Pacific Gas and Electric Company®

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December 16, 2013

Elizaveta Malashenko
Deputy Director
Office of Utility Safety and Reliability
Safety and Enforcement Division
California Public Utilities Commission

Re: Update - Oakland Incident of December 10, 2013

Dear Ms. Malashenko,

I wanted to provide you an update of the actions taken thus far and the current results of our analysis for the incident that occurred on December 10, 2013 near Golf Links Road and Fontaine Street in Oakland. As you recall the incident involved a gas leak and subsequent fire from a 4-inch steel elbow being operated at distribution pressure at a depth of approximately six feet. The elbow was removed and taken to Exponent Engineering's offices in Menlo Park for detailed third party analysis and to determine the root cause as well as the source of ignition. Below is what has been determined to date as well as further planned actions:

- The failure of the 4-inch steel elbow resulted from a single, significant external force to the pipeline. The elbow failed at the inner radius due to an external load to the pipe. The cause of the external force is not known at this time. The elbow failed in a brittle failure mode with no indications of yielding or fatigue. Yielding is the point where a material starts to deform due to the loading. In this case, the steel fractured with no indications of deformation.
- The affected pipe was installed in 1946 with a Maximum Allowable Operating Pressure of 54 psig and a Normal Operating Pressure of 48 psig. The elbow is seamless and showed limited evidence of corrosion or prior mechanical damage, neither of which contributed to the failure. The materials and configuration of the pipelines in the exposed area are consistent with our as-built records of the pipe installed at the location.
- Based on lab testing, the elbow shows high tensile strength and operating at low stress levels. Additional material testing is being conducted to further understand the material properties.

- The ignition source for the gas is currently unknown at this time, but PG&E is conducting a thorough investigation into the matter.
- PG&E reviewed customer odor call-ins for a two-week timeframe prior to the incident date and no calls were received of odor complaints in this area.
- Initial investigation to determine the cause of the elbow failure indicates the pipe is in the vicinity of the Hayward fault, which has a history of slow movement over time (creep), and that there is a known history of landslides in the area. In addition, several sewer and water projects have taken place in the vicinity in the last five to seven years. Additional data collection and analysis is being conducted to better understand the potential impact of geological conditions on the pipeline and the surrounding areas, soil conditions near the pipeline, and any recent work performed by third-parties in the vicinity of the pipeline.
- PG&E plans to conduct a special leak survey of the area surrounding the failure as an interim safety measure to monitor for any leaks as we continue to perform the root cause analysis.
- PG&E is also in the process of contacting East Bay Municipal Utilities District to understand what findings and issues they have experienced historically related to land movement in the area.
- Exponent is continuing to lead the root cause analysis on this incident, and is currently in the process of conducting a detailed finite element analysis to determine what happened. These results are expected within the next two weeks.

Attached is a working draft of the analysis done by Exponent and a map showing the area to be leak surveyed. We are working swiftly and thoroughly in our analysis, and plan to use what we learn from this incident to further enhance the safety and reliability of our gas system.

Please let me know if you have any questions or require further information.

Sincerely,

Jane Yura
Vice President, Risk and Asset Management

Cc: Paul Clanon, CPUC
General Jack Hagan, CPUC
Redacted PG&E
Laura Doll, PG&E
Bill Gibson, PG&E

Attachments

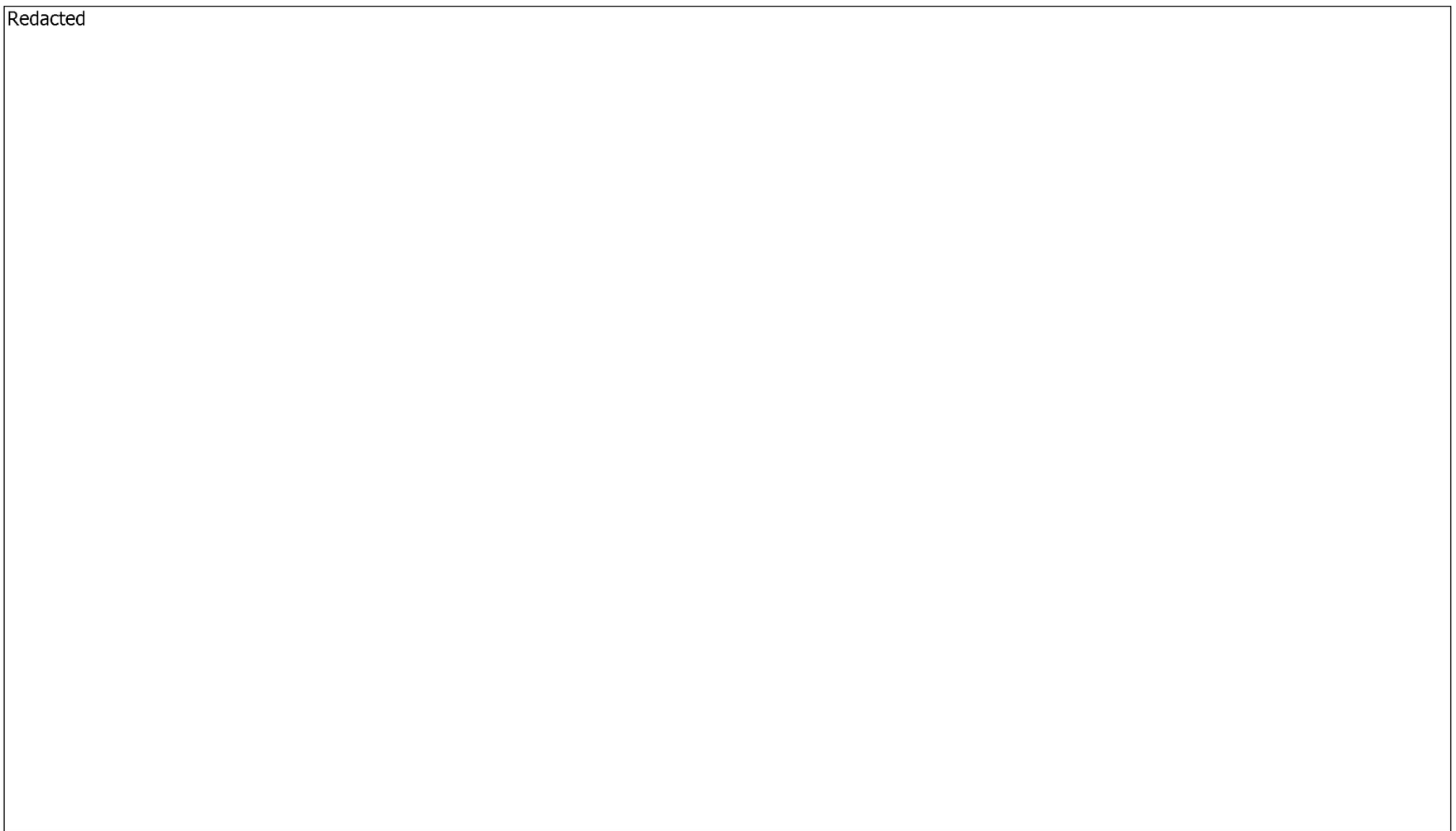
PG&E Redacted Release

Investigation Status Update
12/16/2013

Exponent®
Failure Analysis Associates®

BACKGROUND

Leak Location



Intersection of Redacted Oakland, CA

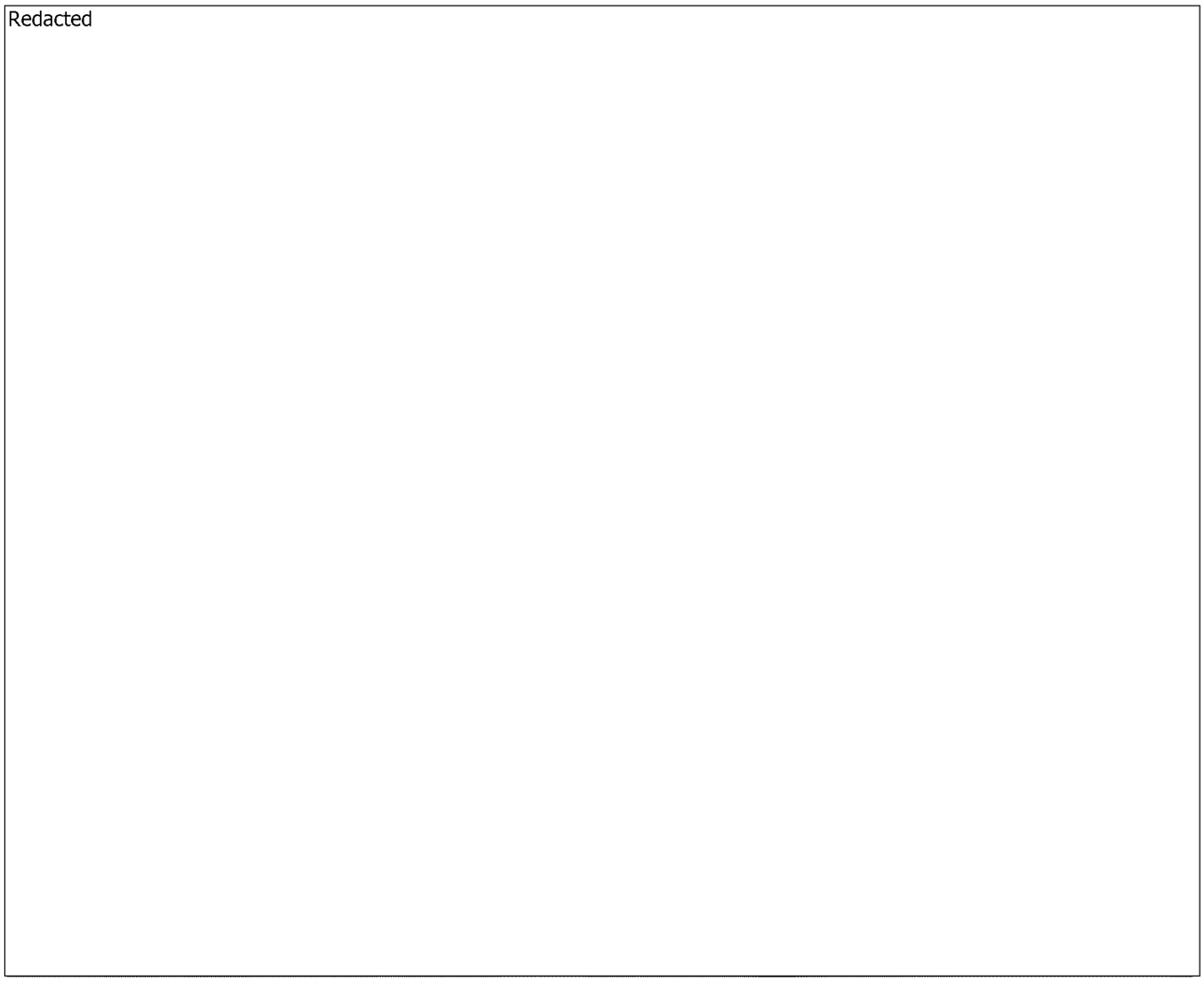
Satellite image from Google Maps

Leak Location

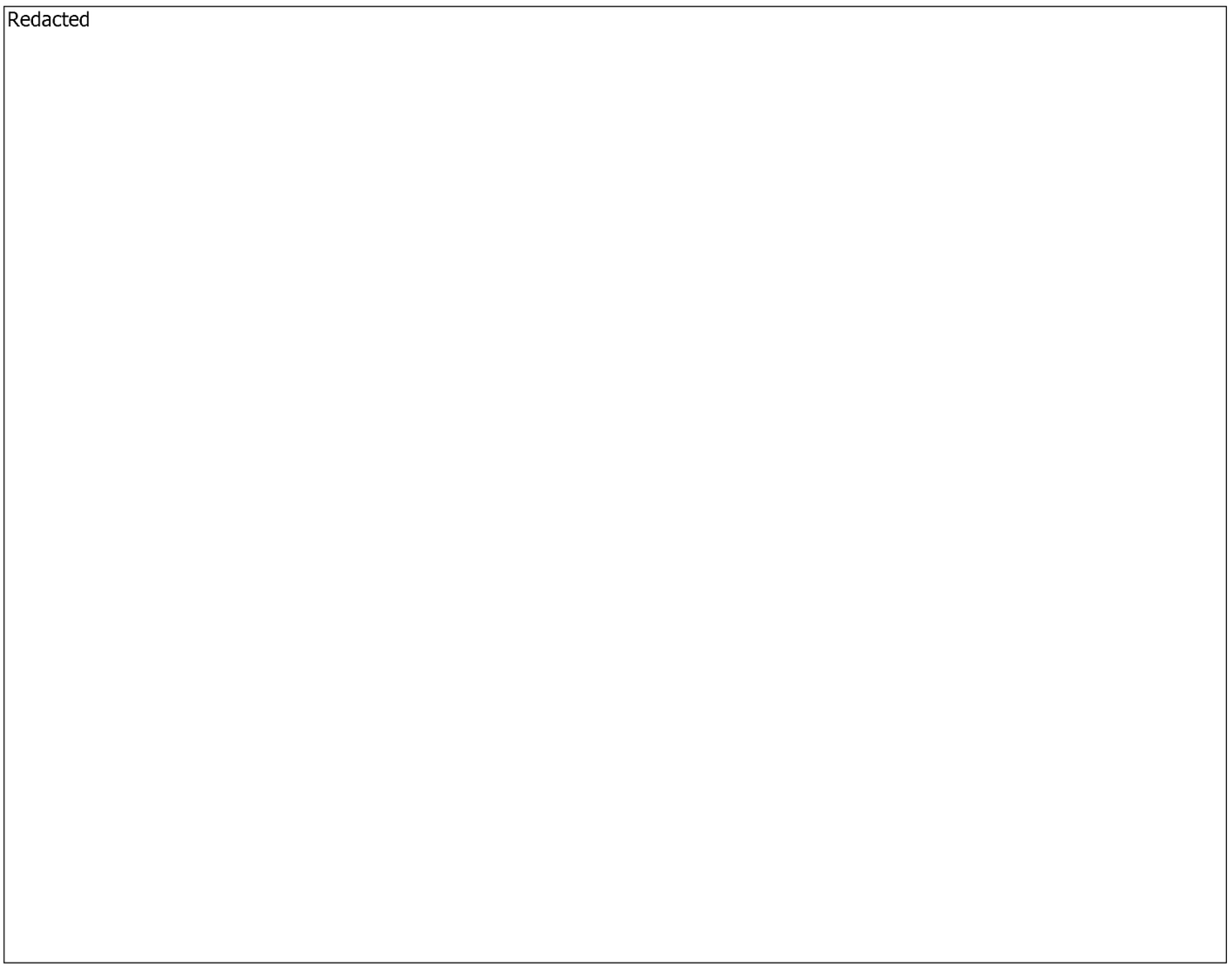
Intersection of Redacted Oakland, CA

2011 Image from Google Street View

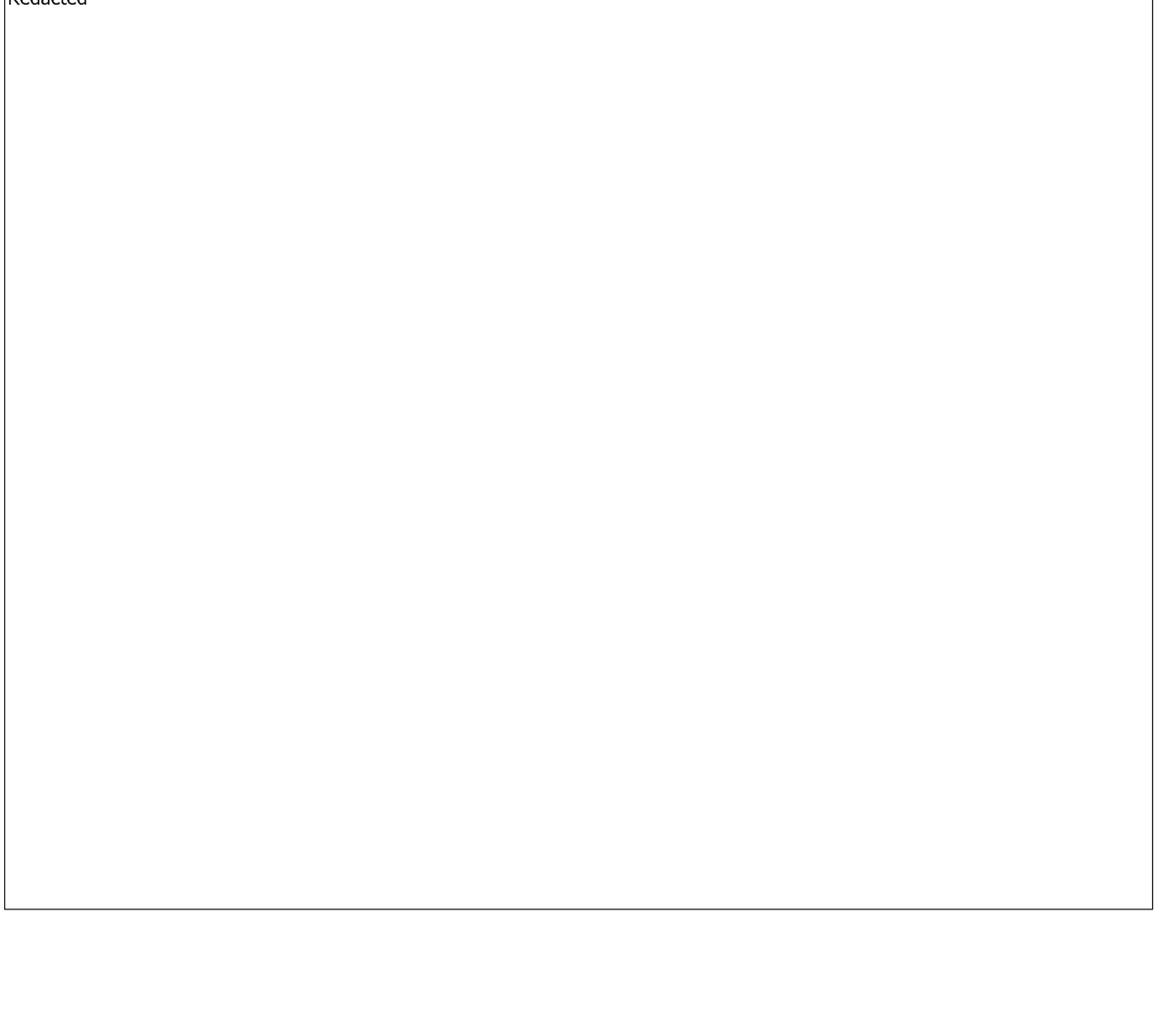
Gas Pipe Location:



Sewer Line Location:



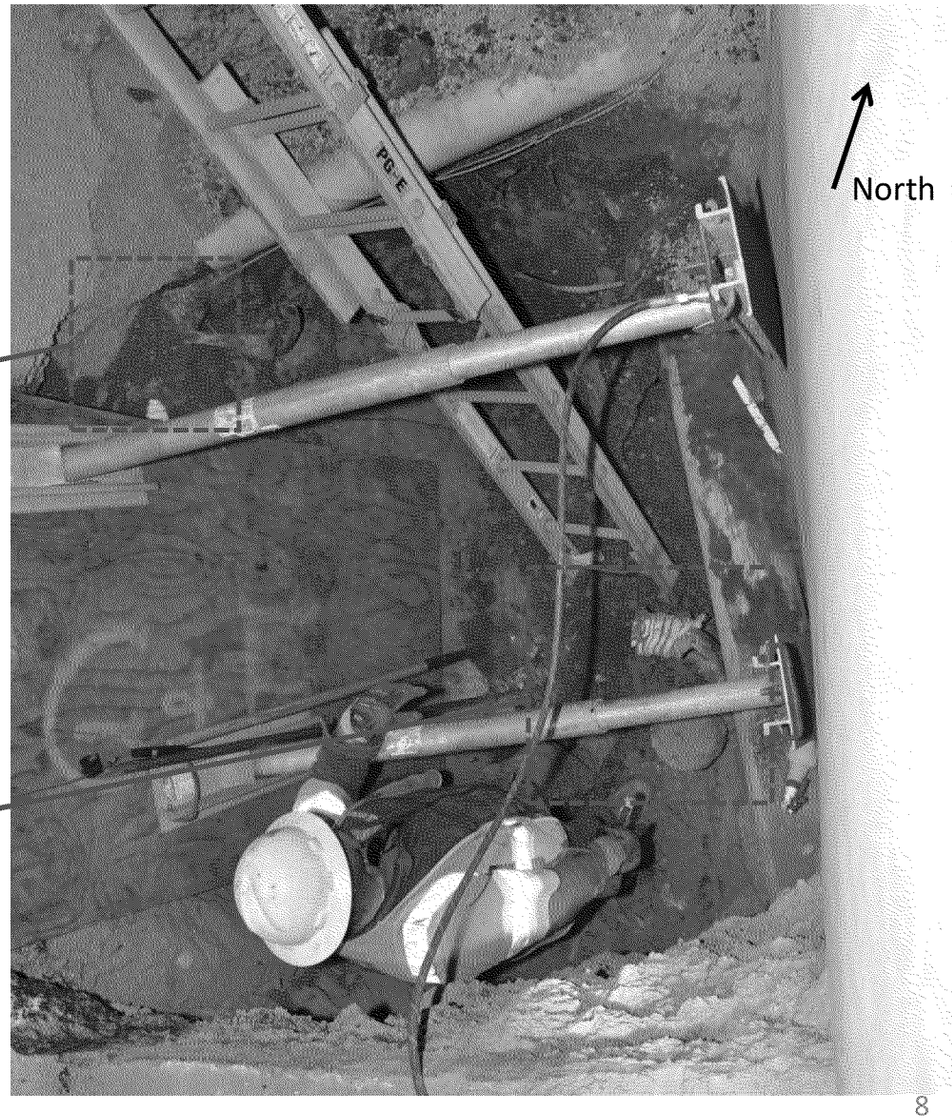
Water Line Location:



Site Inspection on 12/10/13

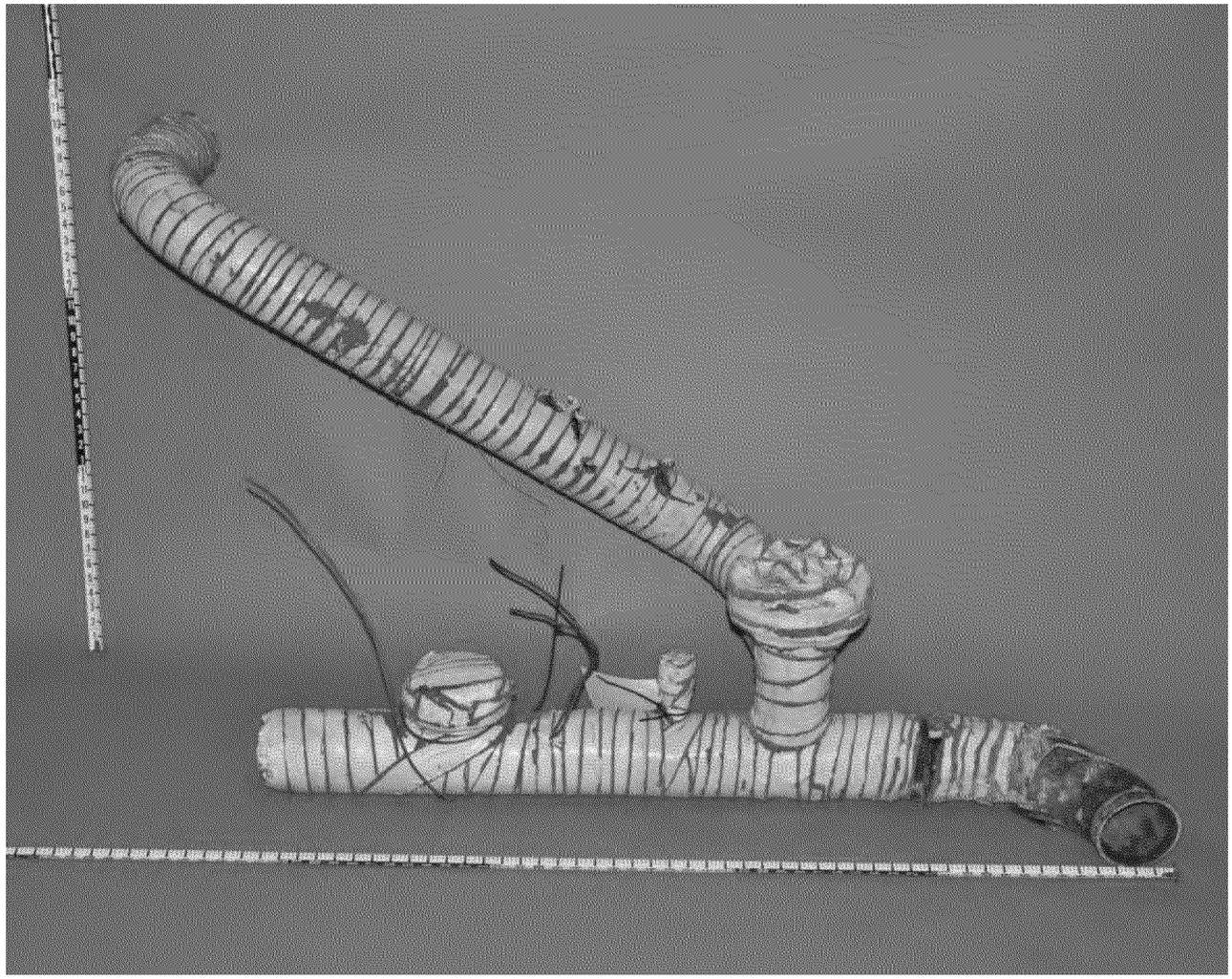
4” gas main and water line

3” and 4” gas mains and sewer line



Failed Elbow Before Removal

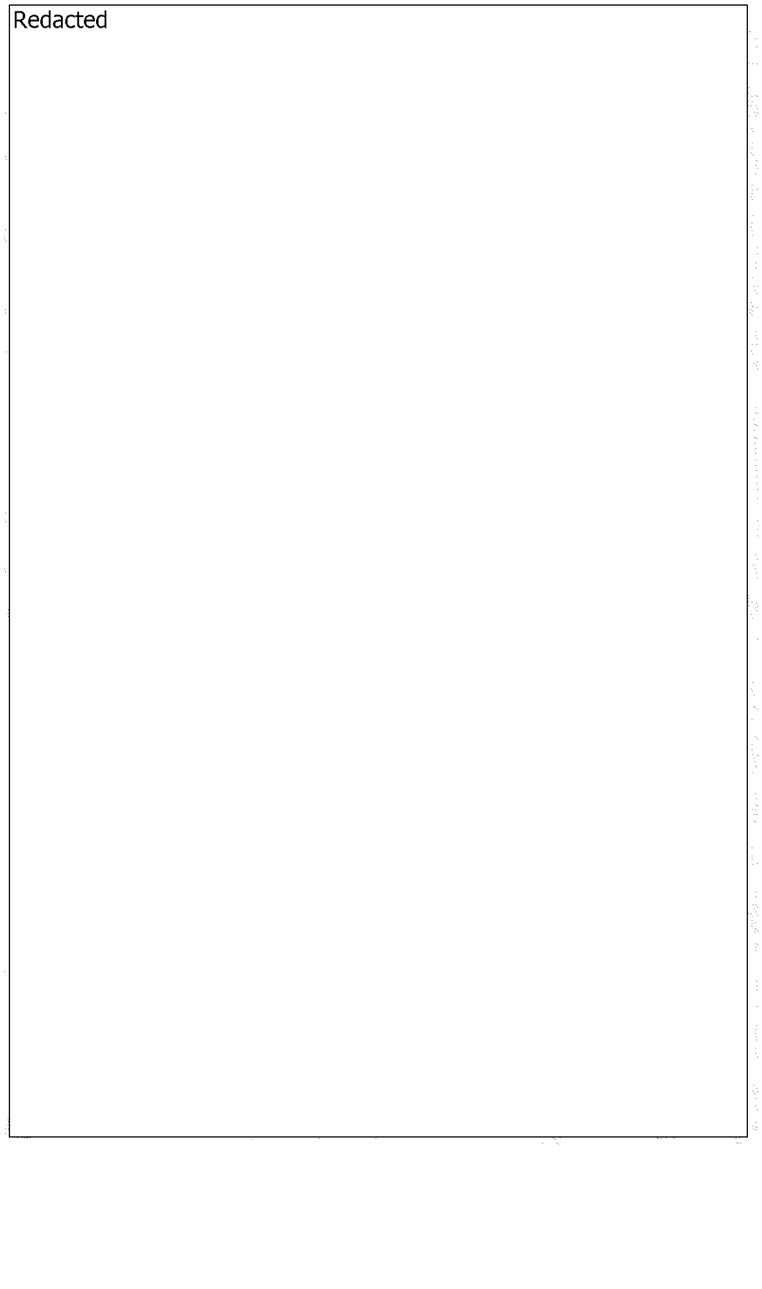
Evidence at Exponent



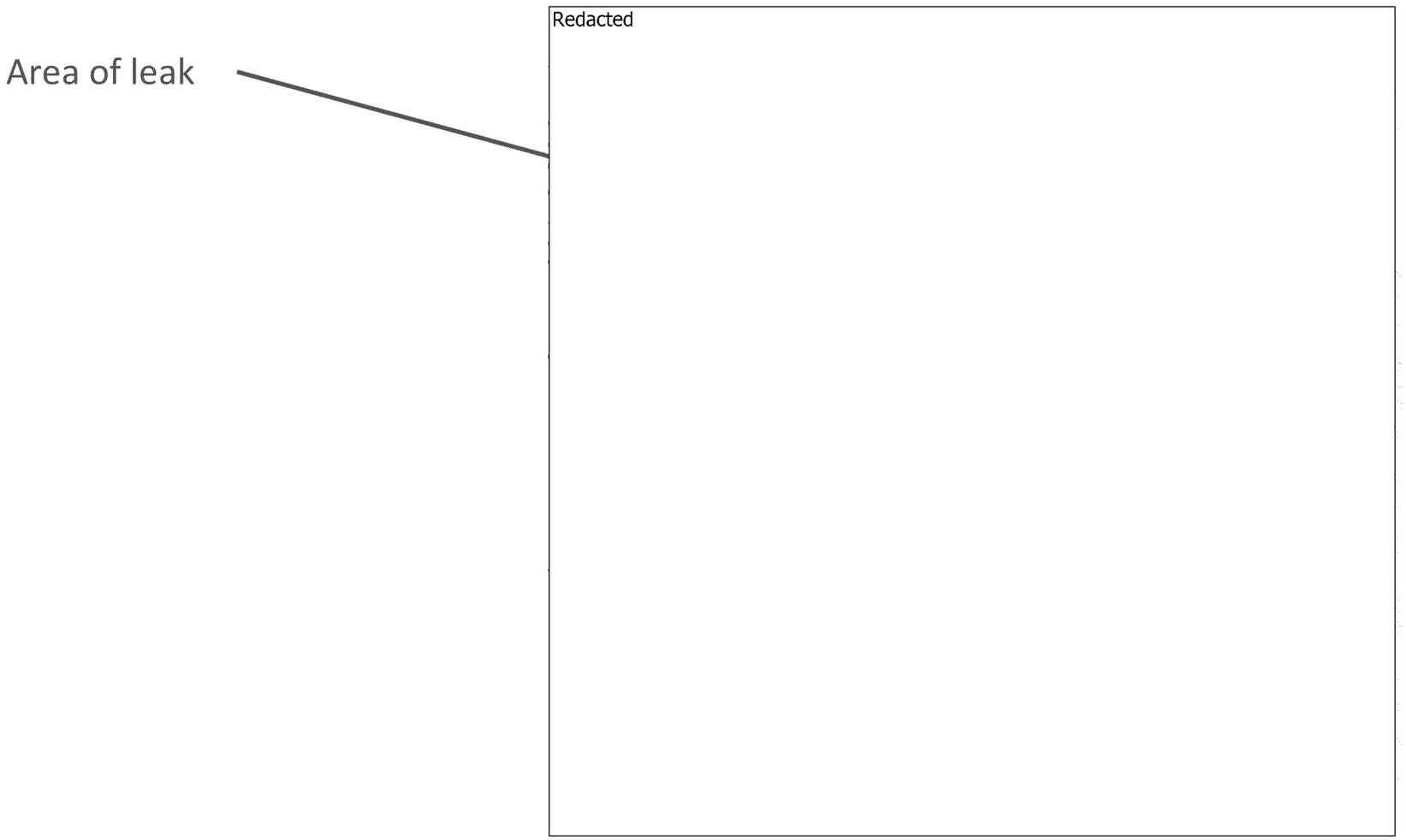
CONSTRUCTION DOCUMENTS AND MATERIAL SPECIFICATIONS

Distribution Plat

- D-Plat 10B-03 shows area of leak
- Indicates three jobs installed mains in the immediate area of the leak



Distribution Plat



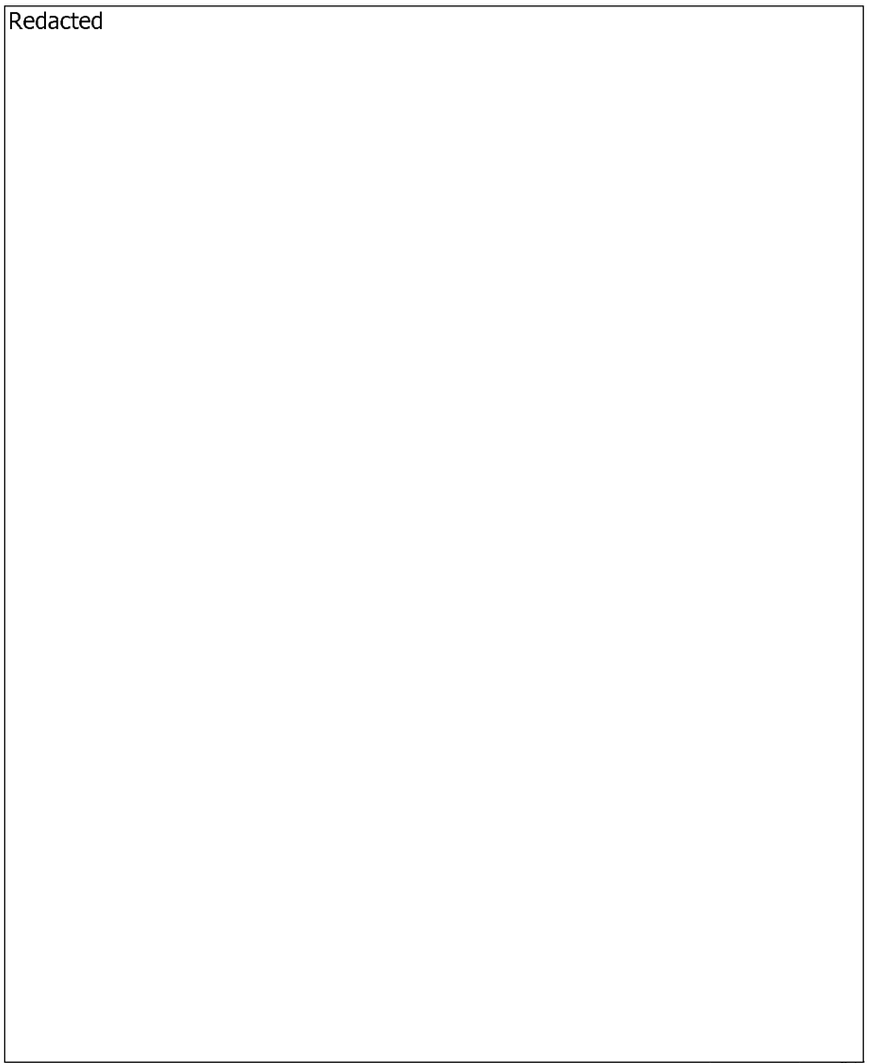
Relevant Construction Jobs

Construction drawings indicate:

- G.M.G. 82435 (1946)
  - Installed a 4” steel distribution main and two 4” weld elbows
  - The distribution main extends along Redacted
- W.O. 4747 (1965)
  - Installed a 3” steel distribution main along Redacted
  - Tapped into the 4” steel main at Redacted with a 3” flange tee
- G.M. 4564829 (1987)
  - Installed a 4” plastic distribution main along Redacted
  - The distribution main connects to the 4” steel main at Redacted with a 3” flange tee and ~4’ of steel pipe
  - Capped the existing 4” steel main and installed a line stopper fitting

G.M.G. 82435 (1946)

- The 1946 construction drawing shows the installation of 4” 90° elbows and a steel distribution line
- Detail A is consistent with the intersection of Redacted and Redacted
- The location of the 4” 90° elbows is consistent with “existing” features shown in later construction drawings



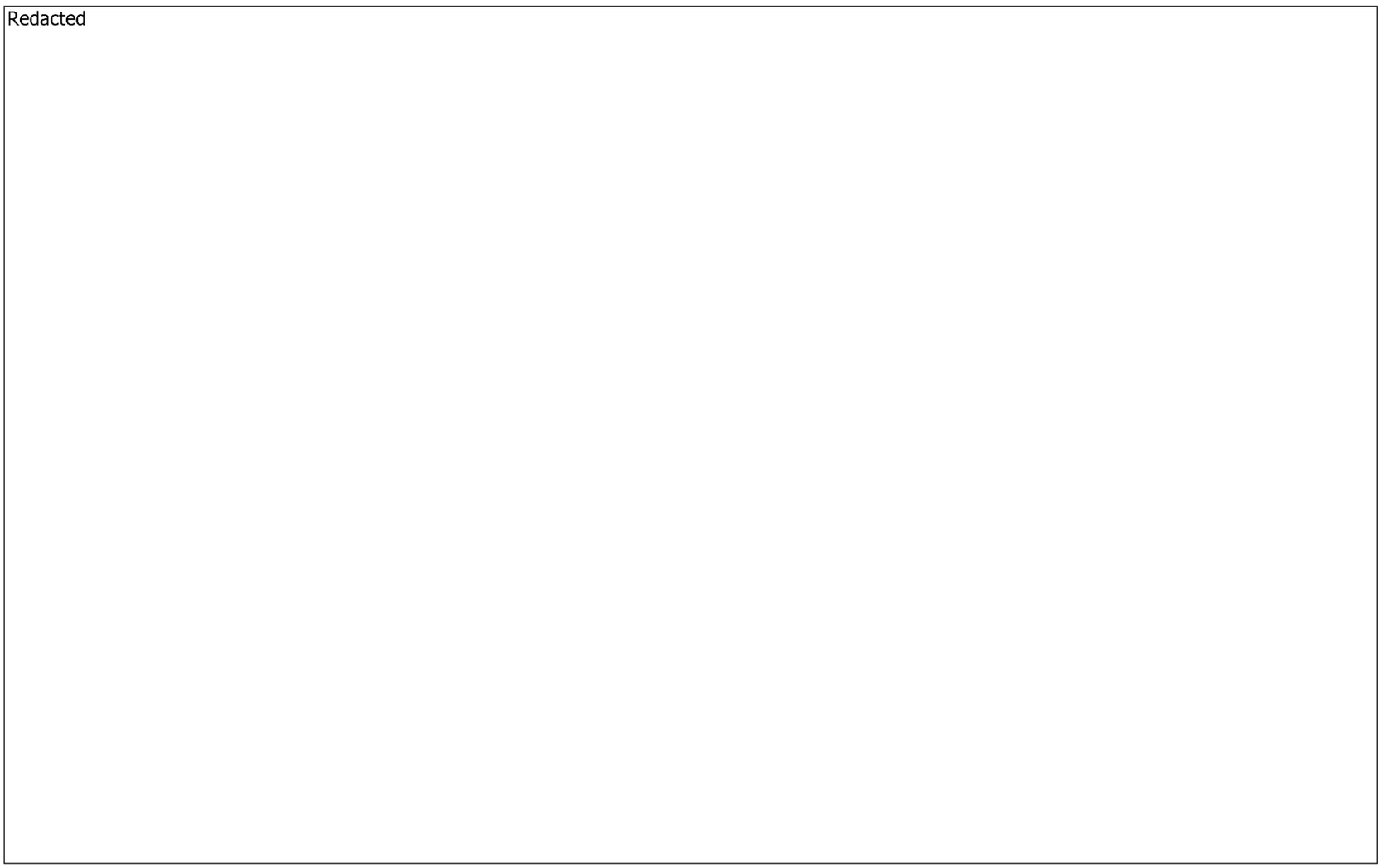
Construction drawing for G.M.G 82435 (1965)

G.M.G. 82435 (1946)

Installed 4” elbow and 4” main (1946)

Redacted

W.O. 4747 (1965)



Construction drawing for W.O. 4747 (1965)

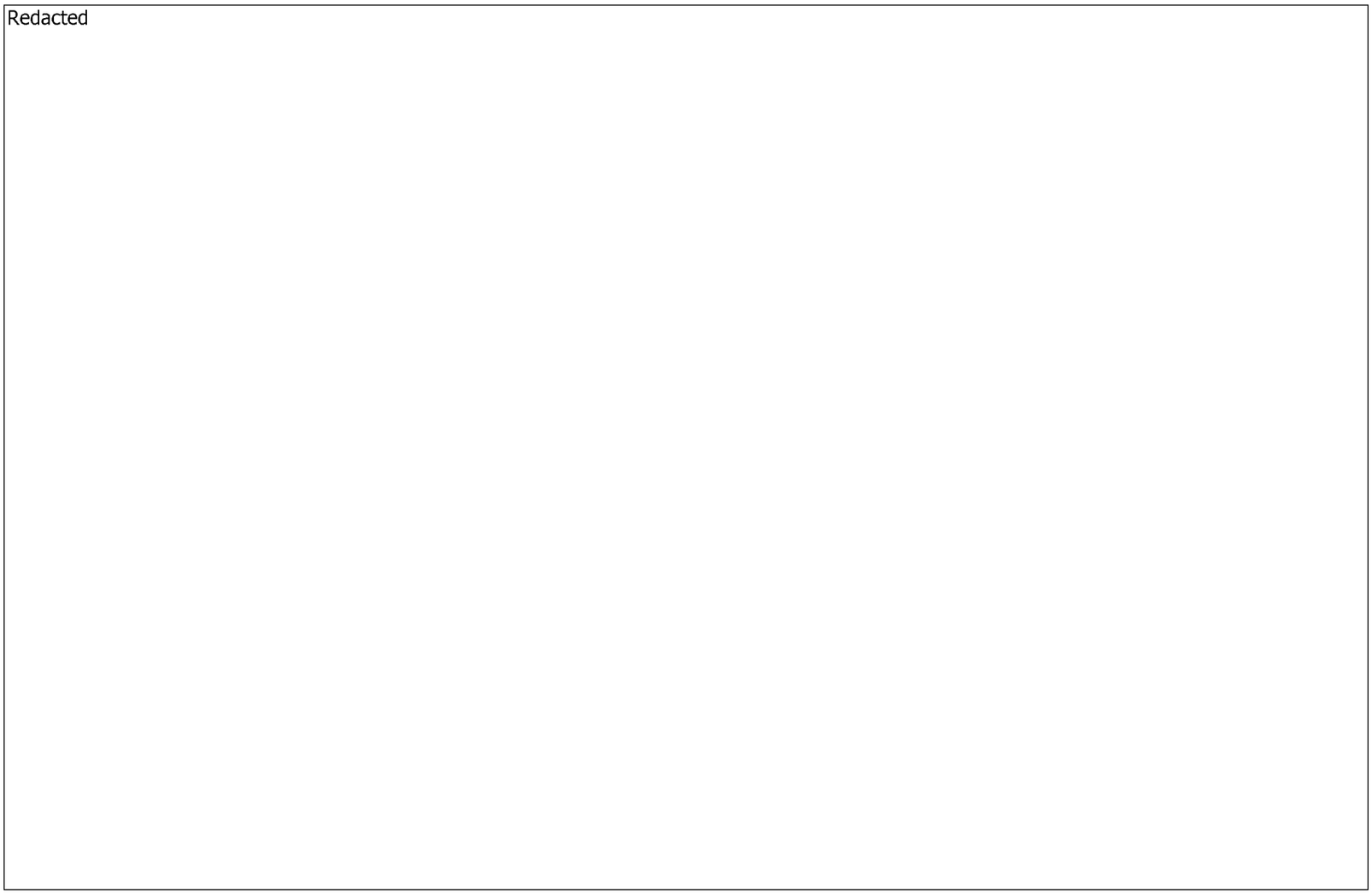
W.O. 4747 (1965)

Installed 3” flanged tee and 3” main (1965)

Redacted

Existing 4” main (1946)

G.M. 4564826 (1987)



As-built construction drawing for GM 4564829 (1987)

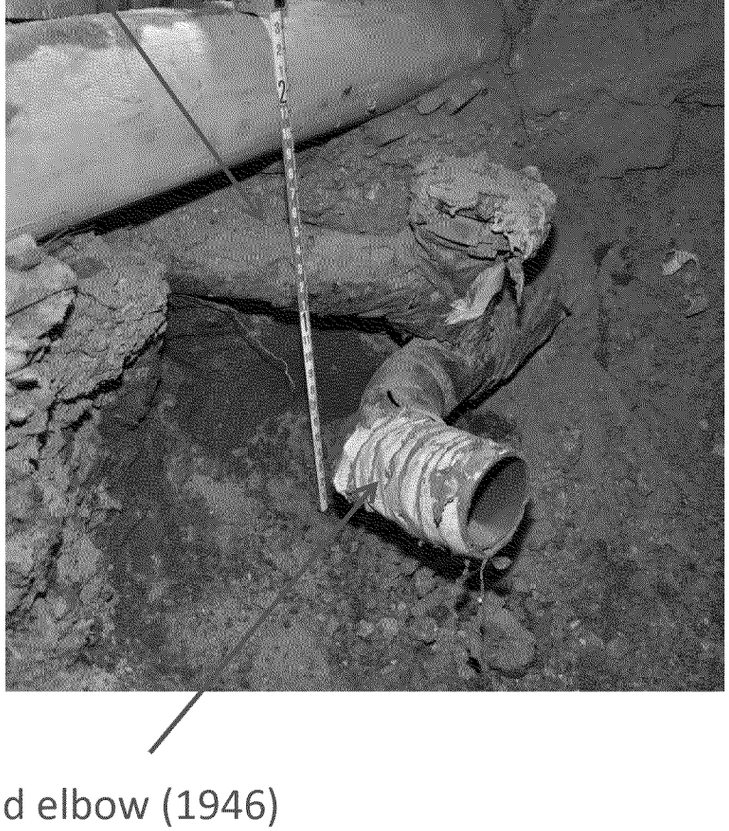
G.M. 4564826 (1987)

Existing 3” line and flanged tee (1965)

As-built construction drawing from GM 4564829 (1987)

Redacted

Inspection photo 12/11/13

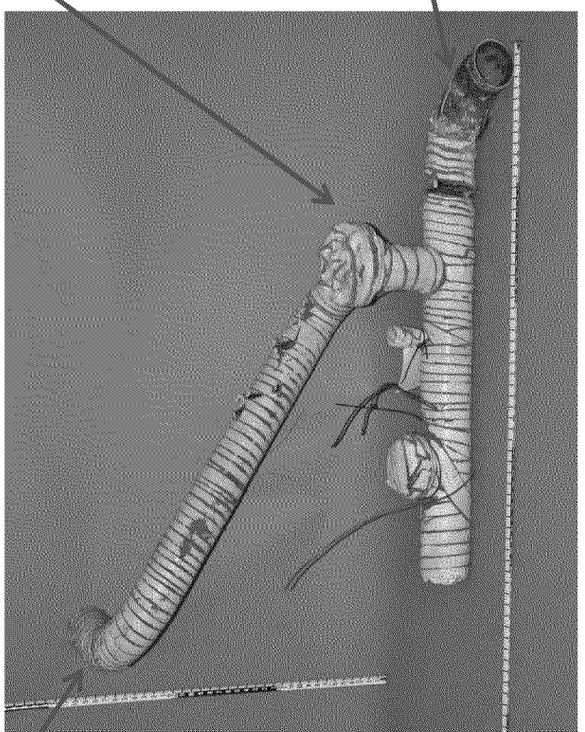


Existing 4” line and elbow (1946)

G.M. 4564826 (1987)

As-built construction drawing from GM 4564829 (1987)

Redacted



Installed flanged tee (1987)

Existing elbow (1946)

Existing 4” line deactivated in 1987

Installed 4” line and elbows (1987)

G.M. 4564826 (1987)

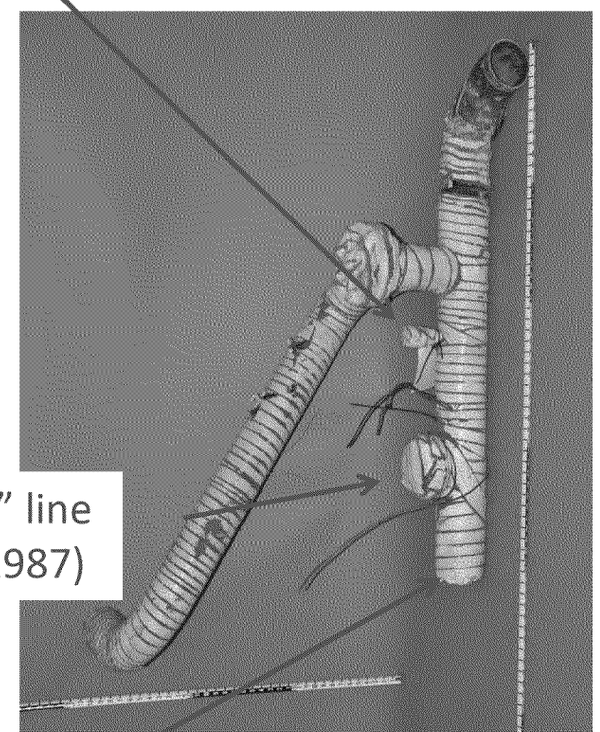
Installed sav-a-valve (1987)

As built construction drawing from GM 4564829 (1987)

Redacted

Redacted

Redacted



Installed 4” line stopper (1987)

Installed 4” cap (1987)

Construction Documents Conclusions

- The component that failed is a 4” diameter, 90 degree manufactured steel elbow that was installed in 1946.
- Immediately upstream the failed elbow, a 3” diameter tee was installed in 1965 that fed the Redacted main.
- Downstream of the failed elbow, the 4” line was cut and capped in 1987 and an upward transition was added to feed a plastic line that continued down Redacted
- The construction documents from 1946 and 1987 accurately reflect the as-installed conditions.

Material Specifications

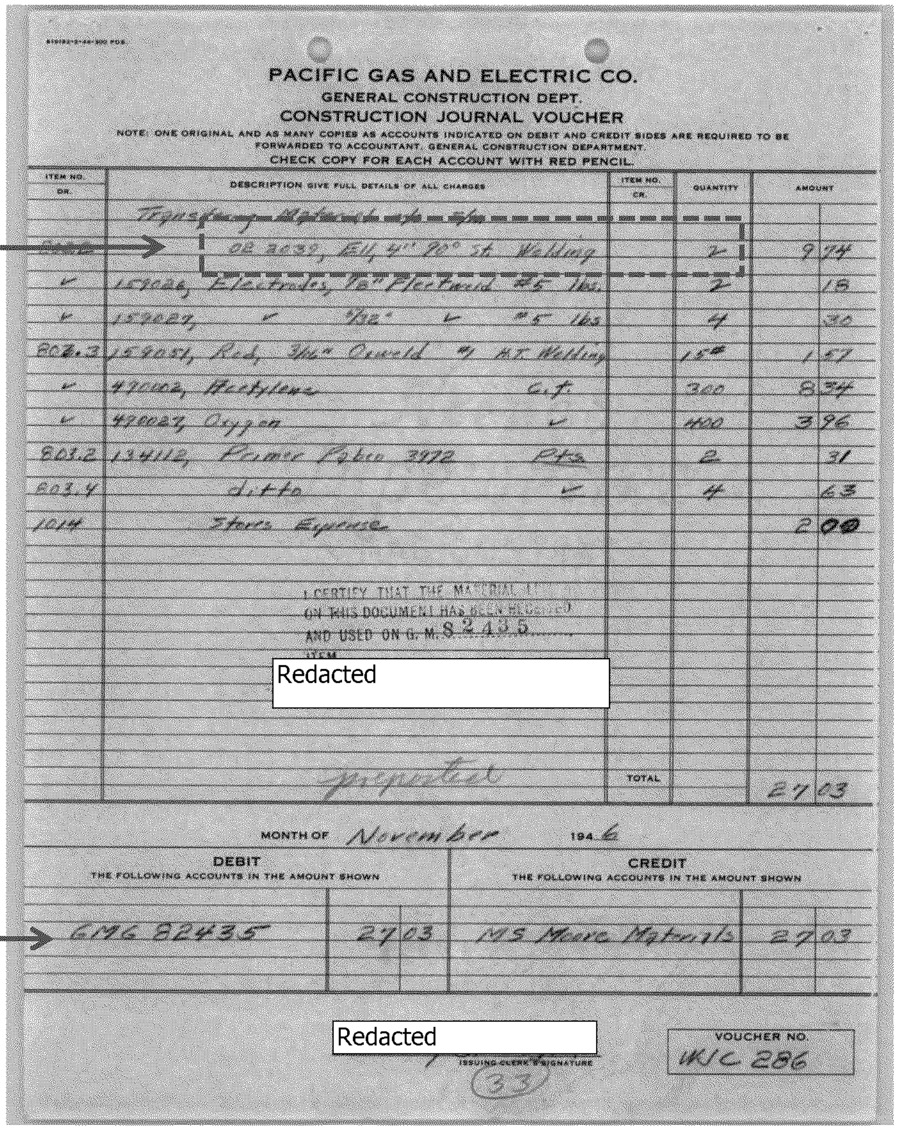
1946 elbow documentation:

Ordered two 4" 90 deg steel weld elbows with material code 02-2039

From PG&E dwg #281992 "Long Radius Welding Elbows" dated 10/8/52, material code 02-2039 corresponds to

- Std. weld elbow
- Wall thickness – 0.237"
- Unknown grade, likely Grade A or Grade B

Installed on GMG 82435



PACIFIC GAS AND ELECTRIC CO.
GENERAL CONSTRUCTION DEPT.
CONSTRUCTION JOURNAL VOUCHER

NOTE: ONE ORIGINAL AND AS MANY COPIES AS ACCOUNTS INDICATED ON DEBIT AND CREDIT SIDES ARE REQUIRED TO BE FORWARDED TO ACCOUNTANT, GENERAL CONSTRUCTION DEPARTMENT.
CHECK COPY FOR EACH ACCOUNT WITH RED PENCIL.

ITEM NO. DR.	DESCRIPTION GIVE FULL DETAILS OF ALL CHARGES	ITEM NO. CR.	QUANTITY	AMOUNT
	Transfer Material [illegible]			
[illegible]	02 2039, Ell 4" 90° St. Welding		2	9 74
✓	159026, Electrodes, 1/8" Fleetweld #5 lbs.		2	18
✓	159027, ✓ 5/32" ✓ #5 lbs		4	30
802.3	159051, Rod, 3/16" Oxweld #1 H.T. Welding		15#	1 57
✓	490002, Acetylene C.f.		300	8 34
✓	490027, Oxygen ✓		400	3 96
803.2	134112, Primer Pabco 3972 Pts		2	31
803.4	ditto ✓		4	63
1014	Stores Expense			2 00
	I CERTIFY THAT THE MATERIAL [illegible] ON THIS DOCUMENT HAS BEEN RECEIVED AND USED ON G. M. 82435 ITEM			
	Redacted			
	prepostal	TOTAL		27 03

MONTH OF November 1946

DEBIT THE FOLLOWING ACCOUNTS IN THE AMOUNT SHOWN		CREDIT THE FOLLOWING ACCOUNTS IN THE AMOUNT SHOWN	
GMG 82435	27 03	MS Meave Materials	27 03

Redacted
ISSUING CLERK'S SIGNATURE
33

VOUCHER NO. W/C 286

MAOP25369015.jpg

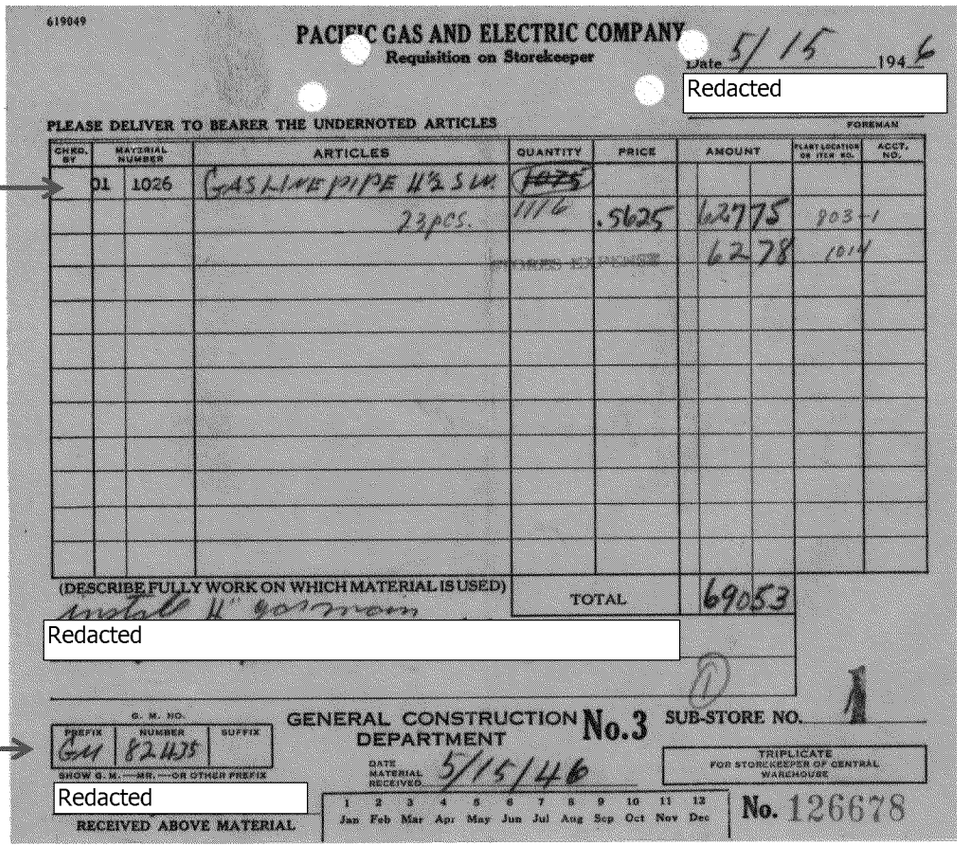
Material Specifications

1946 pipe documentation:

Ordered 1116’ of 4” gas line pipe with material code 01-1026

No information has been located on material code 01-1026

Installed on GMG 82435



619049

PACIFIC GAS AND ELECTRIC COMPANY
Requisition on Storekeeper

Date 5/15/46

Redacted

PLEASE DELIVER TO BEARER THE UNDERNOTED ARTICLES

FOREMAN

CHKD. BY	MATERIAL NUMBER	ARTICLES	QUANTITY	PRICE	AMOUNT	PLANT LOCATION OR ITEM NO.	ACCT. NO.
	01 1026	GAS LINE PIPE 4" S.M.	~~1075~~				
		23 pcs.	1116	.5625	627.75	803-1	
					62.78	1014	
				TOTAL	690.53		

(DESCRIBE FULLY WORK ON WHICH MATERIAL IS USED)
Install 4" gas main

Redacted

G. M. NO. PREFIX GM NUMBER 82435 SUFFIX
SHOW G. M.—MR.—OR OTHER PREFIX

GENERAL CONSTRUCTION DEPARTMENT No. 3

SUB-STORE NO. 1

DATE MATERIAL RECEIVED 5/15/46

TRIPLICATE FOR STOREKEEPER OF CENTRAL WAREHOUSE

Redacted

RECEIVED ABOVE MATERIAL

1 2 3 4 5 6 7 8 9 10 11 12
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

No. 126678

MAOP25369015.jpg

Material Specification Conclusions

A construction journal voucher from GM 82435 (1946) indicates that the failed elbow:

- Is a standard weld elbow with a wall thickness of 0.237” and a material code of 02-2039
- Elbow material grade is specified to be Grade A unless: “if greater working pressure is wanted specify Grade B” (Grade A = 30ksi yield, 48ksi UTS; Grade B = 35ksi yield, 60ksi UTS; Grade C = 40ksi yield, 70ksi UTS*)

A material requisition from GM 82435 (1946) indicates that the pipe in the vicinity of the failed elbow is:

- 4” gas line pipe with a material code of 01-1026 (material specifications for the pipe have not been located)
- Although not the primary subject of this analysis, the material properties of the 4” gas line will be identified via chemical analysis and material properties testing

*ASTM A 106, 1967 version

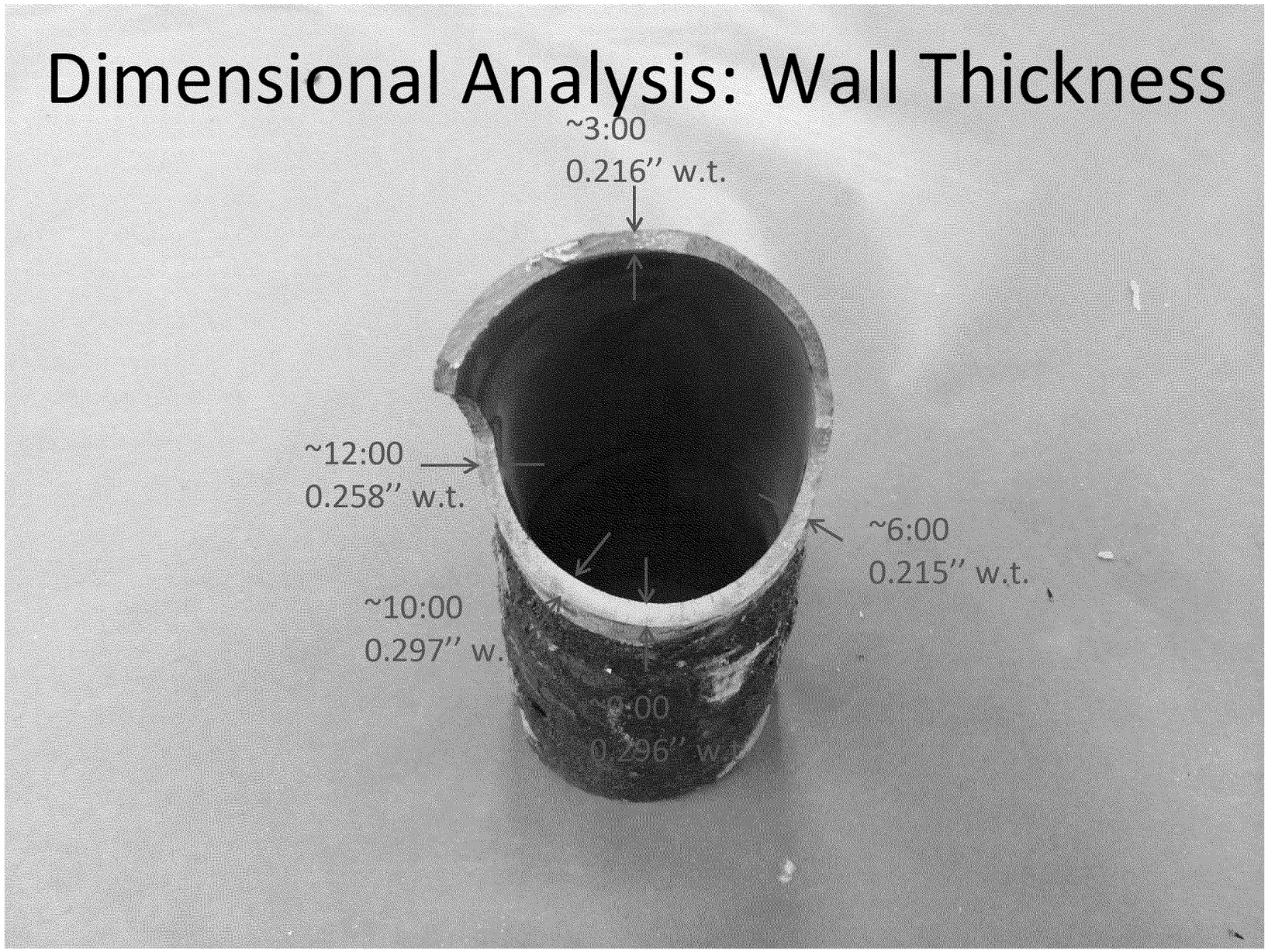
METALLURGICAL ANALYSIS

Metallurgical Analysis

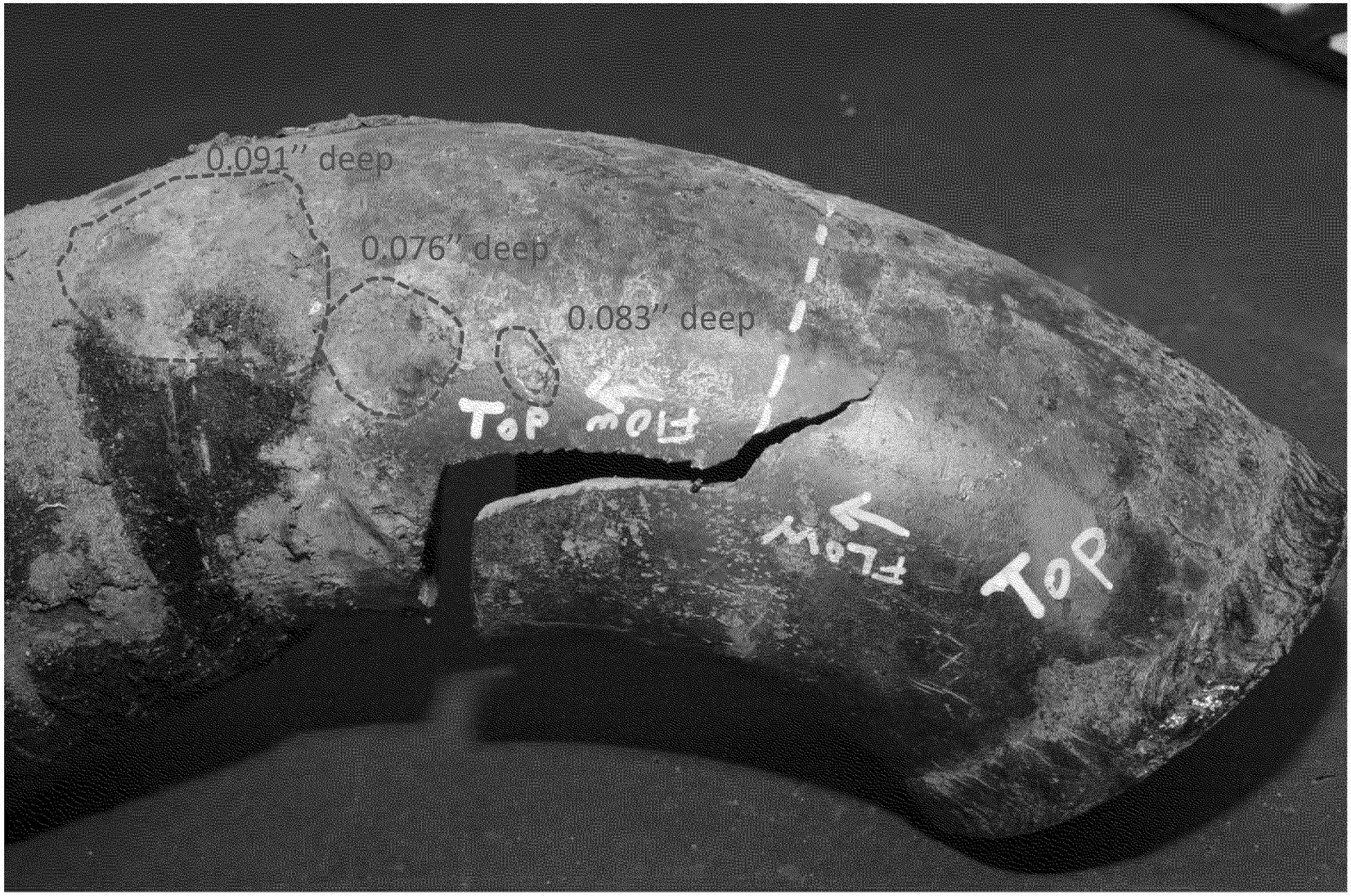
- Visual Inspection
- Optical Microscopy
- Scanning Electron Microscopy
- Energy Dispersive Spectroscopy
- Metallographic Analysis
- Hardness Testing

Visual Inspection

Dimensional Analysis: Wall Thickness

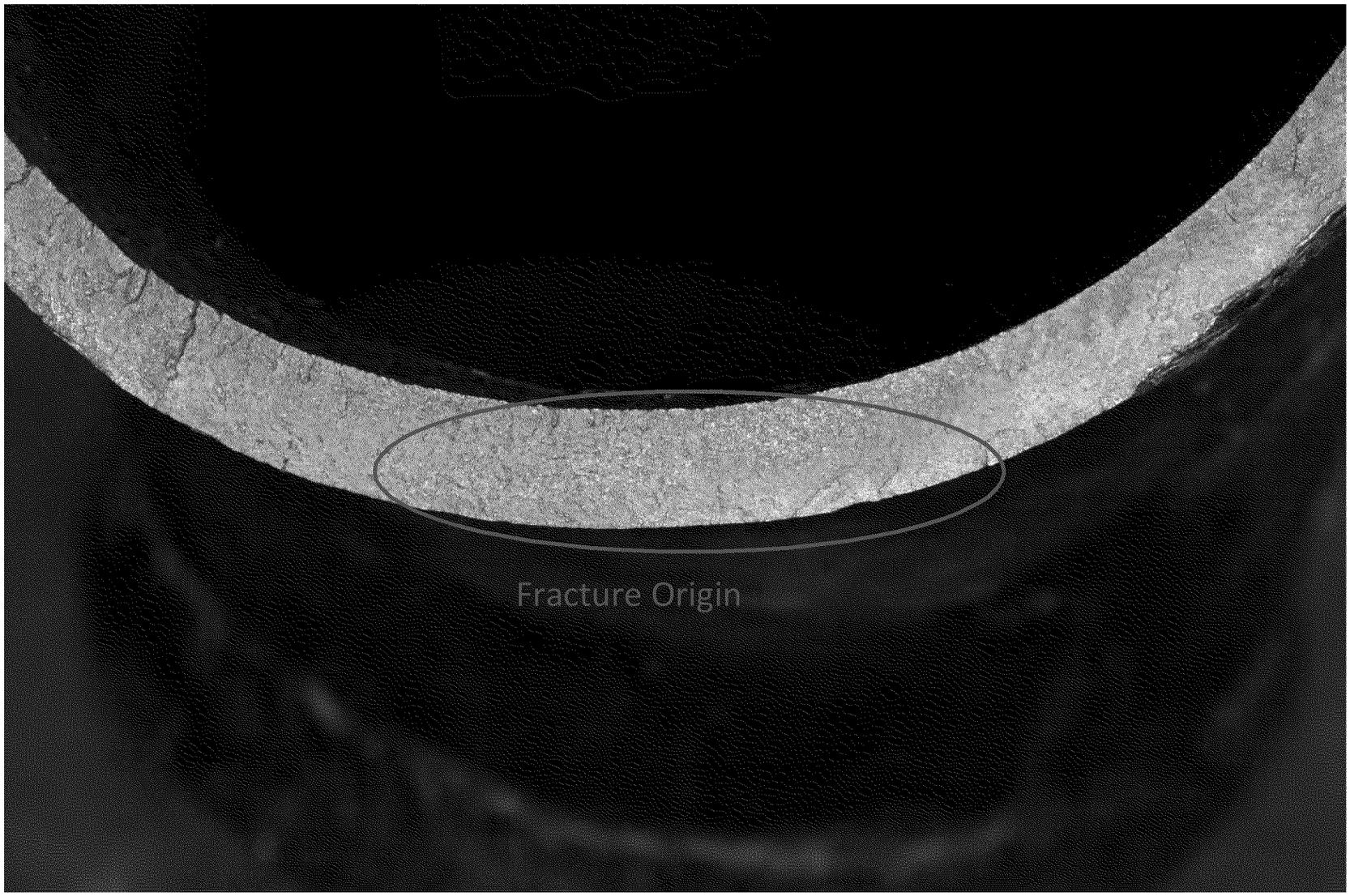


Dimensional Analysis: Corrosion

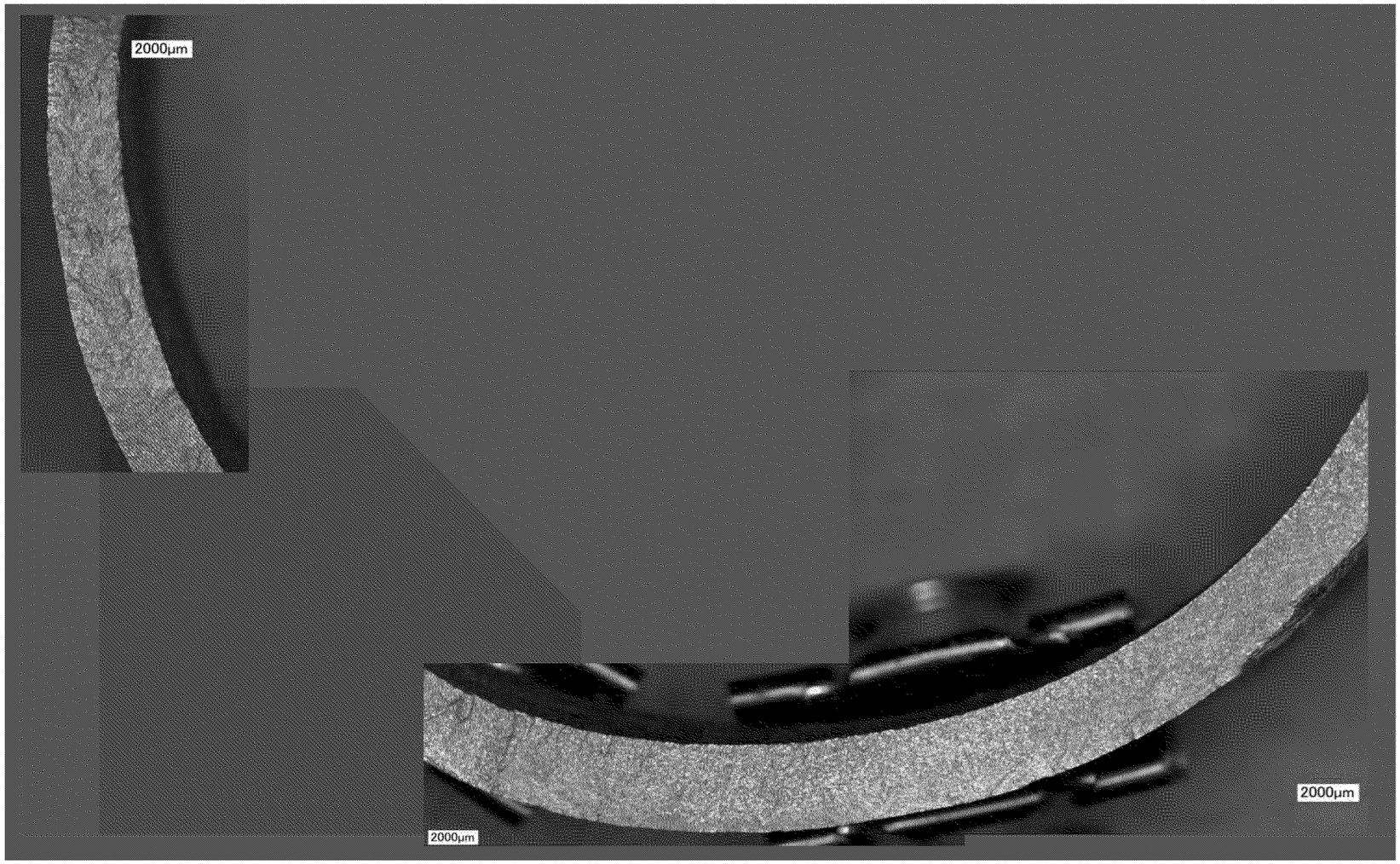


Dimensional Analysis

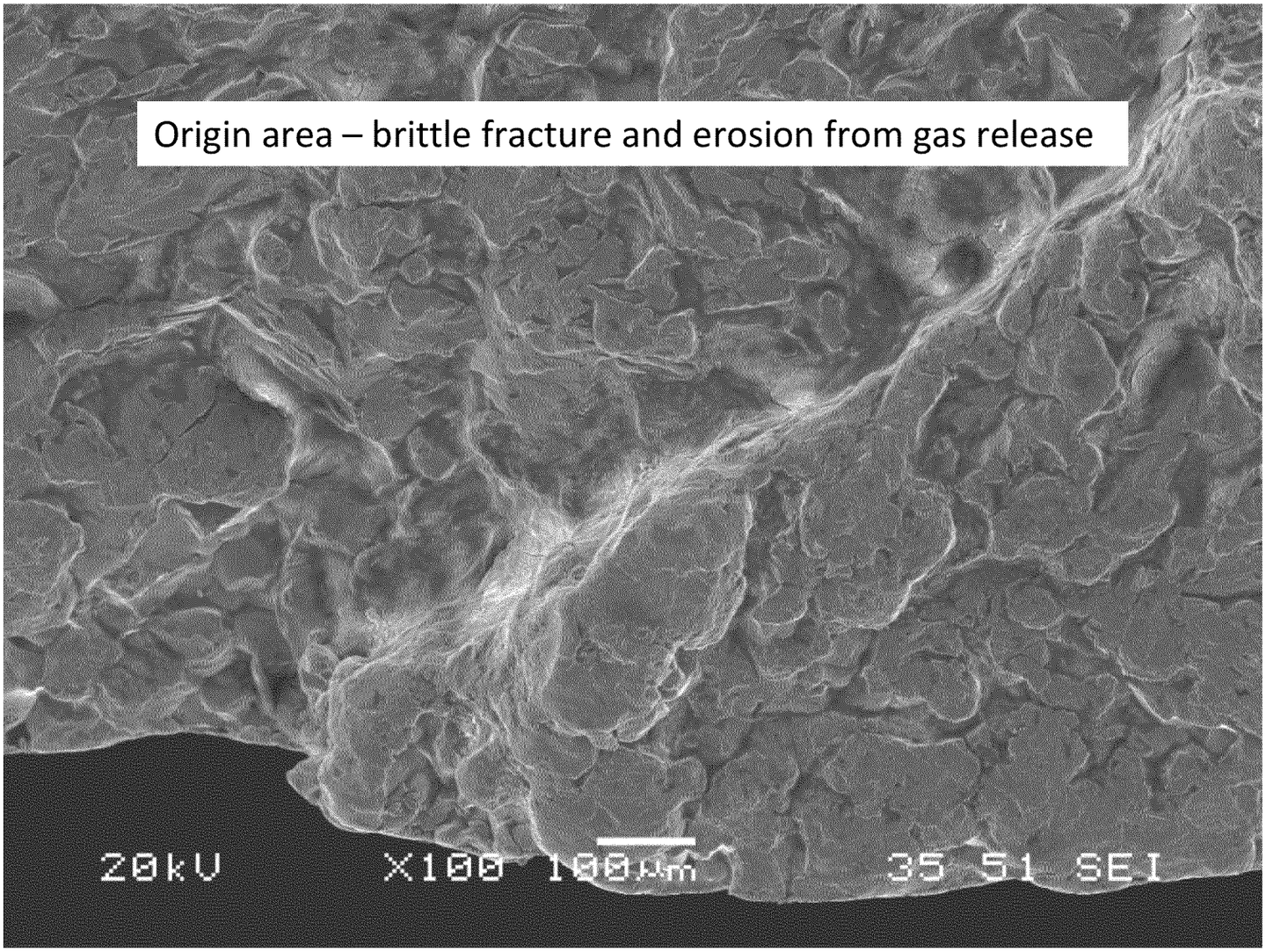
Visual Inspection



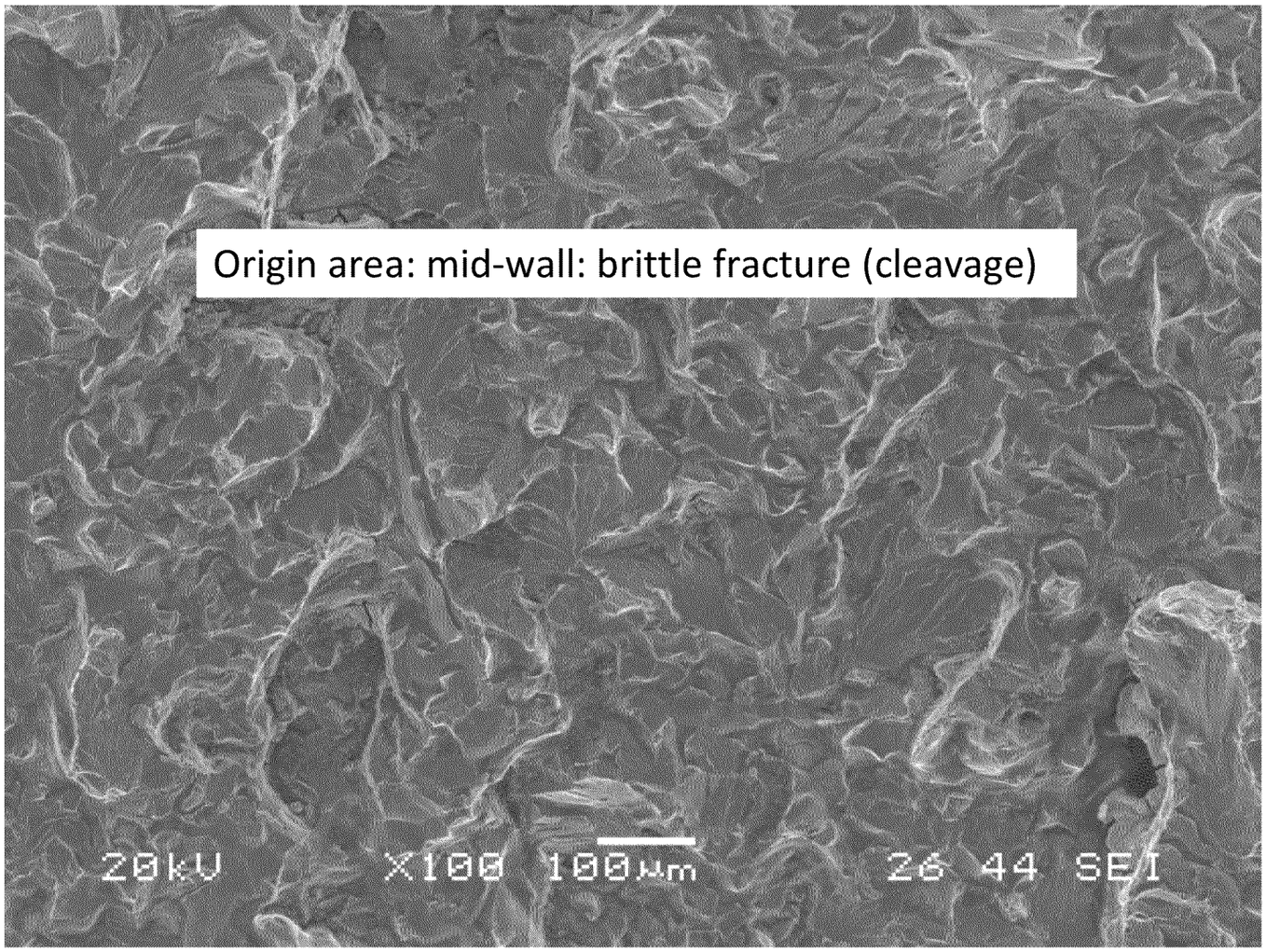
Optical Microscopy



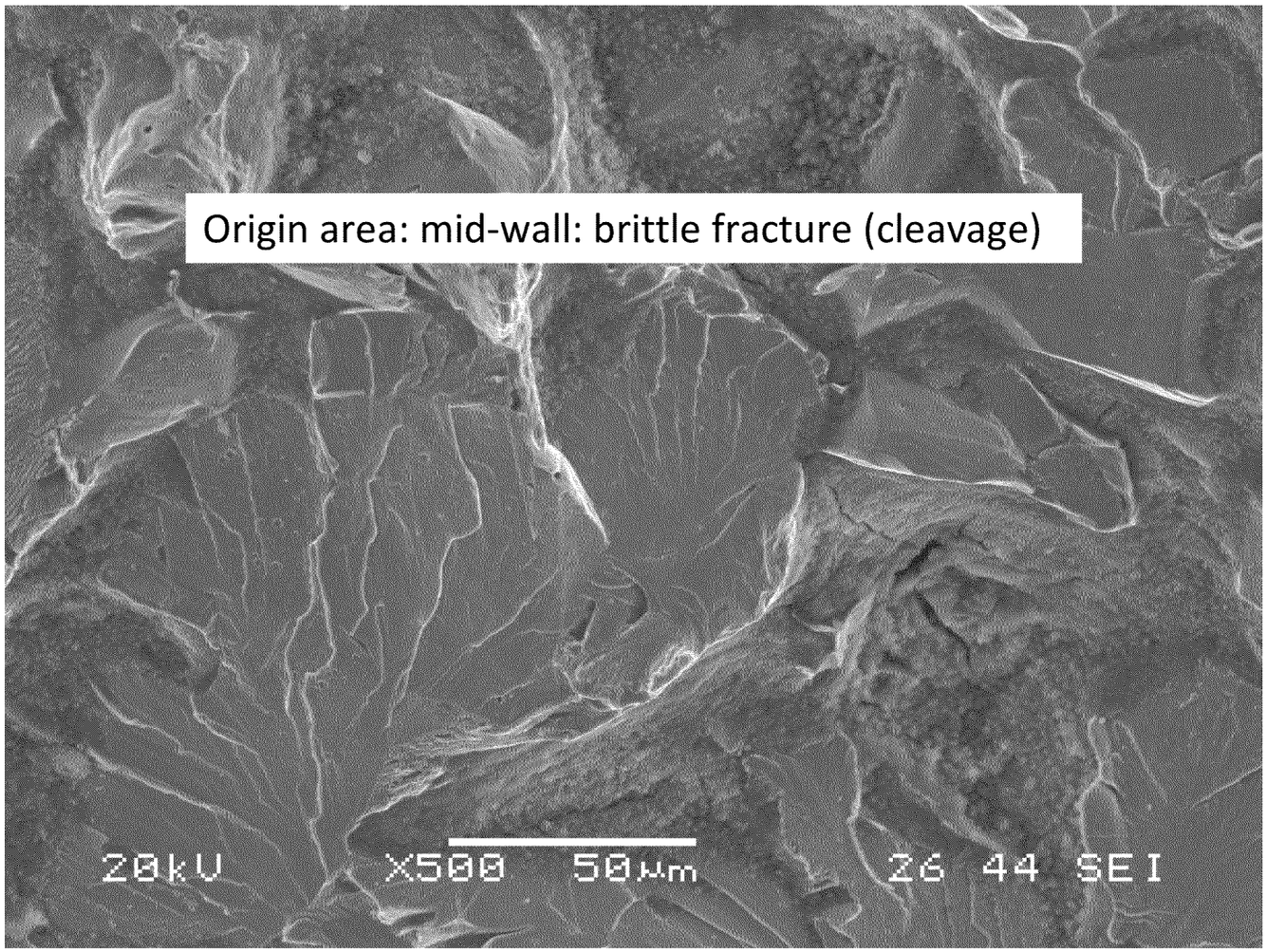
Scanning Electron Microscopy



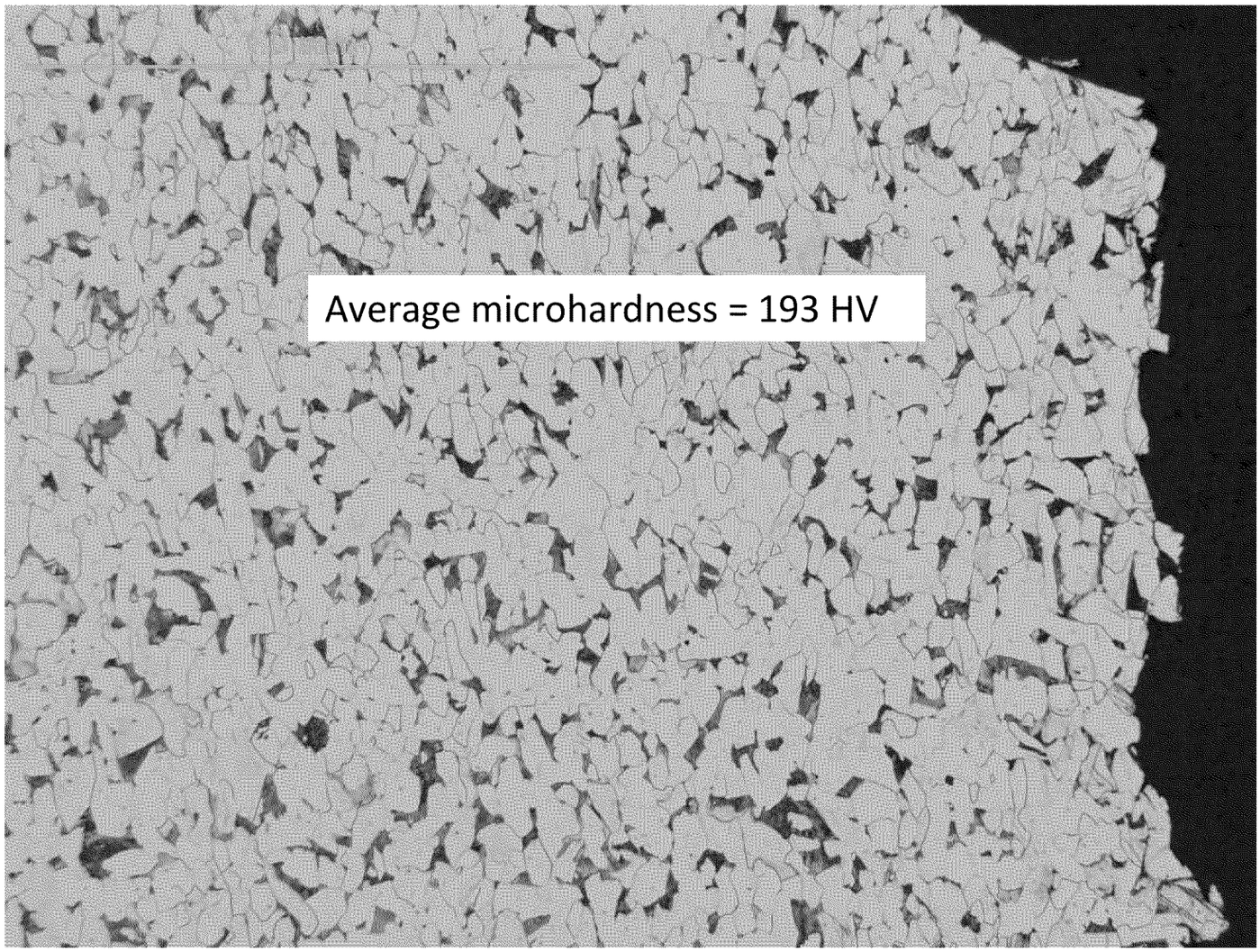
Scanning Electron Microscopy



Scanning Electron Microscopy



Metallography



Metallurgical Conclusions

- External forces acting on the pipeline resulted in stresses that exceeded the subject elbow's tensile strength, resulting in its fracture
- The source of these external forces is currently being investigated
- Brittle (cleavage) fracture morphology was observed
- No evidence of progressive fracture (such as fatigue or stress corrosion cracking) was observed
- The fracture was not associated with a mechanical, corrosion-induced, or metallurgical defect
- The elbow exhibited the expected "ferrite-pearlite" microstructure
- The elbow hardness was measured to be 193 HV, roughly equivalent to a UTS of 92 ksi

Limitations

At the request of PG&E, Exponent performed an analysis of the Redacted natural gas release that occurred on Tuesday December 10, 2013 in Oakland, California. Exponent's analysis is based on data and information provided by PG&E, the accuracy and validity of which has not been independently verified by Exponent. The scope of services performed during this investigation may not adequately address the needs of other users of this presentation, and any re-use of this presentation or its findings, conclusions, or recommendations is at the sole risk of the user. Opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation. No guarantee or warranty as to future life or performance of any reviewed component or condition is expressed or implied.

The findings presented herein are made to a reasonable degree of engineering certainty. We have made every effort to accurately and completely investigate areas of concern identified during our investigation. If new data becomes available or there are perceived omissions or misstatements in this report, we ask that they be brought to our attention as soon as possible so that we may have the opportunity to fully address them.

Redacted

Redacted

Gas Event - Special Leak Survey

PG&E

N

1 inch = 800 feet

SB_GT&S_0269307