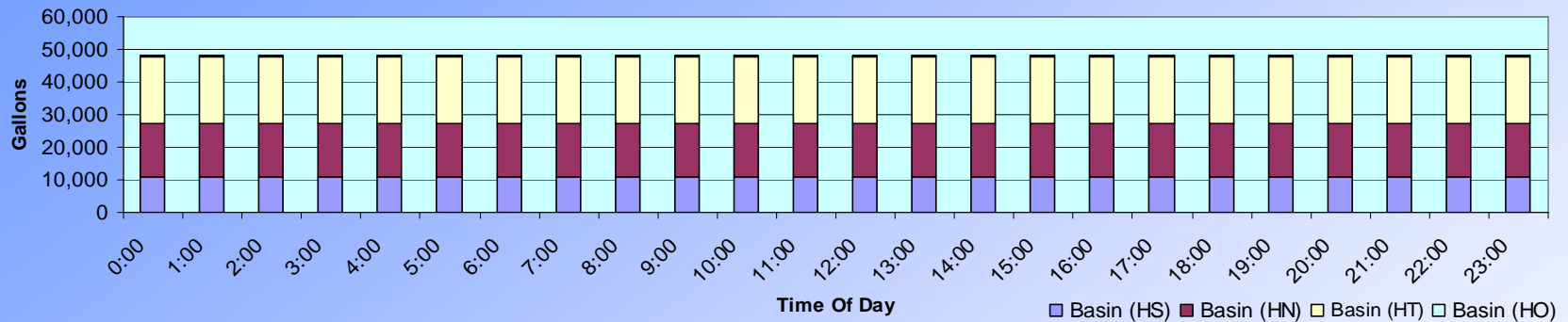
BNL Residence Domestic Water Usage - Average Business Day: Summer



Industry Average of 122 GPD Per Unit

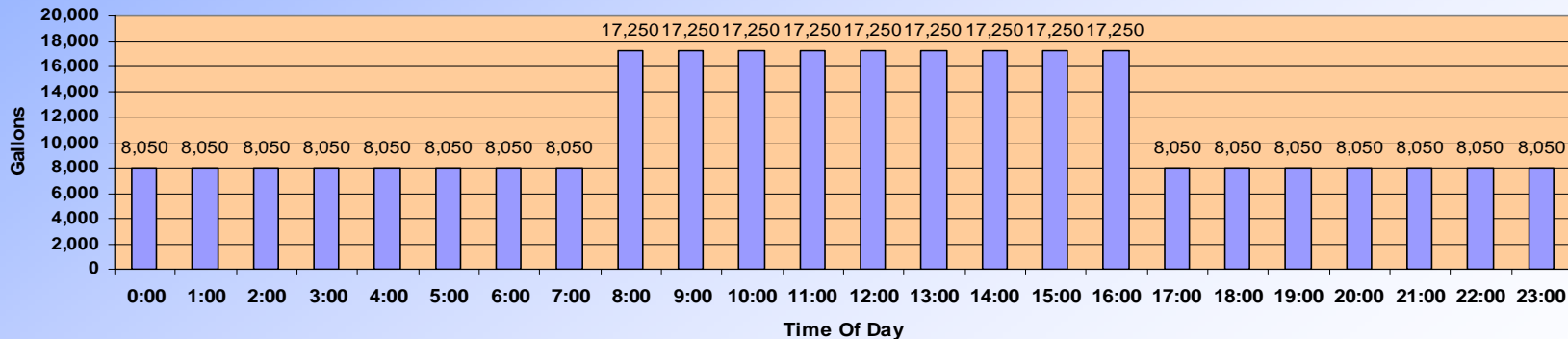
BNL Water Demand: Cooling & Experiments

BNL Experiment Cooling Water Usage - Average Business Day: Summer



Derived From 2002 Annual Water Report

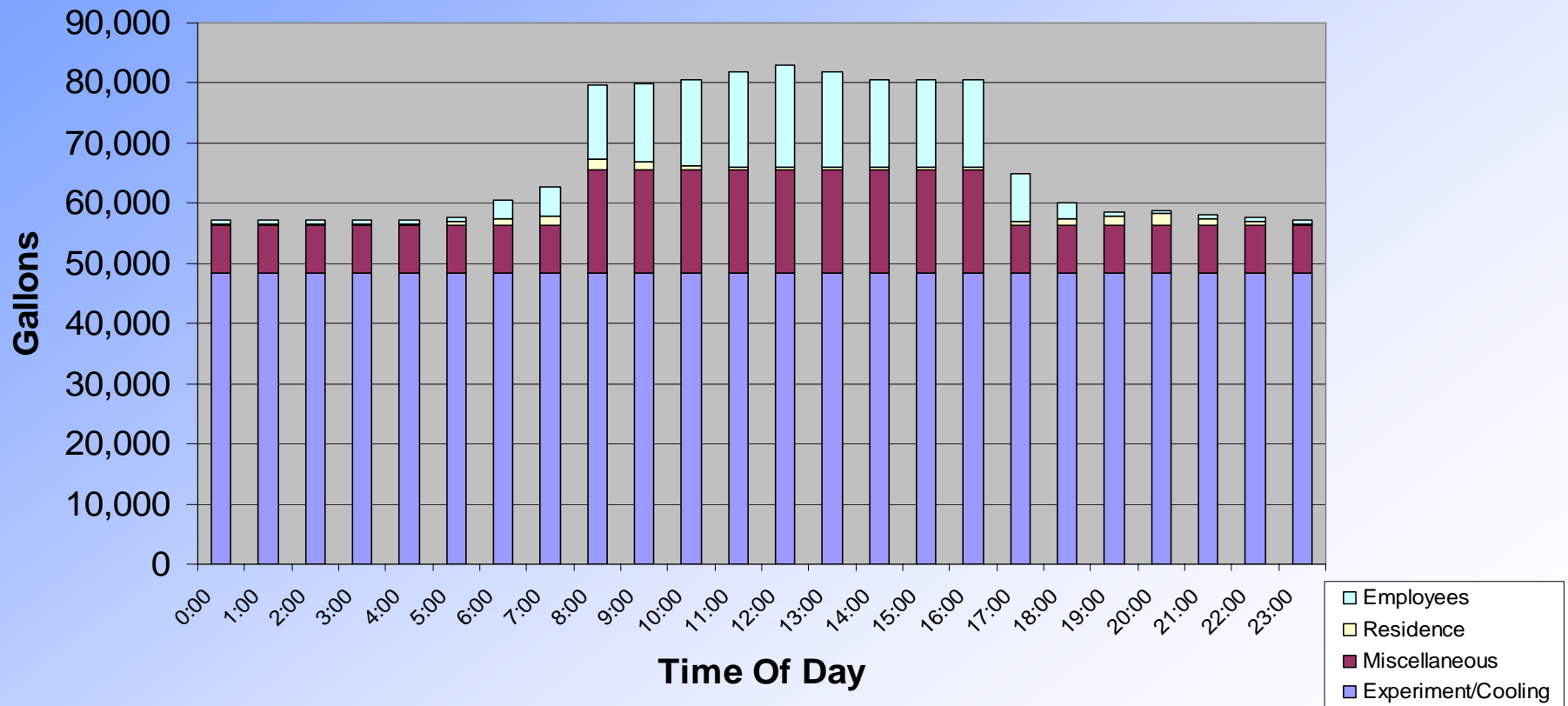
BNL Miscellaneous Domestic Water Usage - Average Business Day: Summer



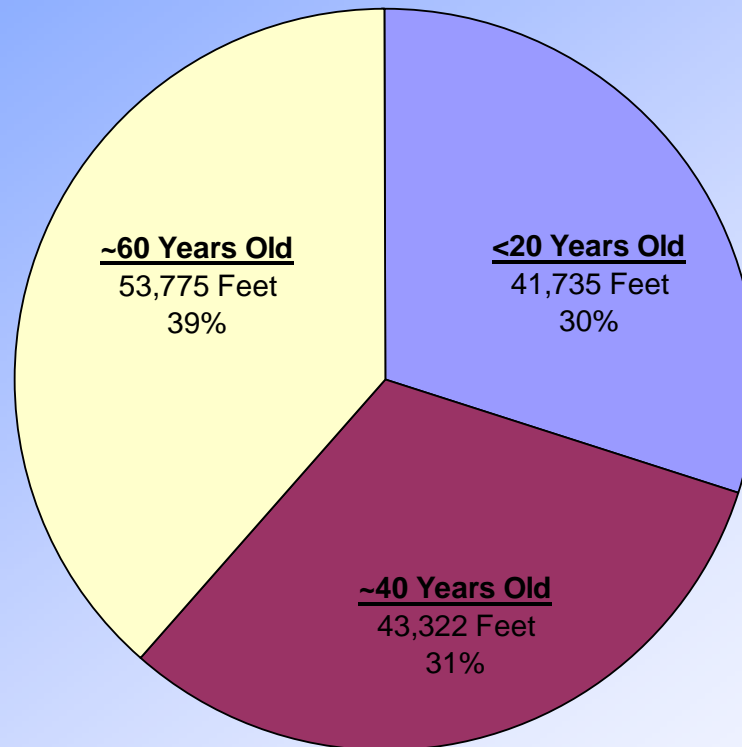
Derived From 2002 Annual Water Report

BNL Water Demand: Composite Graph

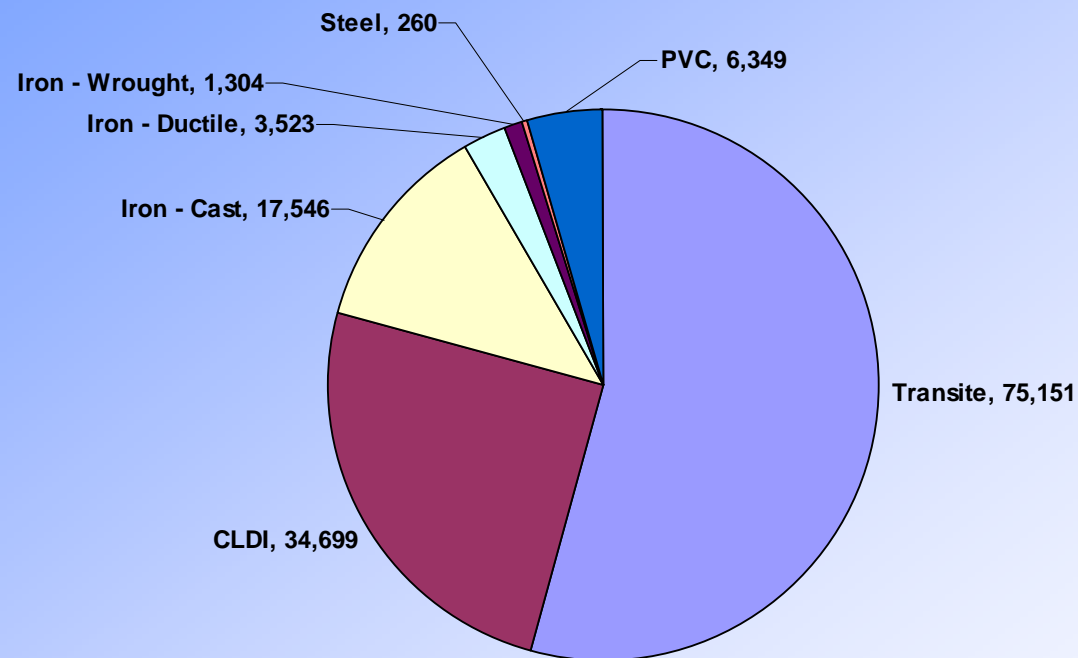
BNL Water Usage By Hour - Average Business Day: Summer



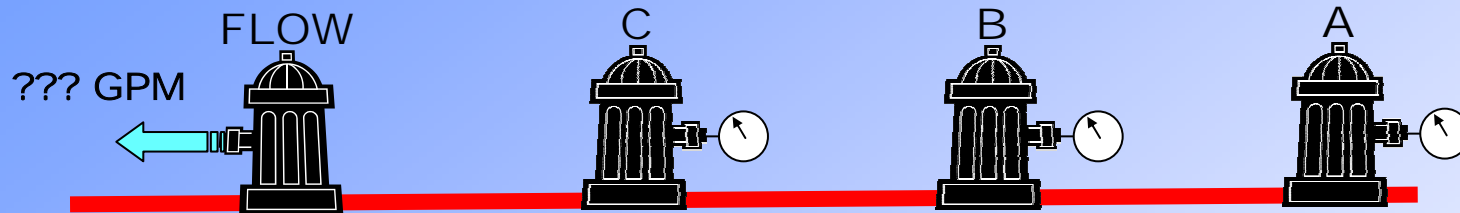
BNL's Aging Pipe – Majority Over 40 Years Old



BNL's Aging Pipe – 26 Miles Of Mixed Materials



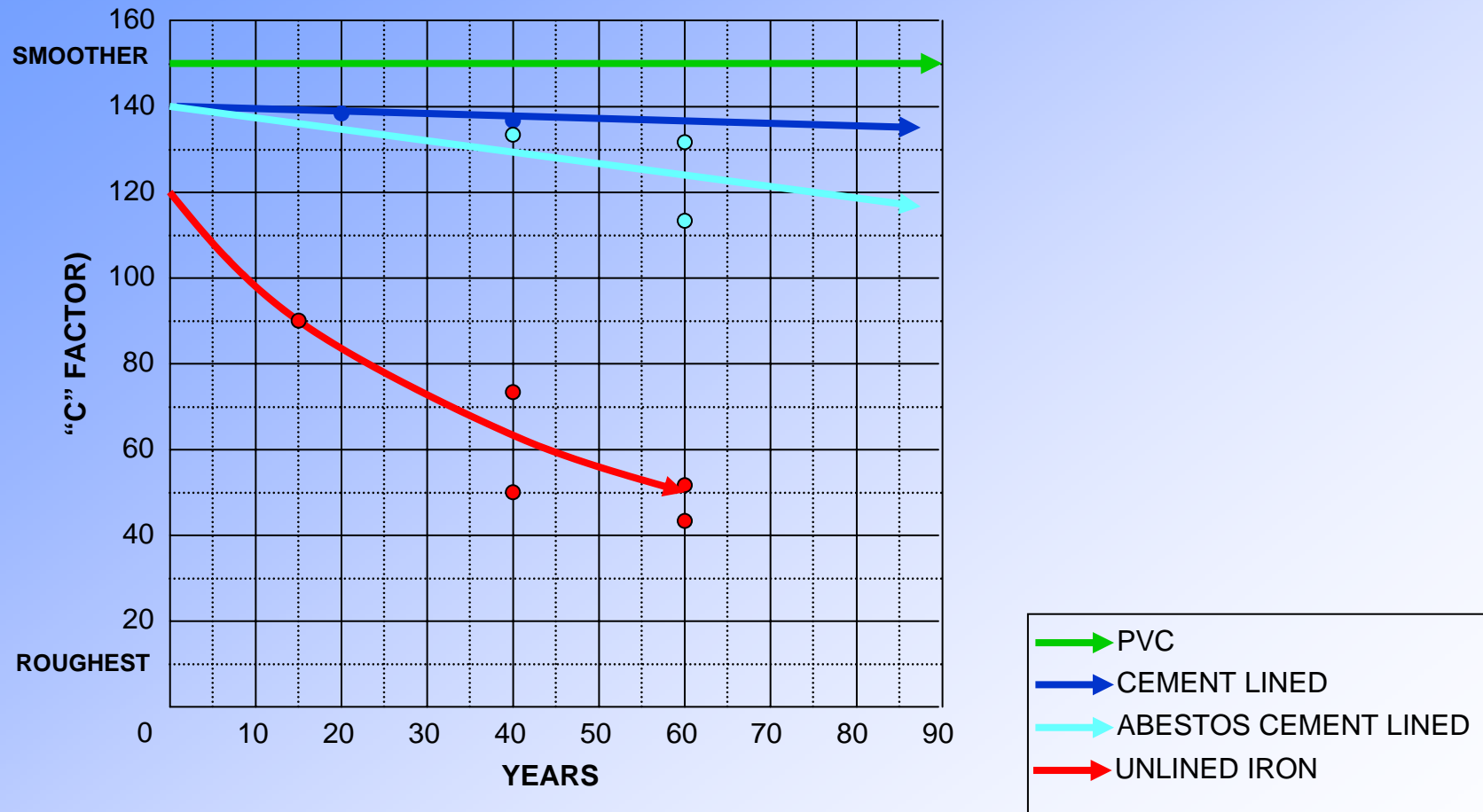
BNL's Aging Pipe – How Did We Determine Condition



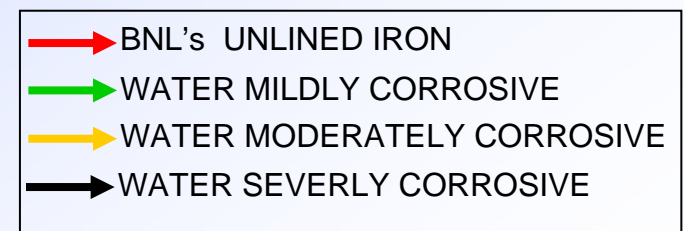
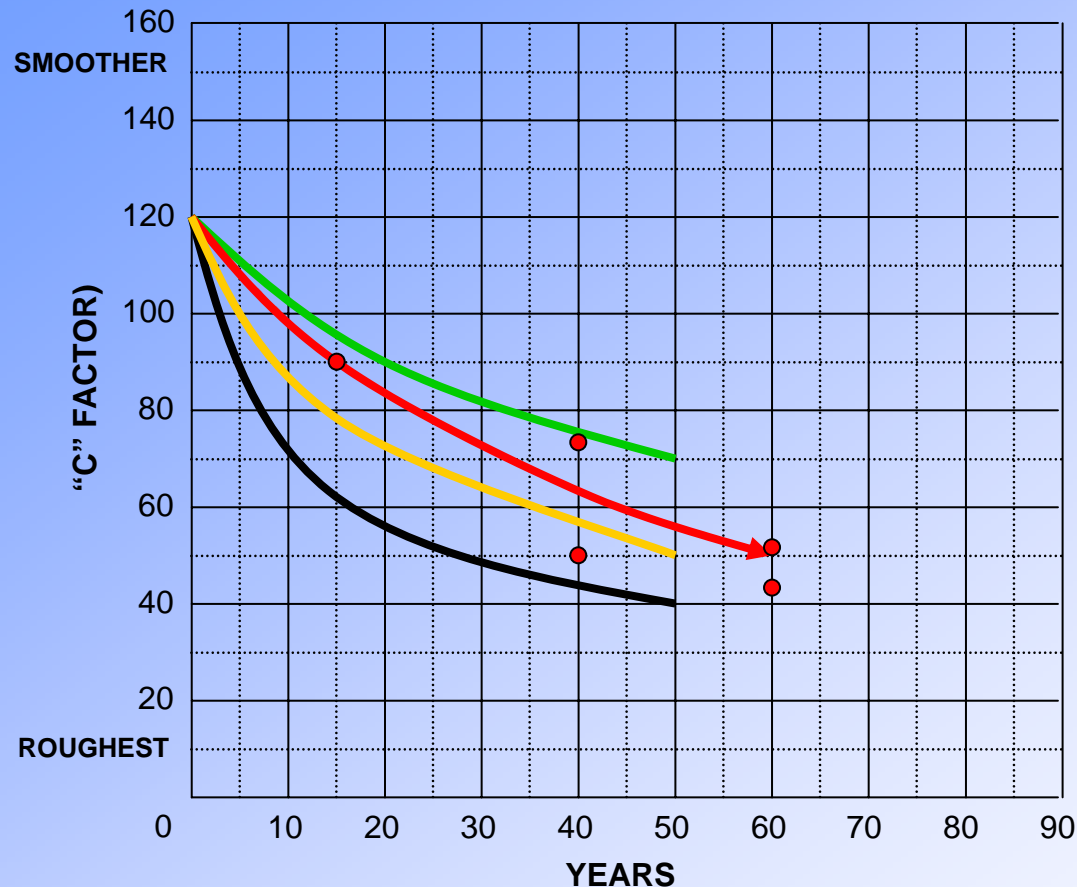
■ Pressure Gradient Tests

- Read pressure differences between two to three pressure hydrants
- Flow hydrant provides flow for the test
- Flow in single controlled direction
- Test area isolated by closing street valves

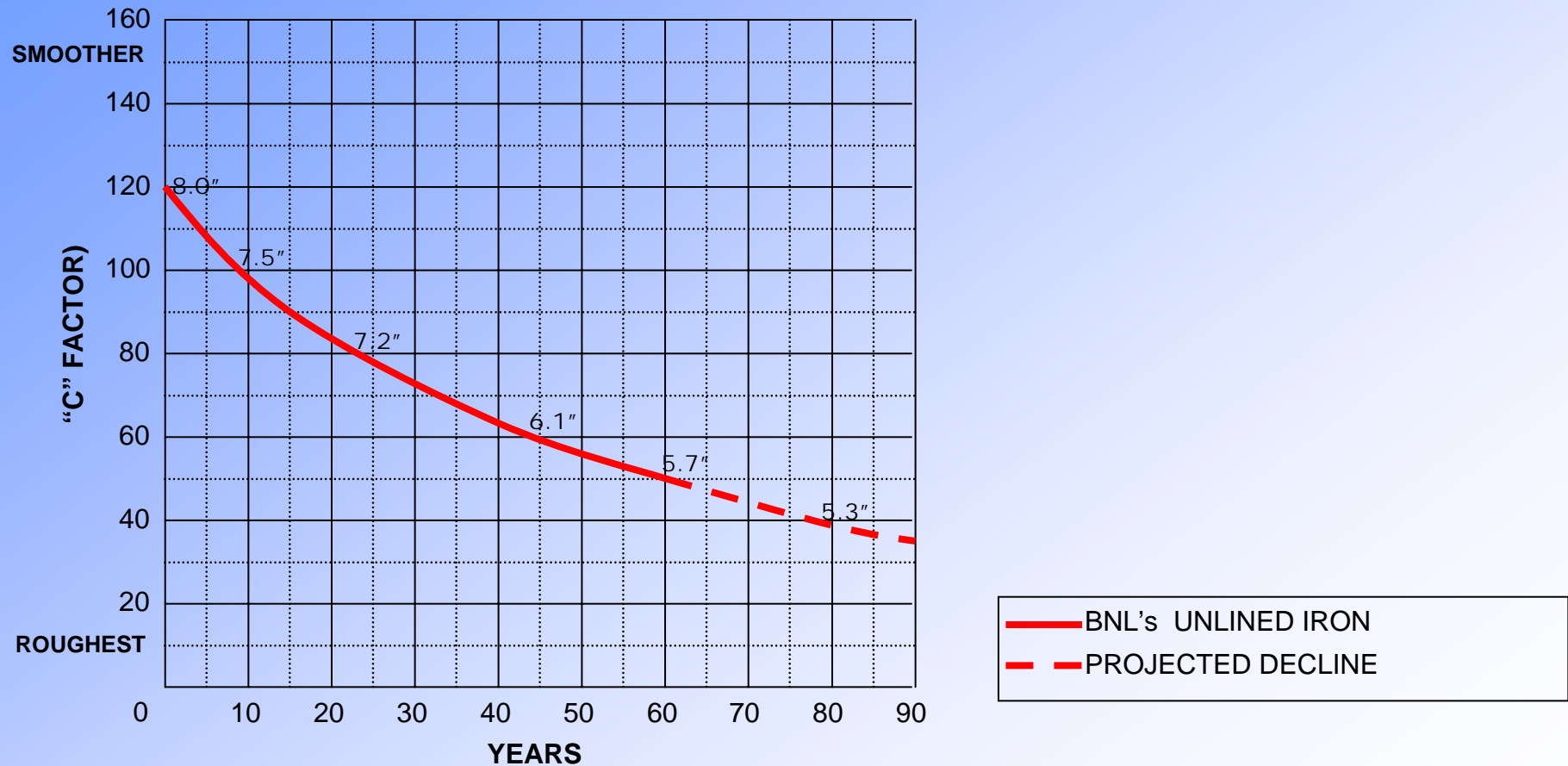
BNL's Aging Pipe – Plot of Gradient Flow Tests



BNL's Aging Pipe – Compared to NFPA Table 10.5.6 “Guide for Estimating Hazen-Williams C Factor”



BNL's Aging Pipe – What "C Factor" Reduction Really Means in Terms of Equivalent Pipe Sizes



BNL's Model Output – How Close Are We To Reality?

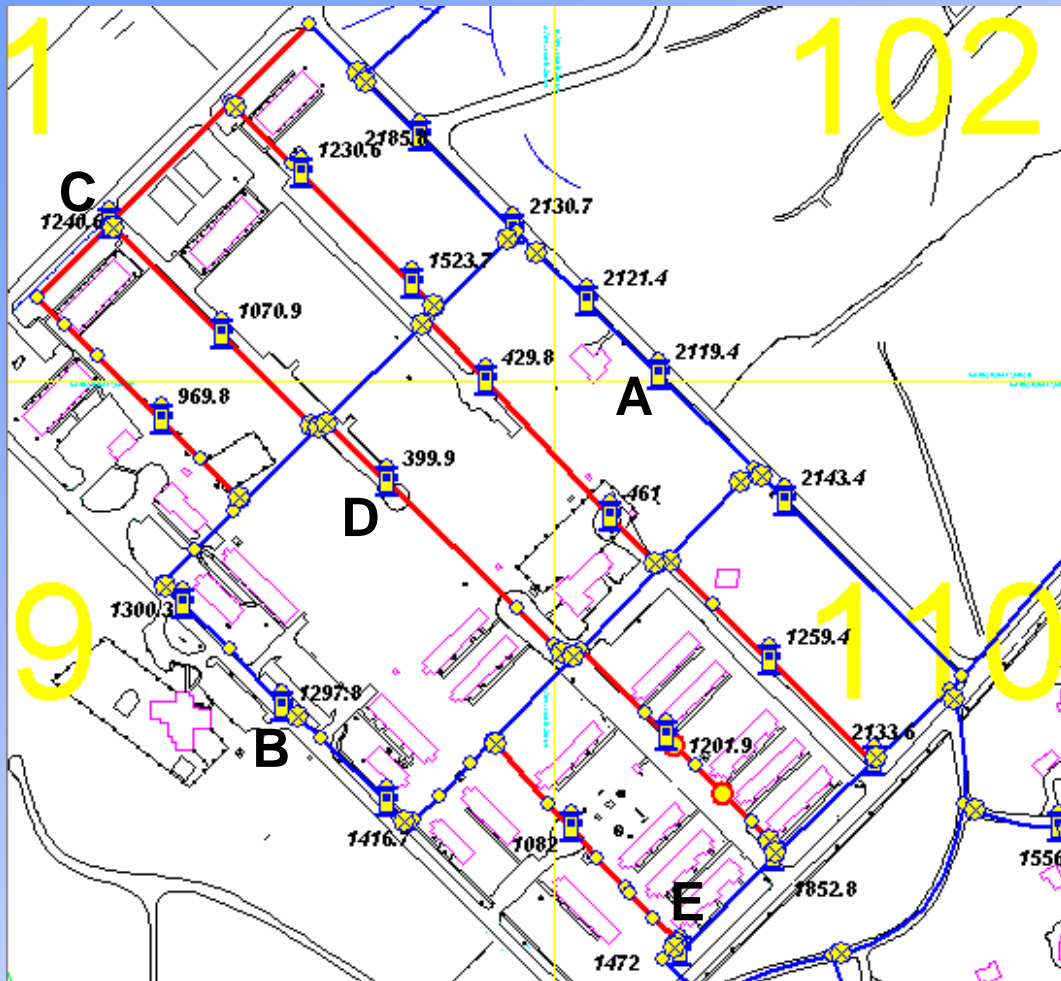


- Conducted Annual Flow Tests
 - Read pressure and flow at 18 locations around the site
- Found a 10% average difference from the flow tests.
 - Industry established a 6% error as a “good model”

BNL's Model Output – Factors Contributing To 10% Error

- Water demand for each building is estimated. Few water meters installed in buildings.
- Model assumes full occupancy of all residences and apartments.
- Assume water usage demand curves for domestic and residence usage is similar to industry averages.
- Assumption that rate of roughness decrease is uniform for all pipe sizes in the same material group
- Pressure gauges accuracy used in all tests.
- Accuracy of piping documentation.

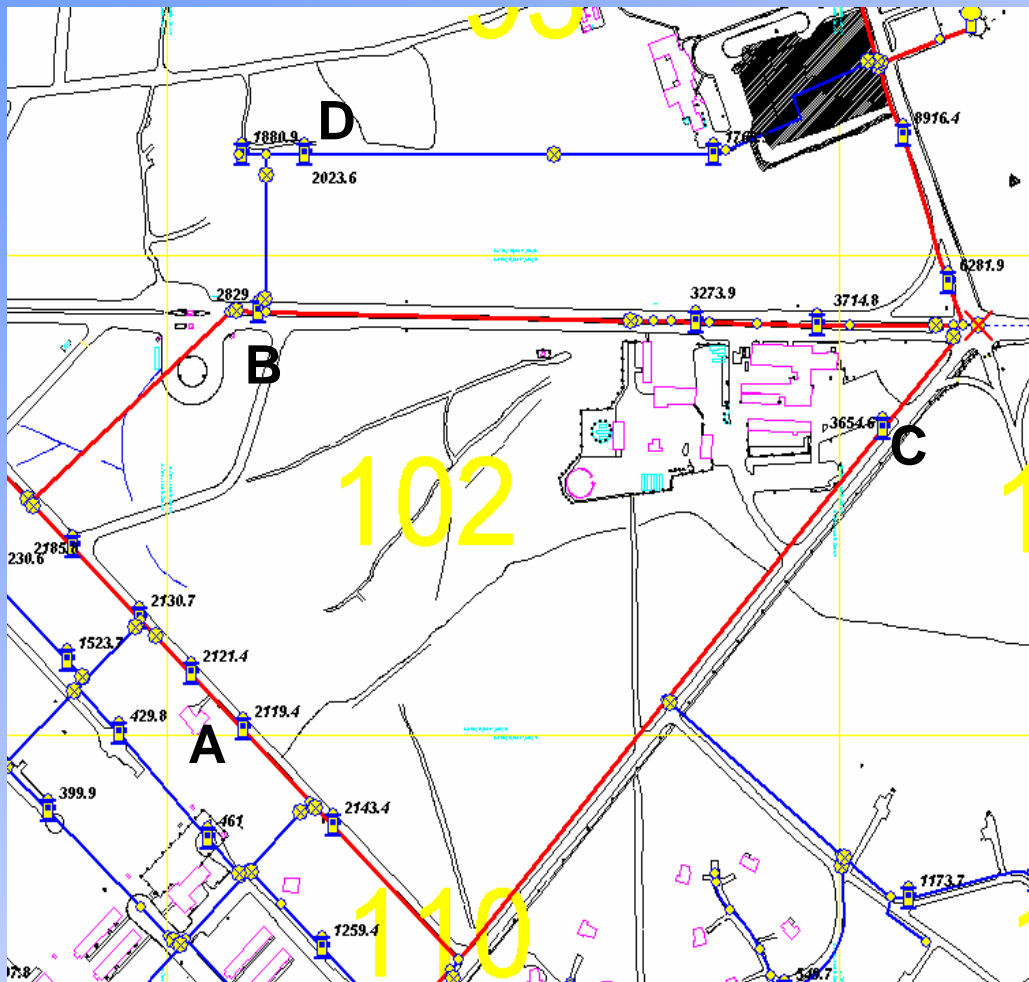
BNL's Model Output - Apartment Area



	1,000K & 300K TANKS (210 FT)				
	HYDRANT (GPM @ 20 PSI)				
	A	B	C	D	E
Year 2004	2,119	1,297	1,240	399	1,472
Year 2024	1,996	1,181	790	155	1,146
Year 2044	1,889	1,072	209	9	397

	1,000K TANK ONLY (210 FT)				
	HYDRANT (GPM @ 20 PSI)				
	A	B	C	D	E
Year 2004	1,377	994	1,036	371	1,147
Year 2024	1,289	910	700	148	914
Year 2044	1,220	835	119	9	365

BNL's Model Output – New Proposed Apartment Area



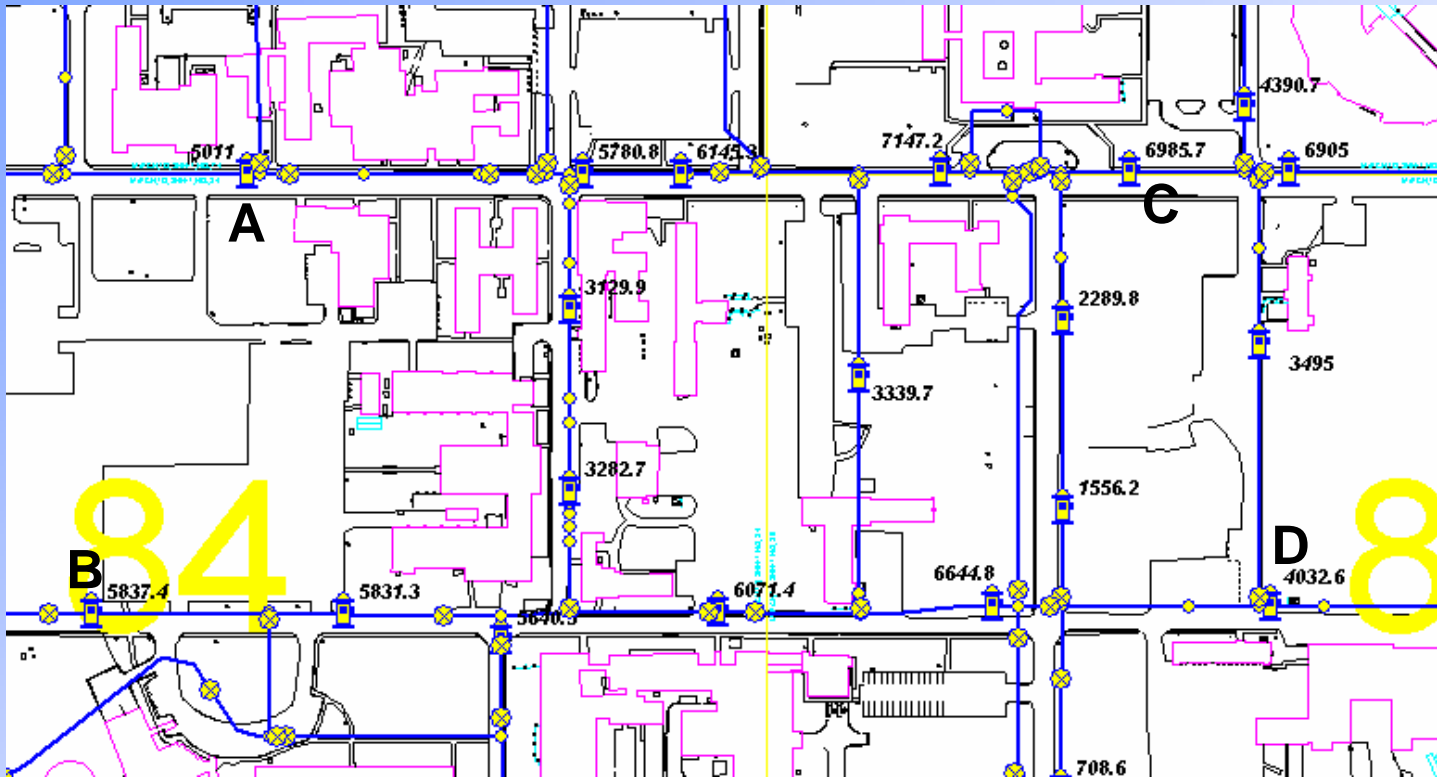
1,000K & 300K TANKS (210 FT)				
HYDRANT (GPM @ 20 PSI)				
	A	B	C	D
Year 2004	2,119	2,829	3,654	2,023
Year 2024	1,996	2,659	3,421	1,902
Year 2044	1,889	2,547	3,288	1,850

1,000K TANK ONLY (210 FT)				
HYDRANT (GPM @ 20 PSI)				
	A	B	C	D
Year 2004	1,377	1,576	1,754	1,508
Year 2024	1,289	1,473	1,629	1,413
Year 2044	1,220	1,401	1,556	1,361

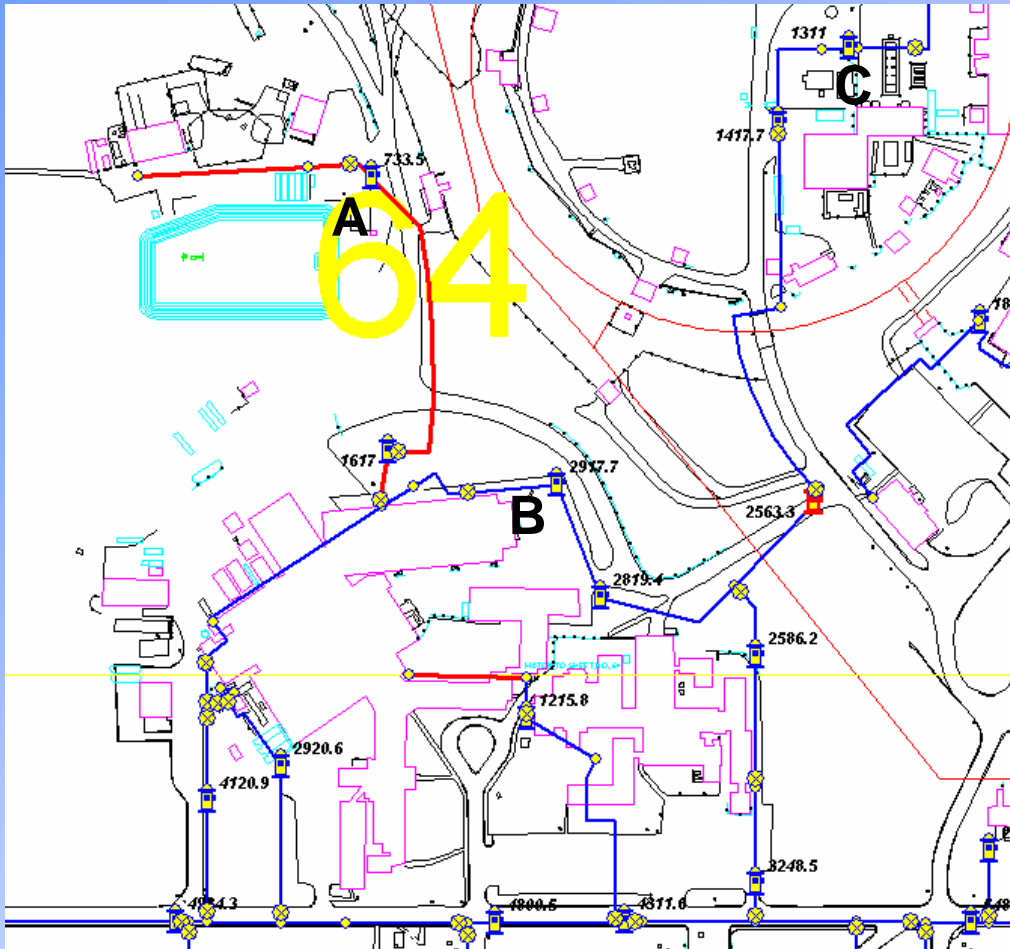
BNL's Model Output – Central Campus Area

1,000K & 300K TANKS (210 FT)				
	HYDRANT (GPM @ 20 PSI)			
	A	B	C	D
Year 2004	5,011	5,837	6,985	4,032
Year 2024	4,705	5,544	6,230	3,800
Year 2044	4,414	5,365	5,940	3,688

1,000K TANK ONLY (210 FT)				
	HYDRANT (GPM @ 20 PSI)			
	A	B	C	D
Year 2004	3,400	2,830	3,458	3,313
Year 2024	3,265	2,726	3,329	3,159
Year 2044	3,096	2,613	3,179	3,059



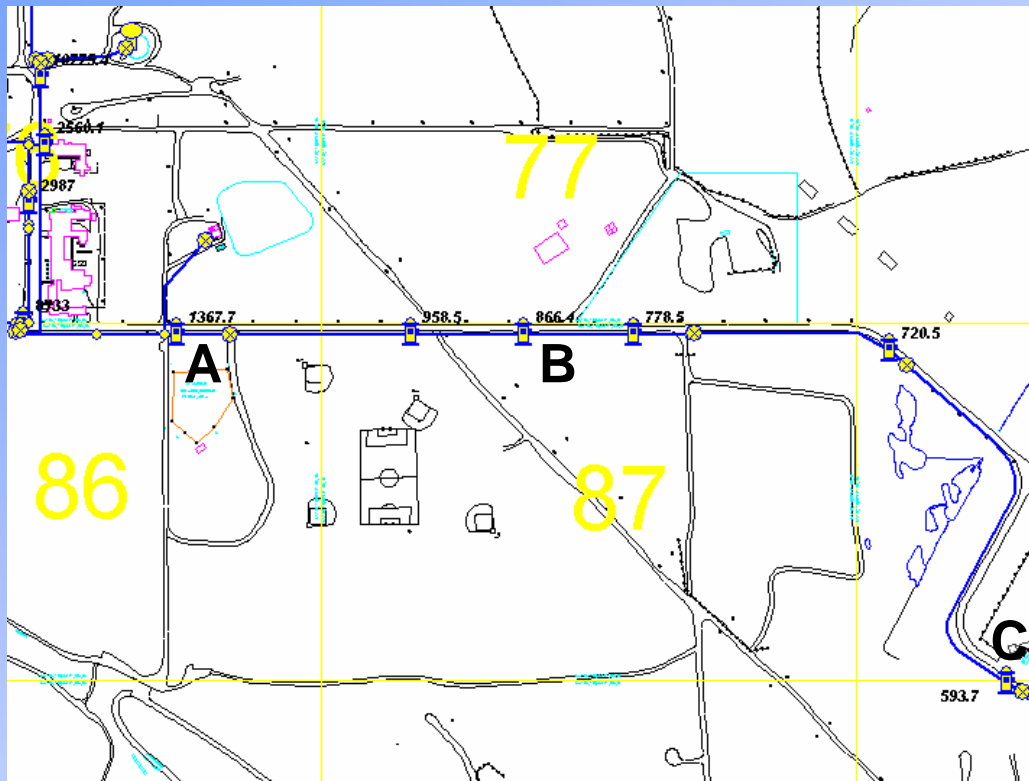
BNL's Model Output – Buildings 938 & 939 Area



1,000K & 300K TANKS (210 FT)			
	HYDRANT (GPM @ 20 PSI)		
	A	B	C
Year 2004	733	2,917	1,311
Year 2024	509	2,813	1,285
Year 2044	268	2,720	1,261

1,000K TANK ONLY (210 FT)			
	HYDRANT (GPM @ 20 PSI)		
	A	B	C
Year 2004	699	2,297	1,224
Year 2024	490	2,229	1,200
Year 2044	263	2,149	1,175

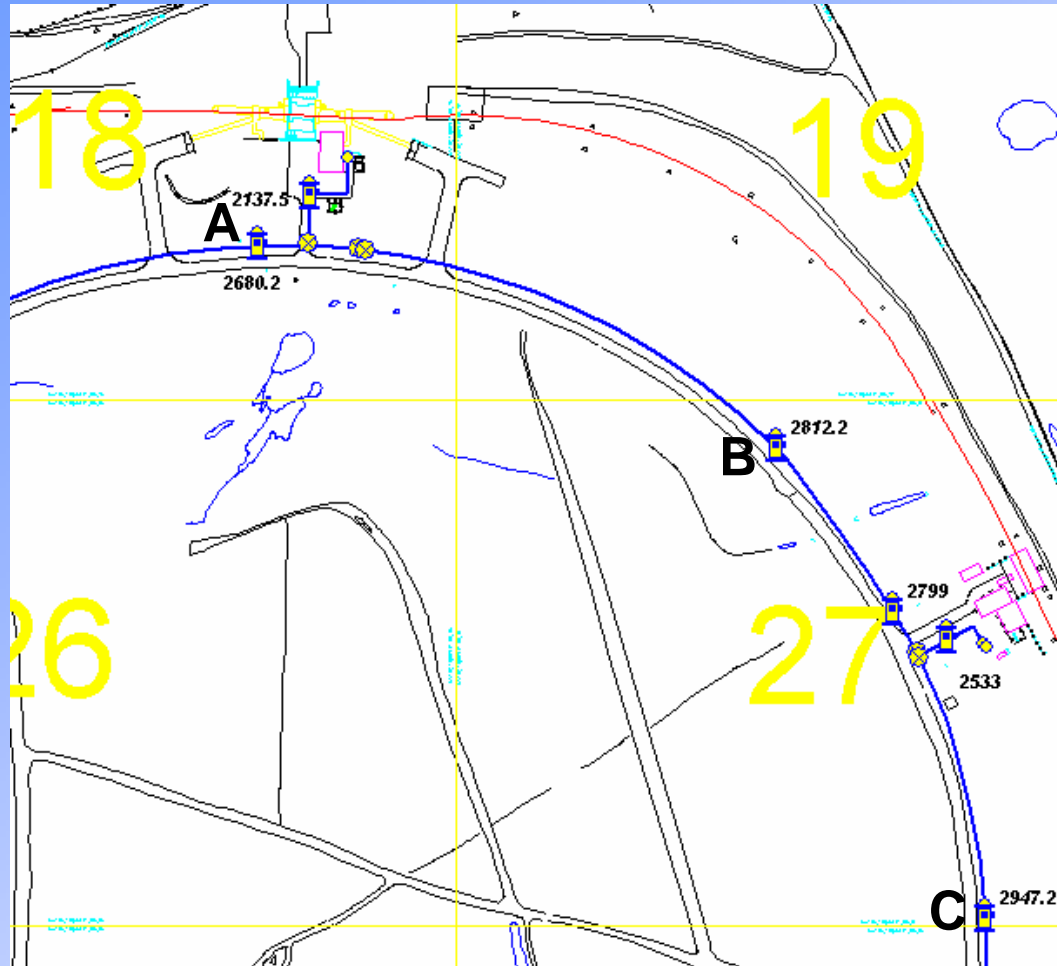
BNL's Model Output – East Brookhaven Avenue Area



1,000K & 300K TANKS (210 FT)			
	HYDRANT (GPM @ 20 PSI)		
	A	B	C
Year 2004	1,367	866	593
Year 2024	1,287	840	583
Year 2044	1,257	825	575

1,000K TANK ONLY (210 FT)			
	HYDRANT (GPM @ 20 PSI)		
	A	B	C
Year 2004	1,316	849	586
Year 2024	1,242	825	576
Year 2044	1,213	810	569

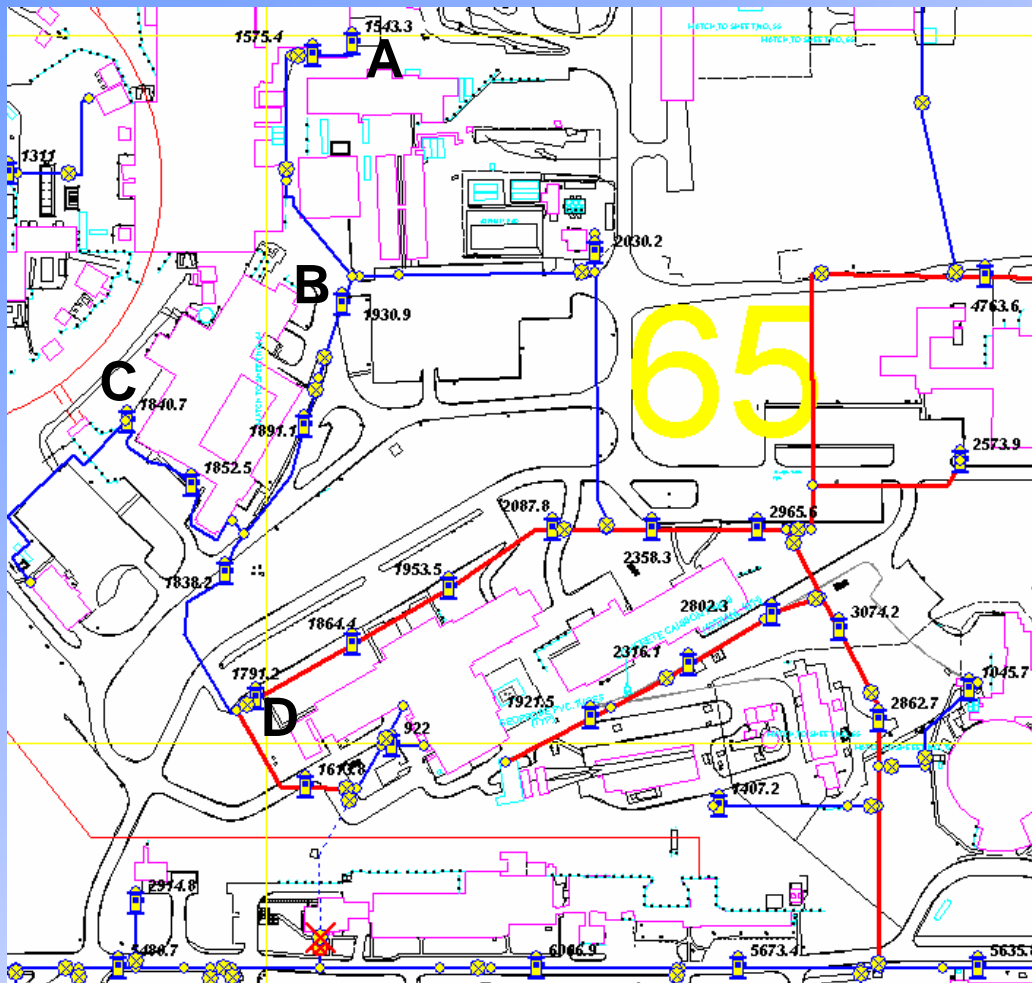
BNL's Model Output – RHIC Ring Area



1,000K & 300K TANKS (210 FT)			
	HYDRANT (GPM @ 20 PSI)		
	A	B	C
Year 2004	2,680	2,812	2,947
Year 2024	2,598	2,726	2,850
Year 2044	2,467	2,589	2,696

1,000K TANK ONLY (210 FT)			
	HYDRANT (GPM @ 20 PSI)		
	A	B	C
Year 2004	2,483	2,605	2,711
Year 2024	2,415	2,534	2,633
Year 2044	2,300	2,413	2,464

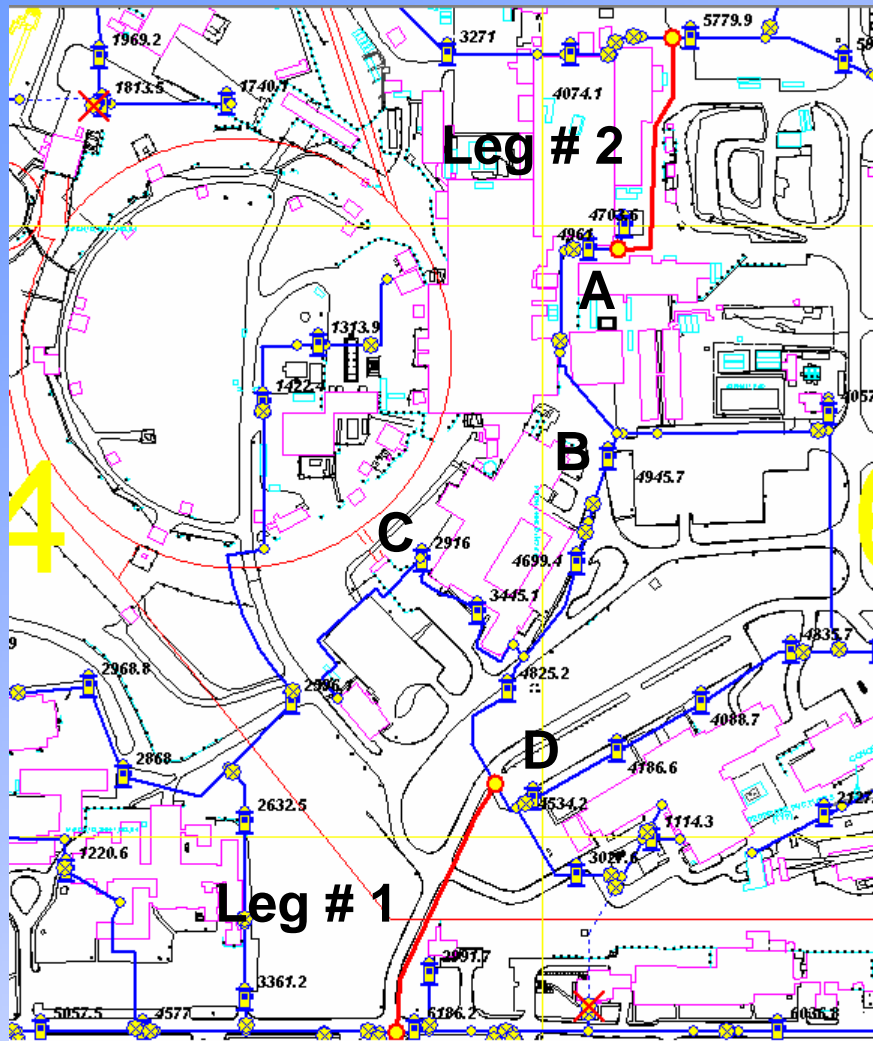
BNL's Model Output- AGS Area



1,000K & 300K TANKS (210 FT)				
HYDRANT (GPM @ 20 PSI)				
	A	B	C	D
Year 2004	1,840	1,930	1,840	1,791
Year 2024	1,297	1,345	1,301	1,273
Year 2044	682	680	667	662

1,000K TANK ONLY (210 FT)				
HYDRANT (GPM @ 20 PSI)				
	A	B	C	D
Year 2004	1,469	1,745	1,682	1,631
Year 2024	1,243	1,249	1,212	1,187
Year 2044	648	646	635	636

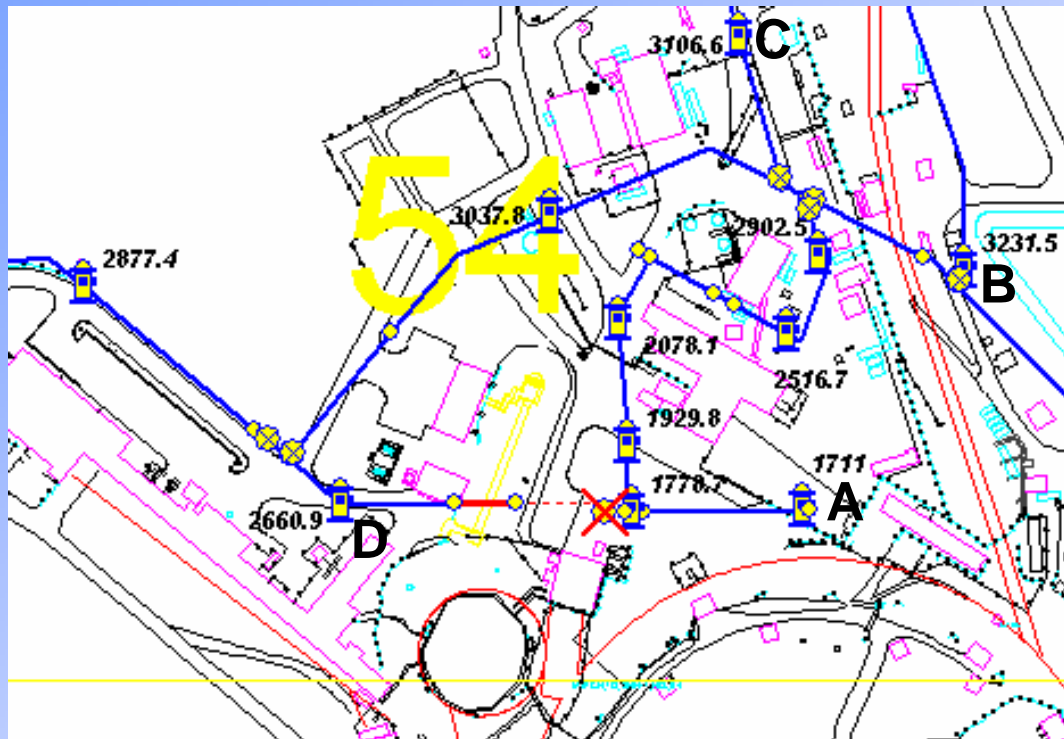
BNL's Model Output – Proposed AGS Piping Addition



1,000K & 300K TANKS (210 FT)				
	HYDRANT (GPM @ 20 PSI)			
	A	B	C	D
Current	1,840	1,930	1,840	1,791
Leg # 1	1,874	4,251	2,741	4,157
Legs # 1 & # 2	4,918	4,945	2,918	4,512

BNL's Model Output – Pipe Under NSRL Tunnel

1,000K & 300K TANKS (210 FT)				
	HYDRANT (GPM @ 20 PSI)			
	A	B	C	D
Pipe Open	2,388	3,327	3,785	3,044
Pipe Closed	1,778	3,231	3,106	2,660



Fire Protection Engineering Recommendations

- Do not eliminate the 300K elevated storage tank.
- Shut Down piping under NSRL Tunnel.
- ADS Activity:
 - Add:
 - 1000Ft. AGS Pipe Extension
 - Replace 700 Ft. Pipe Run to Building 938 & 939
 - Proposed Apartment Area Pipe Extension
 - Remove:
 - Inner AGS Ring Piping Upgrade
- Do not replace broken pipe at intersection of Princeton Ave & Upton Ave.
- Marking “Low Flow “ Hydrants
- Revisit pressure gradient tests with new pressure testing equipment next summer.
- Revise controls for documenting street valve closures