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March 29, 2013

VIA ELECTRONIC FILING AND FIRST CLASS MAIL

PUC Filing Center
Public Utility Commission of Oregon
PO Box 2148
Salem, OR 97308-2148

Re: Docket UM 1635 – Northwest Natural Gas Company's Mechanism for Recovery of Environmental Remediation Costs

Attention Filing Center:

Enclosed for filing in the above-captioned docket are an original and five copies of NW Natural's Direct Testimony.

A copy of this filing has been served on all parties to this proceeding as indicated on the enclosed Certificate of Service.

Please contact this office with any questions.

Very truly yours,

Wendy McIndoo

Wendy McIndoo
Office Manager

Enclosure

cc: Service List

CERTIFICATE OF SERVICE

I hereby certify that I served a true and correct copy of the foregoing document in Docket UM 1635 on the following named person(s) on the date indicated below by email addressed to said person(s) at his or her last-known address(es) indicated below.

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BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1635

In the Matter of

NORTHWEST NATURAL GAS COMPANY, dba NW Natural,

Mechanism for Recovery of Environmental Remediation Costs.

NORTHWEST NATURAL GAS COMPANY

DIRECT TESTIMONY OF

C. ALEX MILLER

March 29, 2013

EXHIBIT 100 – DIRECT TESTIMONY– POLICY

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I. INTRODUCTION AND SUMMARY

Q. Please state your name and position with Northwest Natural Gas Company ("NW Natural" or the "Company").

A. My name is C. Alex Miller. My current position is Treasurer and Vice President of Regulation for NW Natural. I am responsible for Rates & Regulatory Affairs, as well as Treasury operations.

Q. Please summarize your educational background and business experience.

A. I received a B.A. in economics from the University of Oregon in 1980. I received an M.B.A. from Claremont Graduate School in 1984. From 1981 through 1997, I worked at Southern California Edison in various rate and finance positions, including Vice President and Treasurer. From 1997 to 2001, I worked at PacifiCorp in various positions, including Vice President of Business Development. I joined NW Natural in 2003. Since 2005, I have been a member of the environmental steering committee at NW Natural, a group of executives and managers that monitors and helps in decision-making regarding NW Natural's ongoing environmental remediation activities and cost recovery efforts.

Q. What is the purpose of your testimony?

A. I provide NW Natural's policy testimony in support of its request for a Commission order allowing the Company to fully amortize its prudently-incurred environmental remediation expenses, past and future, after application of a reasonable earnings test with a deadband. Specifically, my testimony:

- Provides the background on NW Natural's Commission-approved deferrals for environmental remediation costs;
- Describes the Company's evidence establishing the prudence of its environmental costs deferred from 2003 through 2011;

- Outlines NW Natural's proposal for an earnings test that would allow the Company to fully recover its prudent environmental remediation costs as long as the Company's earnings do not exceed a reasonable range;
- Explains how the Company's proposed earnings test would be applied to the historical period over which costs were previously deferred;
- Explains how the proposed earnings test would operate with the Site Remediation Recovery Mechanism (SRRM) on a going-forward basis;
- Outlines the unintended, negative consequences that would follow if the Commission were to adopt an earnings test that cut off amortization of environmental expenditures at earnings levels at or below the Company's authorized return on equity (ROE);
- Discusses an alternative recommendation that the Commission postpone application of the earnings test to the historical deferred balances until the Company's near-term insurance recoveries become known, because these could fully or partially offset the deferred balances;
- Supports the Company's proposal that prudently incurred costs associated with the Gasco Pumping Station be added to rate base when the project is used and useful, rather than run through the SRRM as an expense; and
- Supports the Oregon/Washington allocation of deferred costs and the parties' rate spread stipulation for the costs amortized through the SRRM.

Q. Based upon the Commission's final order in Docket UG 221, the Company's most recent general rate case, what issues are included in the scope of this docket?

A. In its final order in Docket UG 221, the Commission explicitly reserved the following three issues for decision in a future proceeding: (1) the prudence of NW Natural's environmental remediation costs deferred to date;[1] (2) the earnings test and appropriate deadband to be applied to recovery of environmental remediation costs; and (3) the appropriate rate treatment for the costs of the Gasco Pumping Station.[2] In addition, consistent with the Administrative Law Judge's Memorandum dated December 24, 2012, this docket will also determine the appropriate rate spread to apply to the amortized costs under the SRRM. Finally, in order to set rates including the environmental remediation costs, the Commission will need to confirm the appropriate Oregon/Washington jurisdictional allocation to apply, which was proposed in Docket UG 221.

Q. Please summarize the Company's testimony on these issues.

A. **Prudence:** NW Natural acted prudently in incurring its deferred environmental remediation expenses. In my testimony, I discuss the prudence standard that the Company must satisfy to recover its environmental remediation expenses. The testimony of Andrew Middleton demonstrates that the Company's historical operation of the manufactured gas plants (MGP) was reasonable and prudent in accordance with the standards of the industry prevailing at that time. The testimonies of Robert Wyatt and Sandra Hart demonstrate that the costs associated with the Company's environmental remediation efforts, as well as its insurance and other third-party recovery efforts, have also been prudently conducted.

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[1] In its Order in UG 221, the Commission stated the parties would determine the prudence of the costs for which recovery had been requested in that case. *Re NW Natural Gas Co. Request for a General Rate Revision*, Docket UG 221, Order No. 12-437 at 31 (Nov. 16, 2012) [hereinafter "Order No. 12-437"]. However, given that costs and earnings for 2011 are already known, NW Natural requests a prudence determination in this case of all environmental remediation costs incurred as of December 31, 2011.

[2] Order No. 12-437 at 31-32.

Earnings Test: NW Natural proposes that the Commission adopt an earnings test that would allow the Company to recover deferred environmental remediation expenses, so long as the Company is earning within a reasonable range, which has been defined by the Commission in other relevant contexts as not exceeding 100 basis points above its ROE established in its most recent rate case. For past deferred amounts, the Commission should conduct the earnings test looking at the average earnings of the Company for the historical period over which the costs were deferred. For future deferrals, the earnings test may be conducted on an annual basis, as the SRRM each year amortizes one-fifth of the balance of the Company's deferred environmental costs. Strong policy considerations support NW Natural's proposal, which would allow the Company to collect deferred amounts only to the extent that its earnings remain within the range that has been historically deemed reasonable by the Commission.

The Commission should, on the other hand, reject an earnings test that would cut off amortization at or below the Company's authorized ROE. Such a test would be inconsistent with sound regulatory policy and legal principles, forcing significant write-offs of prudent expenses, and inappropriately depressing the Company's earnings. If the cut-off point were set ***at*** the Company's authorized ROE, the mechanism would as a practical matter make it impossible for the Company ever to earn above its authorized ROE. If the cut-off point were set ***below*** the Company's authorized ROE, the Company would have no opportunity to earn its authorized ROE.

Alternatively, the Company recommends that the Commission wait to resolve the earnings test issues as applied to the historical deferred balances until the Company's near-term insurance recovery efforts are resolved and the insurance offset is known.

Gasco Pumping Station: The Commission should approve NW Natural's recommendation that, after the Gasco Pumping Station is complete and its costs known, and after the Commission has conducted a prudence review of these costs through the SRRM process, they should be added to rate base, rather than being amortized through the SRRM. This question was specifically reserved for future decision in the Commission's order in Docket UG 221, and the Company's proposed treatment will lessen the near-term impact on customers and better match amortization of these costs with the expected life of the facility.

Rate Spread: The parties have reached an agreement in principle on the appropriate rate spread for environmental remediation costs. NW Natural will provide testimony supporting the stipulation after it is finalized and filed with the Commission.

Jurisdictional Allocation: Based on historical load and use patterns, NW Natural has determined that Washington customers should bear 3.32 percent of environmental remediation costs while 96.68 percent should be borne by Oregon customers. The Company asks for confirmation of this determination, which was presented and uncontested in Docket UG 221, before it begins to amortize amounts through the SRRM.

II. BACKGROUND ON COMMISSION-APPROVED DEFERRALS FOR NW NATURAL'S ENVIRONMENTAL REMEDIATION COSTS

Q. Please provide a brief, general background on NW Natural's deferred accounts for environmental remediation.

A. Beginning in the early 1990s, NW Natural became aware of potential environmental clean-up obligations related to historical manufactured gas plants operated by NW Natural's prior owners. After the Environmental Protection Agency (EPA) placed the Portland Harbor on the Superfund list, the Company

started incurring substantial environmental remediation expenses (approximately $5 million for the period up to 2003). While the Company had insurance that may cover some or all of the costs incurred, and while other "potentially responsible" third parties (PRPs) may provide contributions that would also offset some of the costs, such recoveries are uncertain. Accordingly, the Company began considering appropriate mechanisms by which it could recover from its customers environmental remediation costs not offset by insurance or PRPs. Ultimately, the Company decided to request deferral of both costs and insurance/PRP recoveries in one balancing account.

Q. Please describe why the Company decided to propose a deferral and balancing account approach as the cost-recovery mechanism for its environmental remediation costs.

A. The Company's MGP and other environmental remediation costs are similar in many ways to decommissioning costs, in that they are costs imposed by law at the end of the useful life of a plant used to serve utility customers. However, in this case, they do not lend themselves to traditional ratemaking test year estimation because they are unpredictable, highly variable from year-to-year, and subject to offsets through insurance recoveries and contributions from other PRPs. For these reasons, the Company concluded that the normal approach to estimating test year expenses and recovering these expenses through base rates was unsuitable and could lead to the dramatic understatement or overstatement of these costs in rates.

The Company also concluded that the best protection for customers and the Company was a balancing account approach, tracking costs and offsetting insurance and PRP recoveries against those costs as these amounts became known. This approach would permit the Company to fully recover its prudent environmental remediation costs in a stable, predictable, and accurate manner,

and would give customers the benefits of all recoveries from insurance and PRPs.

Q. In 2003, did NW Natural seek Commission approval to defer environmental remediation expenses?

A. Yes. In Docket UM 1078, the Company requested approval to defer environmental costs—namely investigation, study, oversight, and likely remediation costs—associated with five MGP sites, including the Portland Harbor. The Company proposed to record these environmental costs and any offsetting insurance proceeds in deferred accounts and address cost recovery in a future rate case once the magnitude of costs and offsetting recoveries became clear.

The Company made its filing under ORS 757.259(2)(e), which allows deferrals that seek "to minimize the frequency of rate changes or the fluctuation of rate levels or to match appropriately the costs borne by and benefits received by ratepayers." Staff supported the Company's request for deferred accounting.

Q. Did the Commission approve NW Natural's request for deferred accounting for its environmental remediation expenses?

A. Yes, the Commission approved the request in Order No. 03-328.[3] Thereafter, at the Company's request, the Commission renewed NW Natural's deferred account for environmental costs annually and expanded the MGP remediation projects covered. The deferred account was recently renewed for its tenth year in Order No. 13-081.[4]

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[3] *In the Matter of Northwest Natural Gas Company Application for Deferred Accounting of Unrecovered Environmental Costs Associated with Gasco, Wacker, Portland Gas, Portland Harbor and Eugene Water and Electric Board*, Docket UM 1078, Order No. 03-328 (May 27, 2003).

[4] I*n the Matter of Northwest Natural Gas Company, dba NW Natural, Application for Reauthorization of Deferred Accounting*, Docket UM 1078(10), Order No, 13-081 (Mar. 13, 2013).

Q. What was the balance in the Company's deferred account for environmental remediation expense as of December 31, 2011?

A. As of that date, the deferred account was at $34.6 million total, including total expenditures net of the one insurance settlement achieved in 2011, plus accrued interest.

Q. From an earnings perspective, what was the effect of deferred accounting for NW Natural's environmental remediation costs in the historical period (2003 to 2012)?

A. The deferral allowed NW Natural to record a regulatory asset associated with these costs, as such, the costs never "hit" the income statement. Another way of thinking about this is that NW Natural's earnings "assume" that 100% of the costs would ultimately be recovered. Had the costs been considered in NW Natural's earnings without the regulatory asset, it would have resulted in NW Natural significantly **under-earning** on both a period-average basis and in every year in the historical period.

Q. Did the Company seek to amortize the costs in the deferred account in its most recent general rate case filing, Docket UG 221?

A. Yes. Given the uncertainty about how the level of costs compared to the available insurance, the Company was initially inclined to delay requests to amortize deferred amounts until it understood the scope of the uncovered obligation. However, both Staff and the Company grew concerned about the growing balance of the deferral, so the Company opted to request amortization of the deferral in Docket UG 221.

Q. What was the Company's proposal for recovery of environmental costs in Docket UG 221?

A. The Company proposed an automatic adjustment clause that would allow for an ongoing prudence review and recovery of expenses, while at the same time

ensuring that customers would benefit from insurance or recoveries from PRPs. The Company referred to this recovery mechanism as the Site Remediation Recovery Mechanism, or the SRRM. Under the SRRM, the Company would continue to defer environmental remediation costs and offset insurance and PRP recoveries in a balancing account. Each year, one-fifth of the balance of the account would be reviewed for prudence and added to the SRRM account for amortization.

Q. How did the other parties in Docket UG 221 respond to the Company's SRRM proposal?

A. Staff and the intervenors proposed several conditions to the SRRM. These included a fixed percentage disallowance (*i.e.*, "sharing"), a separate prudence review subsequent to Docket UG 221, and an earnings test as a prerequisite to recovery.

Q. How did the Commission resolve the Company's SRRM proposal?

A. The Commission adopted the Company's proposal with certain modifications. The Commission agreed that it should review the prudence of the costs in a separate proceeding and convened this docket to do so. The Commission also decided to adopt an earnings test with a deadband, the details of which it also determined to resolve through this docket.

Q. How did the Commission respond to the parties' request for a sharing mechanism?

A. The Commission rejected a sharing mechanism for the deferral:

> A majority of the Commissioners believe that the use of an earnings test (with a deadband) coupled with the Commission's ongoing prudence review will provide an effective incentive for the Company to manage its costs. Further, the majority adopts an earnings test but no sharing mechanism. An earnings test may operate as a de facto sharing

mechanism in some years, but it is not the intent of the majority to impose an explicit sharing mechanism.[5]

Q. Why is the rejection of a sharing mechanism significant in this case?

A. The Commission's order rejecting a sharing mechanism implicitly recognizes the nature of NW Natural's environmental remediation cost deferral. In the past, the Commission has imposed sharing mechanisms where the deferral was being used to capture costs in excess of those modeled in rates or to capture unforeseen costs not modeled in rates. For instance, in the electric utility power cost adjustment mechanisms (PCAMs), the Commission has ordered sharing of power costs above and below those modeled in rates. This sharing has resulted in the utility and customers sharing both up- and downsides of departures from estimates. We are unaware of any examples in which the Commission has ordered sharing on deferrals where a level of expense was not built into rates.

The deferral here is different in kind, where instead of recovery of environmental costs in base rates, the deferral effectuates a balancing account approach to cost recovery. While such an approach is not typical in ratemaking, the governmentally-mandated nature of the costs, along with their unpredictable nature and the potential for significant insurance and PRP recovery offsets, makes the approach particularly appropriate in this circumstance. Given the fact that the deferral is the only method for rate recovery of these costs, and not a supplemental tool used to true-up actual costs to costs estimated in rates, a sharing mechanism would have functioned inappropriately as a disallowance of a portion of prudent costs in all circumstances.

Q. Do the Company's environmental remediation and insurance recovery efforts remain ongoing?

[5] *In the Matter of Northwest Natural Gas Company, dba NW Natural, Request for a General Rate Revision,* Docket UG 221, Order No. 12-437 at 32 (Nov. 16, 2012).

A. Yes. The direct testimony of Robert Wyatt and Sandra Hart from NW Natural, which I describe below, outlines the current status of these efforts.

Q. Does the Company's estimate of future environmental costs remain consistent with the information you provided in Docket UG 221?

A. Yes. In Docket UG 221, NW Natural estimated $58 million in future remediation costs—which, in accordance with standard accounting practices, is a low-end estimate.[6] That low-end estimate has now been revised to $70 million. Moreover, as described in Docket UG 221, the actual expenses could be much greater than this, and estimates have been adjusted upward over time. For example, the upper end of the range for the Gasco/Siltronic site alone (which includes the Portland Harbor Superfund site) as described in the Company's most recent 10-K is $350 million. Additionally, certain expenses are not estimable at this time, as described in the 10-K.

III. THE PRUDENCE OF THE COMPANY'S HISTORICAL ENVIRONMENTAL REMEDIATION COSTS

Q. Please describe your understanding of the prudence standard that NW Natural must satisfy to recover its deferred environmental remediation costs.

A. To demonstrate that its environmental remediation costs are prudent, I understand that NW Natural must show that its decision-making associated with these costs was reasonable in light of the circumstances it faced at the time. The Commission recently reiterated that "the standard does not require optimal results" and "uses an objective standard of reasonableness."[7]

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[6] *See* Financial Accounting Standards Board Accounting Codification 450-20 and Security and Exchange Commission volume 4940.

[7] *Re PacifiCorp, dba Pacific Power, Request for a General Rate Revision*, Docket UE 246, Order No. 12-493 (Dec. 20, 2012).

Q. Did the Company provide evidence of the prudence of its historical environmental costs in Docket UG 221?

A. Yes. In Docket UG 221, NW Natural provided testimony demonstrating prudence at two levels. First, the Company demonstrated that its historical MGP operations giving rise to environmental impacts that are being remediated were conducted prudently. Second, the Company showed that its environmental remediation costs, including the offsets to costs through insurance settlements, were prudently incurred.

Q. Did the Commission's order allowing amortization of the deferred account without sharing address, at least implicitly, the first question in the prudence review?

A. Yes. In agreeing that the remediation costs should be recovered from customers with no sharing, the Commission arguably determined the prudence of NW Natural's MGP operations. However, because the Commission did not explicitly state such a finding, the Company has again presented evidence on this first level of prudence in this case.

Q. Please provide an overview of the Company's evidence on the prudence of its deferred environmental remediation costs.

A. The Company is presenting three witnesses to establish that its environmental remediation costs were prudently incurred:

- Andrew Middleton: Dr. Middleton is an expert in the historical operation of MGPs. He has reviewed documentation of NW Natural's operations and has concluded that the plants were operated in a prudent manner in accordance with the standards and practices of MGPs and other industries at the time.
- Robert Wyatt: Mr. Wyatt provides detail on the laws and regulations giving rise to Company's remediation obligations, the work with regulators to agree

upon reasonable obligations, and NW Natural's actual investigation and clean-up activities.

- Sandra Hart: Ms. Hart describes efforts to recover remediation costs from historical liability insurance carriers and the status of current settlement negotiations and litigation. As described by Ms. Hart, the Company has entered into a settlement with one insurance carrier, and has reached a settlement in principle with four additional carriers. The trial to resolve the ultimate coverage question with the remainder of the carriers is scheduled for June 2013. Ms. Hart's testimony demonstrates that these efforts, as well as the settlements received to-date, were prudently conducted.[8] In addition, Ms. Hart explains that the Company is involved in a non-judicial allocation process with other entities responsible for contamination in the Portland Harbor Superfund Site. Through this process NW Natural hopes to further offset its environmental remediation costs with third-party contributions.

IV. NW NATURAL'S PROPOSAL FOR AN EARNINGS TEST WITH A DEADBAND

Q. Please provide an overview of the Commission's basic framework for earnings tests for deferred accounts.

A. ORS 757.259(5) provides that, except for automatic adjustment clauses,[9] deferred amounts may be allowed in rates "upon review of the utility's earnings at the time of the application to amortize the deferral." When performing the

[8] The Company has also provided information to Staff and the parties describing the process by which settlement decisions were made and explaining how the settlements entered into meet the prudence standard.

[9] An automatic adjustment clause is a "provision of a rate schedule that provides for rate increases or decreases or both, without prior hearing, reflecting increases or decreases or both in costs incurred, taxes paid to units of government or revenues earned by a utility and that is subject to review by the commission at least once every two years." ORS 757.210(1)(b).

earnings test, the Commission reviews the utility's earnings during the deferral period, or a period reasonably representative of the deferral period.[10]

Q. What is the purpose of an earnings test under ORS 757.259(5)?

A. The earnings test is designed to ensure that utilities do not recover deferred costs if their earnings are already outside of a reasonable range. The Commission has not adopted a general earnings test to be used for all deferrals and instead tailors the earnings test to the particular type of deferral under consideration. In particular, the Commission has determined that the type of deferral will dictate where the maximum collection level is set within a reasonable range of earnings.

Q. Please explain how the Commission considers the type of deferral in conducting an earnings test.

A. In Order No. 93-257, the Commission discussed three types of deferrals and explained the type of earnings test that would be applicable to each as follows:

1. *For deferrals related to an emergency increase in cost, the Commission may apply an earnings test to allow the utility to amortize the deferral to the degree that it raises the utility's earnings to the bottom of a reasonable range of rate of return with the goal of encouraging the utility to control costs.*

2. *If the deferral created a fund for the benefit of customers, the Commission could apply an earnings test that would require the utility to refund the deferral up to the amount that would bring the utility's earnings to the bottom of the reasonable range of rate of return.*

3. *If the deferral was of a cost that was intended to be borne by customers but was delayed in order to match costs and benefits, the Commission might apply an earnings test that would allow the utility to amortize the deferral* ***up to the top of a reasonable range of rate of return****.*[11]

[10] OAR 860-027-0300.

[11] *In re Portland Gen. Elec. Co. Application for an Order Approving Deferral of Costs*, Dockets UM 445 and UE 82, Order No. 93-257 at 11-12 (Feb. 22, 1993) (emphasis added).

Q. Which of the above descriptions of deferrals best matches the environmental deferral at issue in this case?

A. The third. In Docket UM 1078, in authorizing the Company to recover its environmental remediation expenses, the Commission determined that doing so was necessary in order to match costs and benefits; and in Docket UG 221, it expressly found that the deferred environmental remediation costs are appropriately borne by customers.

Q. Has the Commission defined the reasonable range, or deadband, above a utility's allowed return on equity for purposes of an earnings test under ORS 757.259(5)?

A. No, the Commission has not defined a range to be applied in all earnings tests. In other contexts, however, the Commission has defined the upper range as 100 basis points above the utility's allowed ROE.[12]

Q. Does the Commission have considerable discretion in how it designs an earnings test for a particular deferral?

A. Yes. The Commission has broad discretion in deciding whether to allow a deferral, whether to impose sharing in authorizing the deferral and how to conduct an earnings test in amortizing the deferral. In this case, because the deferrals will be amortized through an automatic adjustment clause—the SRRM—the Commission had the discretion to omit an earnings test altogether.

Q. Given the type of the deferral in this case, and the policy considerations outlined above, what is NW Natural's proposal for an earnings test?

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[12] *See, e.g., Re NW Natural Gas Co. Investigation into the Purchased Gas Adjustment (PGA) Mechanism Used by Oregon's three Local Distribution Companies*, Docket UM 1286, Order No. 08-504 (Oct. 21, 2008); *Re PacifiCorp, dba Pacific Power, Request for a General Rate Revision*, Docket UE 246, Order No. 12-493 (Dec. 20, 2012).

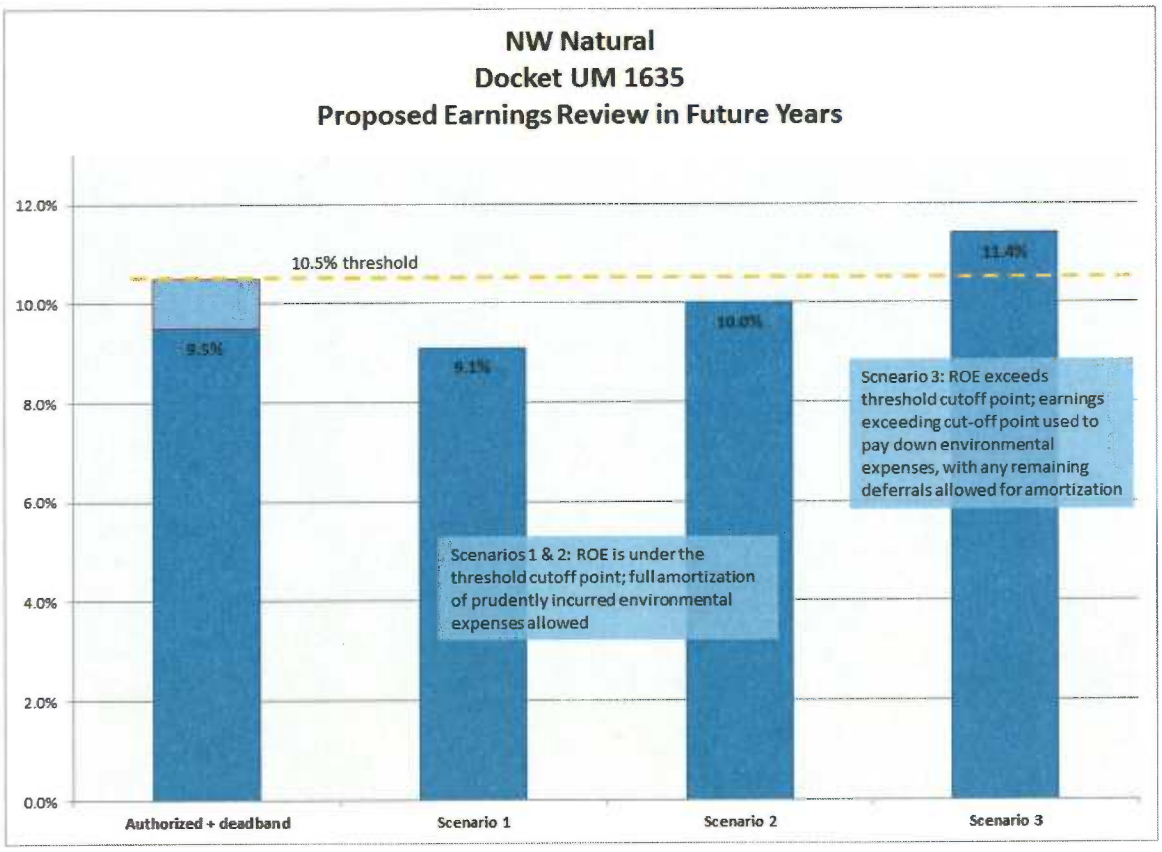
A. NW Natural proposes that the Commission allow the Company to amortize its deferred environmental costs so long as the Company's earnings are not above a "cut-off point" that is set at 100 basis points above its allowed ROE. This earnings test would ensure that deferrals would not be amortized to the extent they would result in the Company earning above a level that the Commission has deemed reasonable in the past.

Q. Please explain the steps involved in applying the earnings test.

A. The steps involved would be the same as those in the existing Spring Earnings Review. The Company would start with its actual ROE as determined each spring for the previous year in its Results of Operations. If the Company's earnings are at or below the threshold (100 basis points above authorized ROE in our proposal) then the Company would be allowed to fully amortize deferrals of prudently-incurred environmental expenses. If the Company's actual earnings exceed the threshold, those earnings in excess of the threshold would be used to reduce the outstanding environmental deferrals, rather than passing those amounts through to customers.

For the historical period, the earnings test should be conducted for the full deferral period (2003-2012), using the Company's average earnings over that time period, with adjustments to the deferred amounts to reflect offsetting insurance recoveries. Going forward, as the SRRM begins to operate on an annual basis, the earnings test should review earnings in the most recent calendar year period using the same 100 basis point cut-off point above the Company's allowed ROE. Chart 1 below illustrates how the earnings review will be applied to a hypothetical future year.

Chart 1



Q. Have you calculated the results of the application of your earnings test for the historical period, 2003 to 2011?

A. Yes. I have prepared Exhibit NWN/101 that demonstrates the operation of the earnings test for costs deferred in the historical period. In summary, the Company's allowed ROE for the historical period was 10.2 percent.[13] The cut-off point for the earnings test would be 100 basis points above that level, or 11.2 percent. Based upon the Company's filed Results of Operations, the Company's average return on equity for the period was 10.15 percent.[14] Accordingly, the

[13] The Commission reset the Company's ROE at 9.5 percent in late October 2012, two months before the end of the historical period, in its final order in UG 221. The average ROE for the historical period remains 10.2 percent taking account of this change.

[14] Exhibit NWN/101 line 12, column j.

Company should be allowed to fully amortize the costs deferred during this period.

Q. Can you provide more information on NW Natural's earnings during the historical period, including how weighted average cost of gas (WACOG) incentives contributed to earnings?

A. Yes. As demonstrated on line 15 of Exhibit NWN/101, between 2003 and 2011, the results of NW Natural's Spring Earnings Reviews demonstrate that NW Natural under-earned by approximately $0.8 million (netting under- and over-earnings for the period). Reviewing earnings after removal of the WACOG incentive demonstrates that, on a period basis, NW Natural under-earned by $12.8 million (line 28). It is important for the Commission to consider how WACOG incentives contributed to earnings in the historical period in designing the earnings test in this case. Otherwise, the Commission could effectively order NW Natural to pay a portion of its past and future environmental costs out of its WACOG incentives, undermining the operation of the Company's Purchased Gas Adjustment mechanism.

Q. Please explain how NW Natural's earnings test is supported by Commission principles and precedent.

A. In Order No. 93-257, the Commission recognized that for deferrals of the type involved in this case (for costs to be borne by customers, but delayed to better match costs and benefits for customers), recovery of deferrals up to the top of a reasonable range of return was appropriate. In Docket UG 221, the Commission found that deferred costs should be recovered from customers without sharing, clearly indicating that these costs are of the type that should be borne by customers.

As noted above, the Company initially proposed deferral treatment because of the uncertain and uneven nature of costs and recoveries. Thus, any

amount proposed to be included in base rates would run a substantial risk of over- or under-recovery, even if the Company filed annual rate cases. Cost recovery through deferral and amortization is the only way to accurately match actual benefits and costs in rates.

For this reason, the deferred amounts in this case should be recovered so long as the Company's earnings do not exceed an upper limit of a reasonable range. Defining this range as 100 basis points above the Company's allowed ROE is consistent with the Company's Spring Earnings Review, where 100 basis points above allowed ROE is the narrowest range available. (In many years, it was actually as high as 300 basis points). It is also consistent with the upper earnings range in current electric company PCAMs.

Q. Is it consistent with Commission rules to conduct the earnings review on a total period basis, as proposed by NW Natural?

A. Yes. Under OAR 860-027-0300, the period the Commission uses for the earnings review includes all or part of the period during which the deferral occurred or must be reasonably representative of the deferral period. The rule specifies review of earnings during the deferral "period" and does not specify that the period must be one year or allow for consideration of multiple one-year periods. Policy considerations support averaging over the deferral period for the following reasons:

- This treatment is consistent with OAR 860-027-0300, which refers to the deferral period, does not limit the review to an annual deferral period, and speaks in terms of a representative period, which an average constitutes.
- In accordance with Commission orders, the deferral account was collected and treated as a whole—not separately divided by year.
- When insurance recoveries were received, they were offset against entire amount without specific allocation to specific years. To conduct the earnings test on a year-by-year basis, the Commission would have to determine how to allocate insurance proceeds to the deferred balances—a process for which there is no rational basis.

Q. What will be the effect on NW Natural's earnings during the historical period if it is allowed to recover all amounts in the deferred account, without disallowance or write-off?

A. Allowing NW Natural to recover all amounts expensed during the historical period would not change the Company's reported earnings. This is because the reported earnings do not reflect those expenses that are deferred. Said differently, full amortization of a deferral creates a perfect match between the recovery and the expense, and therefore cannot result in the Company over-earning. On the other hand, any disallowance or write-off of deferred amounts will result in actual earnings lower than those reported.

Q. What are some of the unintended consequences that could follow if the earnings test capped recovery at or below the Company's allowed ROE?

A. This deferral is unique—it will continue for many years, and the magnitude of the expenditures represents a significant percentage of Company's earnings. For this reason, as a practical matter, wherever the earnings test recovery level is set will serve as the cap on the Company's earnings.

Q. Please explain why this is the case.

A. As demonstrated on lines 32-41 of Exhibit NWN/101, the Company's annual environmental expenditures are large and have been ramping up since the inception of the deferral. Given estimates of future environmental expenditures and the Company's past earnings experience, it becomes clear that the Company's potential over-earnings are highly unlikely to exceed its annual environmental expenditures.[15] As a result, as a practical matter, in the future the Company is highly unlikely to earn at a level greater than the cut-off point for

[15] For the 2003-2011 period, the Company's over-earnings never exceeded its environmental expenditures in a given year. *See* NWN/101 line 41.

amortizations. So, if the cut-off is set at 50 basis points below ROE, the Company will not earn above 9.0 percent. If the cut-off is set at authorized ROE, the Company will not earn above 9.5 percent.

Q. Does this mean that as a practical matter, the Company can expect to earn at whatever level the Commission sets as the cut-off for amortization of its environmental remediation costs?

A. No, on the contrary, the Company is almost sure to earn at a level ***below*** the cut-off. This is true for the following reason: historically, the Company has under-earned some years and over-earned others, averaging slightly below authorized ROE over time. It seems more likely than not that the Company will continue this pattern. However, if in the years the Company over-earns, it is forced to relinquish such over-earnings down to a level at or below authorized ROE, then the Company will on average earn below its authorized ROE. Lines 45-53 of Exhibit NWN/101 demonstrate that if the cut off for amortization had been the Company's authorized ROE during the historic deferral period, the Company's 2003-2011 average ROE would have been 9.81%.

This is a harsh result and one to which investors will react negatively. They will certainly understand that the Company may frequently earn below, for instance, 9.5 percent (if the cut-off is set at ROE) or 9.0 percent (if the cut-off is set at 50 basis points below authorized ROE) but will never earn above it. Indeed, the result is so harsh that it appears to violate the *Hope* principle, codified at ORS 756.040, which provides that a utility must be allowed an opportunity to recovery its reasonable expenses and capital costs.

Q. If the earnings test capped recovery at or below the Company's allowed ROE, could this also raise concerns with respect to the Company's WACOG incentive?

A. Yes. The WACOG incentive is included in earnings and in most years in which Company has over-earned historically, it has been on account of WACOG savings. If the Company's ability to earn its ROE is cut off at some level at or below its authorized ROE, then the incentive will be eliminated. If this treatment is applied to the historical period, Commission will be "stripping" Company of the incentive that was allowed in the past.

Similarly, during this time period the Company was in a rate case moratorium, and as discussed in its rate case testimony, made significant efforts to contain costs. Employing an earnings review that strips the Company of earnings during that period would send the wrong message to utilities taking actions that allow them to stay out of rate cases. To set the cap at authorized ROE would reverse these effects.

Q. Is it inconsistent with Commission precedent to design the earnings test to cap recovery at or below the Company's allowed ROE?

A. Yes. In the past, the Commission has cut off collection of deferrals at some point below authorized ROE only where a Company has the opportunity to over-recover through the inclusion of the same costs in base rates or a true-up mechanism (even if the opportunity functioned asymmetrically). In this case, there is no upside potential for the Company with respect to the recovery of its environmental remediation costs.

Q. What is the alternative recommendation that you mentioned earlier?

A. The alternative recommendation relates to the earnings test as it is applied to the past deferral balance. As discussed above, the earnings test proposed by the Company does not result in a write-off of any portion of that balance. The Company's alternative proposal applies only in the event that the Commission rejects the Company's proposal and is inclined to adopt an earnings test for past amounts that would result in a write-off. In that event, NW Natural recommends

that the Commission delay the amortization of these past amounts and the earnings test, until it has more information as to whether these historical costs can be offset or drawn down with near-term insurance recoveries.

Q. Is there a possibility that near-term insurance and PRP recoveries could eliminate or substantially reduce the amount of deferred costs in the balancing account subject to the earnings test?

A. Yes. As noted above, the trial on insurance coverage is set in June 2013. For this reason, the Commission has the option of deferring the earnings test for the historical costs until near-term insurance and PRP recoveries become known. The Company recommends this alternative approach if the Commission is considering an earnings test that would result in less than full amortization of the historical costs.

Q. Please explain why the Commission should defer ruling on the earnings test in the scenario you describe.

A. Currently, the Company is on "watch" for a downgrade. At this point, a significant write-off could result in a downgrade and therefore cause the Company to face increased costs and risks. If, after a write-off is ordered, it turns out that insurance proceeds will either partially or completely offset the deferral balance, eliminating the need to amortize all or a portion of the costs, the Company will have been unnecessarily harmed. In other words, the Company will be forced to write off significant amounts, even though it ultimately did not need to recover any past deferred amounts from customers.

Q. But if the Commission delays the amortization and earnings review of past deferral balances, wouldn't NW Natural's customers be harmed through the continued accrual of interest on the deferral balance?

A. No, they would not. The Company is accruing interest on deferral balances at its authorized ROE only until the prudence of those amounts is determined. Once

the deferred amounts are judged prudent, in accordance with the Commission's order in Docket UG 221, the amounts earn interest at the five-year treasury rate, plus 100 basis points, until they are moved into the amortization account, at which point they begin to earn the Commission's Modified Blended Treasury Rate (MBTR). To protect customers from any harm flowing from a delay in amortizing deferred amounts, NW Natural recommends that until the Commission decides to approve them for amortization, they should earn interest at the MBTR.

V. RECOVERY OF COSTS OF GASCO PUMPING STATION

Q. The Commission requested that the Company propose a recovery methodology for the costs associated with the Gasco Pumping Station. Could you please provide some background on that project?

A. NW Natural has received the final sign-off from the Oregon Department of Environmental Quality (DEQ) on plans to construct a hydraulic containment system for groundwater source control at the Gasco Site. *See* NWN/200, Wyatt/15. The project, which is required by DEQ, involves the design and construction of an expensive series of wells, pumps, and water treatment facilities. The general purpose of the project is to prevent the further movement of contaminated groundwater from the Gasco Uplands into the Willamette River.

Q. What treatment did NW Natural request for this investment in Docket UG 221?

A. The Company proposed that the costs of the Gasco Pumping Station be treated as an addition to rate base once the project is put into service, to allow for amortization over a longer period of time more closely matching the expected life of the facilities.

Q. Why did the Company propose to treat the costs of the pumping station differently than its other remediation costs?

A. Unlike most other required actions NW Natural expects to take in fulfilling its remediation obligations, the pumping station involves the construction of actual physical plant that will be operated over a longer period of time. Such plants are normally added to rate base and amortized over the life of the plant. This treatment would be helpful in the case of the pumping station because it is expected to cost between $11 million and $30 million to construct.

Q. How did the Commission rule on the Company's proposal?

A. The Commission found that the Company's request was premature given that the project had not been built, was not used and useful, and costs were not yet known.[16] It appears that the Commission, and parties, may have misunderstood NW Natural's request as seeking to add this plant to rate base before it was completed. NW Natural's request had been simply to track it in, once completed.[17]

In any event, the Commission stated that the Company could seek in the future to either add the plant to rate base, or to recover it through the SRRM. For that reason, the Company is now proposing to recover it through rate base. The Company asks the Commission to decide this issue now, rather than at the time the plant is included in rates, so the Company understands the appropriate accounting to use for plant costs. The Company is not asking the Commission to prejudge the prudence of the plant.

Q. What is the status of the project now?

A. We expect the project to be operational in 2014.

Q. When does NW Natural propose to add the prudently-incurred costs of constructing the Gasco pumping station to rate base?

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[16] Order No. 12-437 at 32.

[17] *Re NW Natural Gas Co. Request for a General Rate Revision*, Docket UG 221, NW Natural's Posthearing Brief at 28 (Sept. 12, 2012).

A. We would request that the Commission review the plant for prudence after it is completed and allow NW Natural to add it to rate base at that point. This review could occur during the same timeframe as the first review of costs under the SRRM, and the rate change could be made during the next PGA following the review.

Q. What does the Company propose for the prudently incurred operating costs of maintaining the Gasco pumping station?

A. We propose that the operating and maintenance costs related to the Gasco pumping station be deferred and recovered through the SRRM.

VI. RATE SPREAD

Q. Does the Company have a recommendation as to the rate spread for environmental remediation costs?

A. Not at this time. I can report that the parties have reached a settlement in principle on this issue and will be signing a stipulation on this subject.

VII. JURISDICTIONAL ALLOCATION

Q. Is NW Natural proposing to collect its environmental remediation costs only from its Oregon customers?

A. No. The Company expects to collect an appropriate percentage of these costs from its Washington customers as well. The Company has learned that beginning around 1913, it served Washington customers with gas that was manufactured at its Gasco MGP facilities. Thus, the Company is proposing to collect from Washington customers some of the costs of remediation of environmental harms associated with historic Gasco operations.

Q. What portion of costs is the Company proposing to collect from Washington customers?

A. The Company believes that approximately 3.32 percent of its costs of remediation related to Gasco should be allocated to Washington customers.

This percentage, which is based on the limited data we have available to us, is the Company's best estimate of the percentage of gas from the Gasco facility that was sold to Washington customers during the period from 1913 through 1956, when the plant ceased operations. Exhibit NWN/102 provides the calculations that support the 3.32 percent figure. During the course of this proceeding the Company will work jointly with the Commission and the Washington Utilities and Transportation Commission, as well as the parties to determine whether they can support a joint solution.

Q. Is this the first time the Company has proposed this jurisdictional allocation?

A. No. The Company proposed this allocation in Docket UG 221, and it was not contested there. The Commission's order did not address this allocation, however, so NW Natural is seeking to have it confirmed in this proceeding before it begins to amortize amounts under the SRRM.

Q. Does this conclude your direct testimony?

A. Yes.

NWN/101
Witness: Alex Miller

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1635

NW NATURAL

Exhibit Accompanying Direct Testimony of Alex Miller

Analysis of Oregon Earnings Test

March 29, 2013

NW Natural
OPUC Docket UM 1635
Analysis of Oregon Earnings Tests
($MILLIONS)

NWN/101
Miller/1

	1	2	3	4	5	6	7	8	9	
	2003 (a)	**2004** (b)	**2005** (c)	**2006** (d)	**2007** (e)	**2008** (f)	**2009** (g)	**2010** (h)	**2011** (i)	(j)
Authorized ROE	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	
ROE Threshold for each year's Spring Earnings Test	13.27%	13.27%	13.32%	13.44%	13.40%	13.14%	11.54%	11.02%	10.92%	

Per Results of Operations ("ROO") as filed: data is from filed ROOs, column c (after Type I normalizing adjustments), there are slight rounding differences

	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Net Operating Revenue	$61.5	$71.7	$78.8	$82.8	$84.0	$83.9	$89.5	$84.8	$86.7	
Total Rate Base	$814.1	$858.5	$940.1	$958.8	$976.0	$978.9	$986.2	$967.3	$993.2	
Return on Rate Base	7.56%	8.35%	8.38%	8.63%	8.60%	8.57%	9.08%	8.77%	8.73%	
Return on Equity	8.05%	9.49%	9.77%	10.31%	10.17%	10.05%	11.21%	11.10%	11.19%	**2003-11 average 10.15%**
Pre tax amount of ROE compared to 10.2% [a]	**($14)**	**($5.4)**	**($3.5)**	**$0.9**	**($0.2)**	**($1.3)**	**$8.7**	**$6.9**	**$7.6**	**Totals ($0.8)**

Proforma calculations of excluding WACOG sharing from all years

	2003	2004	2005	2006	2007	2008	2009	2010	2011	
	already excluded	already excluded	already excluded	already excluded	already excluded					
WACOG Sharing after tax	$0.0	$0.0	$0.0	$0.0	$0.0	($4.5)	$9.5	$0.6	$1.5	
WACOG Sharing pre tax	$0.0	$0.0	$0.0	$0.0	$0.0	($7.5)	$15.9	$1.1	$2.5	
Proforma Operating Income & ROE										
Operating income	$61.5	$71.7	$78.8	$82.8	$84.0	$88.5	$80.0	$84.2	$85.2	
ROE	8.05%	9.49%	9.77%	10.31%	10.17%	10.90%	9.36%	10.96%	10.87%	Totals
Pre tax amount of ROE compared to 10.2%	($14.5)	($5.4)	($3.5)	$0.9	($0.2)	$6.2	($7.2)	$5.9	$5.2	($12.8)

Comparison of environmental deferral activity with earnings over/under 10.2%

	2003	2004	2005	2006	2007	2008	2009	2010	2011	Totals
Pre tax amount of ROE compared to 10.2% (from line 15 above)	($14.5)	($5.4)	($3.5)	$0.9	($0.2)	($1.3)	$8.7	$6.9	$7.6	($0.8)
Environmental costs (excludes insurance proceeds for illustration):										
Environmental deferrals (as actually recorded each year)	$1.0	$2.2	$9.2	$5.3	$6.8	$5.4	$6.5	$9.2	$6.0	$51.6
Interest on deferrals (as actually recorded each year)	$0.0	$0.0	$0.0	$1.3	$2.0	$2.7	$3.5	$4.4	$5.6	$19.5
Total Environmental deferrals with interest	$1.0	$2.2	$9.2	$6.6	$8.8	$8.2	$10.0	$13.7	$11.6	$71.1
ROE variances vs Environmental activity (line 34 minus line 39)	($15.5)	($7.6)	($12.7)	($5.7)	($9.0)	($9.5)	($1.2)	($6.7)	($3.9)	($71.9)

Impact of environmental writeoffs on earnings test when cut-off is at authorized ROE

	2003	2004	2005	2006	2007	2008	2009	2010	2011	Totals
Pre tax amount of ROE compared to 10.2% (from line 15 above)	($14.5)	($5.4)	($3.5)	$0.9	($0.2)	($1.3)	$8.7	$6.9	$7.6	($0.8)
Proforma Operating writeoff & Resulting ROE										
Write off to extent earnings exceeded 10.2% deadband	$0.0	$0.0	$0.0	$0.9	$0.0	$0.0	$8.7	$6.9	$7.6	$24.2
Resulting Operating income	$61.5	$71.7	$78.8	$82.2	$84.0	$83.9	$84.3	$80.7	$82.1	
Resulting proforma ROE	8.05%	9.49%	9.77%	10.20%	10.17%	10.05%	10.20%	10.20%	10.20%	**2003-11 average 9.81%**

Notes:

[a] Earnings of $0.2 million and $0.7 million have already been refunded to customers for 2010 and 2011, respectively. Any write offs of environmental amounts should take this into account.

NWN/102
Witness: Alex Miller

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1635

NW NATURAL

Exhibit Accompanying Direct Testimony of Alex Miller

Proposed State Allocation of Environmental Deferrals

March 29, 2013

NW Natural NWN/102
OPUC Docket UM 1635 Miller/1
Proposed State Allocation of Environmental Deferrals
Volumes in therms

Year	Gas Volumes Sold		Washington % Gas Volumes Sold
	Washington	System	
1925	49,060	4,130,818	1.19%
1926	52,150	3,998,203	1.30%
1927	59,070	4,362,441	1.35%
1928	64,710	4,335,864	1.49%
1929	78,102	4,435,926	1.76%
1930	82,788	4,341,878	1.91%
1931	80,833	3,996,857	2.02%
1932	73,077	3,721,513	1.96%
1933	60,020	3,329,499	1.80%
1934	58,294	2,967,388	1.96%
1935	60,388	3,367,475	1.79%
1936	66,167	3,598,131	1.84%
1937	76,592	3,890,948	1.97%
1938	80,418	3,926,566	2.05%
1939	84,615	3,978,949	2.13%
1940	101,524	4,183,852	2.43%
1941	128,591	4,065,870	3.16%
1942	179,752	5,160,805	3.48%
1943	218,537	5,925,699	3.69%
1944	225,971	6,248,702	3.62%
1945	260,899	7,050,560	3.70%
1946	282,474	5,984,619	4.72%
1947	301,472	6,078,065	4.96%
1948	313,922	6,203,992	5.06%
1949	303,749	6,038,748	5.03%
1950	413,877	8,997,327	4.60%
1951	391,543	8,511,795	4.60%
1952	394,493	8,575,939	4.60%
1953	376,454	8,183,793	4.60%
1954	276,767	6,644,537	4.17%
1955	288,932	8,834,971	3.27%
1956	292,045	8,930,158	3.27%
Total	**5,777,286**	**174,001,886**	**3.32%**

Notes/Legend:

Derived from available data

The % from 1955 is repeated for 1956 due to lack of data

NWN/200
Witness: Robert Wyatt

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1635

In the Matter of

NORTHWEST NATURAL GAS COMPANY, dba NW Natural,

Mechanism for Recovery of Environmental Remediation Costs.

NORTHWEST NATURAL GAS COMPANY

DIRECT TESTIMONY OF

ROBERT WYATT

March 29, 2013

EXHIBIT 200 – DIRECT TESTIMONY – ENVIRONMENTAL REMEDIATION PROGRAMS AND CURRENT STATUS

Table of Contents

I. INTRODUCTION AND SUMMARY

Q. Please state your name and position with NW Natural Gas Company ("NW Natural" or "the Company").

A. My name is Robert J. Wyatt. I am Environmental Manager of NW Natural. I manage all aspects of environmental compliance at NW Natural's former manufactured gas plant (MGP) sites. I also serve as the Chairman of the Lower Willamette Group, which is described below.

Q. Please describe your educational and professional background.

A. I earned a Bachelor of Science degree in Geology in 1984 from Lafayette College in Easton, Pennsylvania. I studied hydrogeology at Temple University in Philadelphia, Pennsylvania from 1984 to 1986 and conducted additional graduate studies on coastal habitats at East Carolina University in North Carolina. I have been a Licensed and Registered Geologist in Oregon, North Carolina, Pennsylvania, Tennessee, Kentucky, and Georgia. In the mid-1980s, I began working as an environmental consultant focused primarily on Superfund and Resource Conservation and Recovery Act (RCRA) sites. I became Vice President of Front Royal Environmental Services, Inc. in 1989 and served as Senior Scientist and Principal in Charge for a number of large scale projects. I became Environmental Manager of NW Natural in 2000.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to demonstrate that the actions NW Natural has taken to comply with the Environmental Protection Agency (EPA) and Oregon Department of Environmental Quality (DEQ) mandates to investigate and remediate environmental impacts related to the Company's historical operation of its MGP have been prudent.

Q. Have you testified on this topic before?

A. Yes. In Docket UG 221 NW Natural Exhibit 1300, I described the regulatory process, the status of remediation at various sites, the Company's cost containment efforts, and

the status of the Company's work on the various sites as of September 2011. This testimony provides the same information included in my Docket UG 221 testimony with updates for developments that have occurred in the interim.

Q. Please summarize your testimony.

A. In my testimony, I:

- Provide background on the sites where the two MGPs operated by NW Natural's predecessor in interest were located and the contamination that resulted from their operation;
- Describe the sites that are subject to environmental remediation, a.k.a. "clean-up," activities;
- Describe the statutory framework that governs environmental remediation and the specific state and federal agency actions taken at the sites pursuant to this statutory framework;
- Explain the process of environmental remediation;
- Describe the status of environmental remediation activities at the sites;
- Explain the costs incurred to date by NW Natural in its remediation efforts and discuss the uncertainties surrounding future costs; and
- Describe the actions NW Natural have taken to control the costs associated with environmental remediation.

II. BACKGROUND

Q. Please describe the sources of contamination that led to the environmental remediation efforts you discuss in your testimony.

A. Natural gas did not come to Western Oregon until 1956. Before that, NW Natural's predecessor, Portland Gas & Coke (PG&C), manufactured gas primarily at two MGPs.[1] The Portland Gas Manufacturing (PGM) facility, which was located in downtown Portland, operated from 1860 to 1913. The much larger Gasco facility was constructed downstream of PGM and operated from 1913 to 1956.

MGPs produced gas for commercial and residential use using different feedstocks. PGM used coal as a feedstock from 1860 to 1906 and then used oil as its principal feedstock from 1906 until 1913. The Gasco plant used only oil. The manufacturing process produced marketable products, recyclable materials and waste materials. The processes used to manufacture gas are described in detail in the direct testimony of Andrew Middleton. For the purpose of my testimony, it is important only to understand that the by-products and wastes from these processes resulted in contamination of the MGP sites and, in some cases, nearby areas.

Q. When were the environmental impacts of the MGPs first identified?

A. The DEQ first identified contamination at the site of the former Gasco facility (the "Gasco Site") in the late 1980s. The EPA placed the larger Portland Harbor Superfund Site on the National Priority List (NPL or "Superfund list") in 2000. Environmental impacts near the PGM site were identified in 2007 during the investigation of the Portland Harbor Superfund Site.

III. REMEDIATION SITES

Q. Please describe the sites that are the subject of NW Natural's environmental remediation efforts.

[1] A predecessor to PG&C, the East Portland Gas Light Company, also operated a small MGP on the east side of the Willamette River between 1882 and 1892. NW Natural has not been required to take any remedial action in connection with that operation.

A. There are four sites associated with former manufactured gas operations: the Portland Harbor Site, the PGM Site, the Gasco Site, and the Siltronic Site. The Company is managing six remediation projects at these sites, as described below.

- **The Portland Harbor Site**, which EPA has listed as a Superfund site, is a ten-mile stretch of the bed and banks of the Willamette River, from River Mile 1.9 to River Mile 11.8. Investigation of the site as a whole is being managed by a consortium of potentially responsible entities known as the Lower Willamette Group (LWG), under EPA's oversight. NW Natural is a participant in the LWG; this participation is referred to within the Company and in this testimony as our **Harborwide Project**. As I will explain later in my testimony, the Company is managing MGP-contaminated sediments adjacent to the Gasco Site as a separate project within the Portland Harbor Site, also under EPA oversight. This is our **Gasco Sediments Project.**
- **The PGM Site** covers approximately 3.7 upland acres and is located on the Willamette River near the Steel Bridge. The location of the former MGP is now a fully developed part of downtown Portland. NW Natural is managing this site as the **PGM Project** under DEQ's oversight.
- **The Gasco Site** covers approximately 45 acres and is located on the Willamette River between the St. Johns Bridge and the Railroad Bridge. The manufacturing facility is gone, and the site is currently occupied by the Company's Portland liquefied natural gas storage facility and two tenant facilities. Work at this site consists of two projects: the **Source Control Project** and the **Uplands Project**. These projects are subject to DEQ oversight. Both projects include work on the Siltronic Site, described below.
- **The Siltronic Site** is adjacent to the Gasco Site. The land is now owned by Siltronic Corporation ("Siltronic"), but approximately 38.5 acres of it was

previously owned by PG&C. Some of the contamination at the site resulted from PG&C's use of approximately 400 feet of the property adjacent to the Gasco Site for storage and management of MGP residuals. Subsequent owners of the Siltronic Site placed a significant amount of fill on the property and redistributed MGP material across the property. Other contaminants from different sources, including Siltronic's own operations, also exist at the site. The Siltronic Site is managed by Siltronic and NW Natural under DEQ's oversight. Both the Gasco Source Control and Gasco Sediments projects involve work on the Siltronic property. The **Siltronic Project** consists of all of NW Natural's work on the Siltronic Site that is not covered by the other two Gasco Site projects.

Q. Are there any other sites that NW Natural is required to remediate?

A. Yes. NW Natural is responsible for clean-up activities at three other sites: the Eugene Water Electric Board; French American International School; and Albany sites. NW Natural was named a responsible party at each of these sites and required to clean up contamination resulting from former manufactured gas activities and fuel leaks. The Company obtained approval to defer these costs on an annual basis in conjunction with the other clean-up sites previously discussed.

IV. REGULATORY FRAMEWORK

Q. Please describe the general statutory framework that governs NW Natural's responsibilities related to remediation for past gas manufacturing operations.

A. Congress enacted the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in 1980. The law empowers EPA to require the owner or operator of any facility from which a release of a hazardous substance has occurred to perform or pay for cleanup of property contaminated by the release. These owners and operators are known as Potentially Responsible Parties (PRPs). CERCLA initially created a cleanup fund (the "Superfund") with revenues from a tax on certain industries

but the tax expired in the mid-1990s and has not been renewed. All cleanup activities, including agency and trustee oversight costs, are now funded by the PRPs. EPA can also require current PRPs to pay for the cleanup of contamination caused by entities that no longer exist—known as "orphan shares." Many of the entities that contributed to the contamination in Portland Harbor sediments over nearly 150 years of industrial activity are now out of business, leaving NW Natural and other current PRPs with potential liability for the orphan shares as well as the contamination attributable to their own properties or operations. Finally, under the "joint and several liability" provisions in CERCLA, EPA may be able to order one PRP, or a small number of PRPs, to bear all of the remediation costs associated with the Portland Harbor Site. Those PRPs would then have to seek reimbursement from other PRPs, likely through litigation.

Oregon's Environmental Cleanup Law provides similar authority to DEQ. Enforcement orders and agreements with EPA and DEQ ("the agencies") define the investigation and remediation activities that NW Natural must undertake.

Q. What actions have the agencies taken under these laws with respect to the Portland Harbor?

A. EPA has taken action on the Portland Harbor Site as a whole and also on the sediments immediately adjacent to the Gasco Site.

In approximately 1997, EPA began a Preliminary Assessment of sediment contamination in the Portland Harbor. In December 2000, EPA placed the Portland Harbor on the Superfund list and sent letters to 69 parties, including NW Natural, advising those parties that EPA considered them jointly and severally liable for completing a Remedial Investigation and Feasibility Study (RI/FS) for the Portland Harbor. In September 2001, EPA, NW Natural and eight other PRPs entered into an Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Studies for the Portland Harbor Superfund Site (the "RI/FS

Consent Order"). One additional party signed the RI/FS Consent Order in 2002. These ten parties, together with four other parties who provide funding for the RI/FS, constitute the LWG. NW Natural's work as a part of the LWG is our current Harborwide Project.

In 2004, EPA issued an Administrative Order on Consent for Removal Action, which required NW Natural to remove a tar-like feature in the Willamette River adjacent to the Gasco Site. Except for long-term monitoring, that work was completed in 2005.

Shortly thereafter, EPA indicated that it would require the Company to perform a second, much more extensive, removal action. The Company resisted and instead proposed carving the sediments adjacent to the Gasco Site out of the larger Portland Harbor Site for an expedited final remedial design. EPA agreed, but required that Siltronic be involved in that work. Accordingly, in 2009, NW Natural and Siltronic entered into an Administrative Settlement Agreement and Order on Consent for Removal Action with EPA. That document requires the Company and Siltronic to design a final remedy for sediments adjacent to the Gasco Site. NW Natural's work on the Sediment Project is being performed pursuant to this order.

Q. What actions have the agencies taken with respect to the Gasco Site?

A. In 1993, DEQ proposed the Gasco Site for the Oregon Confirmed Release List (CRL). The CRL is the state law equivalent of EPA's Superfund list, and DEQ may require owners and operators of listed sites to clean them up. In 1994, NW Natural entered DEQ's voluntary cleanup program for the Gasco Site by signing a Voluntary Agreement with DEQ. It is important to note that such an agreement is "voluntary" in name only. Our failure to enter into the voluntary program would have resulted in immediate enforcement action. Further, in 2006, DEQ required an amendment to the Voluntary Agreement that added stipulated penalties and other provisions typical of consent orders. The Voluntary Agreement requires NW Natural to investigate contamination from the former Gasco MGP at both the Gasco Site and the adjacent Siltronic Site and,

where necessary, to perform clean-up work or take measures to prevent contamination from spreading.

In 2000, DEQ issued an Order Requiring Remedial Investigation and Source Control Measures at the Siltronic Site. NW Natural and Siltronic are both subject to the Order. NW Natural's work on the Gasco Uplands Project and the Source Control Project are being performed pursuant to these orders.

Q. What action have the agencies taken with respect to the PGM site?

A. In 1987, EPA performed a Preliminary Assessment of the PGM site and concluded that no further federal action was warranted under CERCLA at that time. In approximately 1992, DEQ completed a preliminary assessment of the PGM site and concluded that it was a low priority for further environmental investigations. In 2007, the LWG collected sediment samples upstream of the Portland Harbor Site, in the vicinity of the PGM site. Laboratory analyses of those samples identified contaminants that may be related to MGP operations. Accordingly, on April 27, 2009, NW Natural entered into an Order on Consent with DEQ. The order requires NW Natural to define the nature, extent, and potential risks associated with gas plant-related chemicals in river sediments and to determine whether any contamination in shoreline soils or groundwater might be a continuing source of contamination to the river. This order is the source of our work on the PGM Project.

Q. Have the agencies taken any additional actions with respect to the Siltronic Site?

A. Siltronic is working under a separate agreement with DEQ to investigate and remediate contamination from TCE, a chlorinated solvent, that is attributable to its manufacturing operations. That work is being performed independently by Siltronic and is in addition to the work being done by NW Natural for DEQ on the Gasco projects. The Siltronic property is also impacted by groundwater contaminated by offsite sources; this contamination is being investigated by the current owners of the Rhone-Poulenc

property, a nearby site from which chemical contamination is suspected to have originated.

Q. How have EPA and DEQ determined the Company's specific obligations for clean-up work?

A. The agreements and orders described above set forth the general scope of work NW Natural must perform at each site. The details of the work are generally resolved by technical consensus or negotiations with EPA and DEQ project staff. When the Company or the LWG cannot reach technical agreement with the relevant agency on some aspect of work, the agency staff will issue a directive that requires a particular approach. From time-to-time, NW Natural or the LWG will dispute an agency directive because we disagree with agency staff on legal, technical, or policy grounds. In these instances, the work is determined by upper management at DEQ or EPA.

V. ENVIRONMENTAL REMEDIATION PROCESS

Q. What is the process for remediation at the sites?

A. Each site proceeds through a sequence of activities required by the regulatory agencies. These stages are: Remedial Investigation; Risk Assessment; Feasibility Study; Remedy Design and Construction; Operation and Maintenance; and Monitoring.

Q. Please explain the Remedial Investigation stage.

A. During the Remedial Investigation (RI) stage, the parties determine the nature and extent of the contamination at the site. This stage includes extensive sampling of soil, groundwater, surface water, stormwater, air, sediment, porewater, Dense Non-Aqueous Phase Liquid (DNAPL), bioassays, and tissue. The samples are used to evaluate the physical, chemical, and biological factors at a site. Laboratory analysis of the samples determines the extent and magnitude of contamination.

The RI is an iterative process. After each round of data collection, the data must be analyzed and reported to the regulatory agency for review and approval. The

process continues until the agency determines that it has the information it needs to understand the nature and extent of the contamination at the site. At that point the agency approves the RI Report.

Q. How does the RI stage of remediation transition to the Risk Assessment stage?

A. Information in the RI is used to conduct the Risk Assessment (RA). The RA determines whether the contamination at the site poses unacceptable risks to human and ecological "receptors." In the human health risk assessment, the universe of human receptors is refined into smaller population groups for focused evaluation of their exposure to chemicals from the site. In the ecological risk assessment, the receptors are organisms that may be exposed to chemicals from the site. Ecological receptors include fish, birds, mammals, amphibians, reptiles, insects, invertebrates and plants. The regulatory agency approves the RA when it is satisfied that all routes of exposure for each chemical to each receptor have been adequately evaluated.

Q. Please explain the Feasibility Study stage of remediation.

A. The Feasibility Study (FS) is written after the RA. The FS evaluates various technologies that can be used to remediate the chemical impacts that are causing unacceptable risk. The FS provides the agency with a range of clean-up alternatives. The FS evaluates each alternative in terms of its environmental benefit, its cost, and the feasibility of implementation. The agency considers the alternatives described in the FS and selects its proposed remedy. The agency solicits public comment on its proposal and then makes a final decision.

Q. Please explain the final stages of remediation—Design and Construction, Operation and Maintenance, and Monitoring.

A. Once the agency has selected a remedy, the PRP must develop a construction design for the remedy. Remedy design is also an iterative process, with revisions based on agency reviews and comments. After the agency approves a final design, the PRP

begins construction. Depending on the scope and design of the remedy, the construction stage may be short or construction may be performed in phases that occur over multiple years. For example, dredging activities can only take place in the Willamette River during discrete periods of time (in total, about four months each year) when potential impacts to fish from dredging activities are lowest. A large dredging operation would therefore need to be phased over multiple years.

After construction, the agencies require operation and maintenance as well as performance monitoring and reporting. If the remedy does not perform as predicted, the agency has the authority to require additional remediation work.

Q. Do all remediation projects move through all of these stages?

A. No. In some cases governed by CERCLA, EPA has enough information early in the process to determine that some clean-up should occur before the agency has all of the information it will need to select a final remedy for the site. In such a case, CERCLA gives EPA the authority to order a "removal," also known as an "early action." Removal actions can include physical removal of material (such as excavation or dredging), or less intrusive means of preventing exposure to hazardous materials (such as capping, fencing, or installing signs). It is important to note that EPA does not issue a record of decision in such a case and the PRP performing the removal does not receive any of the legal protections (*e.g.* covenants not to sue and releases) that come with the performance of a final remedy pursuant to a record of decision.

VI. STATUS OF REMEDIATION WORK AT THE SITES

Q. What is the status of the LWG's remediation work at the Portland Harbor Site?

A. The LWG has completed most of the work required by the RI/FS Consent Order; the work is at the Feasibility Study stage. The LWG has submitted and received comments from EPA on drafts of the Remedial Investigation Report, the Human Health Risk Assessment, and the Ecological Risk Assessment. The LWG submitted revised drafts of

each of those documents to EPA in 2011. Since then, the LWG submitted a third version of the Human Health Risk Assessment and EPA approved it on February 26, 2013. The LWG and EPA are currently working on revisions to the Ecological Risk Assessment and the Remedial Investigation Report. These three documents provide EPA with analyses of the nature and extent of the chemical impacts to Portland Harbor sediments, and the risks to human and ecological receptors. The LWG submitted the draft Portland Harbor Feasibility Study in March 2012. EPA provided preliminary comments on the Feasibility Study in December 2012, and EPA and the LWG are currently working together to resolve the comments. .

Q. Does the LWG's work on the Portland Harbor Site affect any of NW Natural's other remediation projects?

A. Yes. All of our work on the Gasco Sediment Project must be consistent with Portland Harbor data and regulatory requirements. Therefore, NW Natural will use the information developed for the Portland Harbor Site to design a remedy for the Gasco sediments. The Company will also use information from the Portland Harbor in the Source Control Project to ensure that the source control measures we construct will both satisfy DEQ requirements and prevent recontamination of the Portland Harbor Site.

Q. What is the status of NW Natural's work on the Gasco Sediments Project?

A. This project is at the Feasibility Study stage. As I mentioned earlier, in 2004, EPA required NW Natural to remove a tar-like feature from the sediments adjacent to Gasco under CERCLA's "removal" provisions. The Company completed the removal in 2005. Shortly after that project was completed, EPA indicated that it would require the Company to perform a second, more extensive removal action. The Company resisted the second action and instead proposed carving the sediments adjacent to the Gasco Site out of the larger Portland Harbor Site for an expedited final remedial design. EPA agreed. The Order with EPA for this project allows NW Natural to utilize information in

the RI, RA, and FS documents for the Portland Harbor to conduct an Engineering Evaluation/Cost Analysis (EE/CA) for the Gasco sediments. EPA will select a remedy for the Gasco Sediments Project from this analysis, which will be consistent with the FS for the rest of the Portland Harbor Site. NW Natural will then produce a remedial construction design that can be included in the Portland Harbor Record of Decision (ROD). NW Natural will construct the remedy under a Consent Decree with EPA, after EPA issues the Record of Decision (ROD) for the Portland Harbor Site. The EE/CA was submitted to EPA in May 2012. EPA has not yet established a timeline for providing its final comments or for submittal of a revised EE/CA.

Q. What is the status of the remediation work at the PGM Site?

A. This site is in the Investigation stage. DEQ's Order for the PGM Site requires NW Natural to report on historical operations to determine the nature and extent of contamination in river sediments and porewater, evaluate upland groundwater and soil along the river bank, determine hydraulic conditions in the uplands, and investigate source control. To date, the Company has submitted a detailed history of the facility operations to DEQ and conducted extensive sediment and upland riverbank investigations. We are currently conducting supplemental sediment and riverbank groundwater studies required by DEQ.

Q. What is the status of the remediation work at the Gasco Site?

The projects at the Gasco Site are at different stages:

- Gasco Uplands Project: This project is in the Risk Assessment stage. Extensive soil sampling, groundwater monitoring, air quality analysis, stormwater study, DNAPL evaluation, and surface water sampling have provided a comprehensive understanding of the nature and extent of the contamination in the uplands. NW Natural anticipates collecting a limited amount of additional data to support risk

assessment and source control activities. All of the data will be utilized to finalize the RA. After DEQ approves the RA, NW Natural will develop the FS.

- Gasco Source Control Project: This project is in the Construction stage. DEQ requested that NW Natural use information specific to groundwater and DNAPL contamination from the Gasco Uplands RI and RA to prepare a Focused Feasibility Study (FFS) for groundwater and DNAPL source control. The FFS was submitted in 2007. DEQ then requested a series of extensive data collection, analysis, and modeling efforts to supplement the FFS and assist its evaluation of alternatives. NW Natural disputed direction from DEQ in 2010 to construct only a partial groundwater source control system. The dispute was resolved in early 2011 when DEQ agreed to a complete hydraulic containment system for groundwater source control. The Company submitted a comprehensive design for that system in May 2011. We received comments from DEQ in September 2011. The final design was submitted to DEQ on January 31, 2012, DEQ approved ordering long-lead items for the treatment plant on April 5, 2012 and provided approval of construction on August 9, 2012. Construction is underway and the plant is expected to be operational in 2014.

Q. What is the status of the remediation work at the Siltronic Site?

A. The Siltronic Project is in the Investigation stage. NW Natural is currently investigating the presence of MGP-related contaminants on the Siltronic property. The RI is nearing completion, and the risk assessment for those chemicals will be initiated when the RI is approved by DEQ. Siltronic is independently conducting a separate soil, groundwater, surface water, stormwater, and sediment investigation for TCE.

Q. Has EPA required any "early actions" in the Portland Harbor Site?

A. Yes. EPA's 2004 order requiring the Company to remove a tar-like feature in the sediments adjacent to the Gasco Site was issued pursuant to the agency's "early action"

authority. This work was completed in 2005. EPA has also required two other members of the LWG to perform early actions at other locations within the Portland Harbor Site.

VII. NW NATURAL'S COSTS OF REMEDIATION

Q. To date, how much has NW Natural spent in connection with the remediation work described in your testimony?

A. As of December 31, 2012, we have spent about $71 million, including legal, investigation, remediation, and monitoring costs. Approximately $10 million of that amount was spent on removal of the tar-like feature in 2005.

Q. What types of remedial actions will likely be required in the future?

A. The goal of clean-up work is to reduce the risks posed by chemicals to humans and the environment to acceptable levels. NW Natural does not have the authority to decide which measures will best achieve that goal on each site; EPA and DEQ will make those decisions. The Feasibility Studies will, however, present viable technical alternatives to the agencies for consideration. Technologies currently available for the upland components of the Gasco, Siltronic, and PGM sites include excavation with offsite disposal, excavation with onsite treatment, *in situ* treatment of soils, capping, subsurface barrier installation, groundwater pumping and water treatment plant operations with offsite discharge, surface water body removal, DNAPL recovery and offsite disposal, engineering controls on existing structures, capping, and institutional controls. Technologies currently available for cleanup of the sediments in the Portland Harbor and PGM sites include dredging with associated surface water containment (*e.g.* silt curtains or sheet pile walls), stabilization capping, *in situ* treatment, monitored natural recovery, enhanced monitored natural recovery, augmented and chemical isolation caps, sediment treatment and stabilization, offsite disposal at a hazardous waste landfill, offsite disposal at a solid waste landfill, bank excavation, and construction mitigation steps.

Q. Has NW Natural projected the costs that may be incurred in the future?

A. We do not have an estimate of our total future costs due to the ongoing nature of our work and the many uncertainties surrounding the agencies' remediation decisions. In NW Natural's 10-K for the year that ended December 31, 2012, we estimated a minimum future liability of about $70 million. Future filings may reflect increased estimates as we gain more information.

Q. For how long will NW Natural incur remediation costs for the Harborwide and PGM Projects?

A. We do not know. The time frame for the Portland Harbor Site as a whole will be determined by EPA decisions that have not yet been made. EPA currently estimates that the ROD for the Portland Harbor will be available in 2015. After that, the design and construction of remedies throughout the Harbor will likely take several years. Operations and maintenance (O&M) and monitoring costs will continue for an undetermined period of time after construction. If post-construction monitoring reveals that a remedy is not effective, EPA will likely require the design and construction of additional remedial measures, which would extend the timeframe over which the Company will incur remediation costs.

We cannot predict the timeframe for the PGM Site because it is still in the Investigation stage.

Q. Will the timeframe over which the Company anticipates incurring remediation costs relevant to the other Projects be different?

A. We anticipate a somewhat shorter timeframe for construction of the Source Control, Gasco Uplands, and Gasco Sediments Projects.

NW Natural began construction of the source control system in October 2012 and we expect to complete that project in 2014. Operation and maintenance of the system is expected to continue for decades.

Remediation of the Gasco Uplands is scheduled to occur next and should be completed before the construction of remedial measures in the Portland Harbor Site.

The Gasco Sediments Project was originally governed solely by the RI/FS Consent Order but, as I described earlier in my testimony, NW Natural entered into a separate order for those sediments in 2009. Under that order, NW Natural will design the Gasco Sediments Project remedy prior to the issuance of EPA's ROD for the Portland Harbor Site and will be prepared to implement that remedy under a Consent Decree with EPA as soon as practicable after the ROD is issued. This approach will minimize the amount of time it will take to resolve the majority of NW Natural's liability. There will, however, be ongoing O&M and monitoring costs as described above and the potential for additional remedial work if the remedies do not work as planned.

Q. In addition to the costs associated with remediation at the Portland Harbor Site, could NW Natural incur other costs associated with that site?

A. Yes. CERCLA and Oregon law also allow designated natural resource trustees to recover monetary damages for injuries to natural resources resulting from hazardous substance releases. Two federal trustees (the National Oceanic and Atmospheric Administration and the U.S. Fish & Wildlife Service), six Tribal trustees, and the Oregon Department of Fish & Wildlife have notified NW Natural and other parties of their intent to seek damages for alleged injuries to natural resources in the Portland Harbor. NW Natural and 22 other parties are participating in a cooperative assessment with the Portland Harbor Trustee Council in an attempt to reach a settlement of the trustees' claims.

VIII. COST CONTAINMENT EFFORTS AND EFFORTS TO RECOVER FROM THIRD PARTIES

Q. Has NW Natural attempted to contain its environmental remediation costs?

A. Yes. Two of the Company's top priorities are to aggressively manage the costs arising from our environmental liability and to maximize recovery from our insurance companies and other PRPs. Our efforts in these areas reflect our commitment to minimize costs at the same that time we comply with applicable law, act as a responsible corporate citizen, meet our customers' expectations, and ensure solid working relationships with regulatory agencies and other stakeholders.

Q. What steps has NW Natural taken to control the costs associated with the remediation of past manufactured gas operations in its interactions with relevant agencies and parties?

A. The Company evaluates each task required by EPA and DEQ for cost effectiveness, environmental benefit, and technical merit before we perform the work. We object to tasks that we believe are unnecessary, technically unsound, or beyond the scope of the agency's jurisdiction or legal authority. Those objections are usually resolved through collaborative negotiations with the agency in question. When we cannot resolve our concerns though negotiations, we invoke the formal dispute resolution mechanisms available under both the DEQ and EPA processes and advocate vigorously for the most cost-effective approach.

Q. **Please describe your formal disputes with the agencies.**

A. I described our successful source control dispute with DEQ earlier in my testimony. We also disputed two EPA staff directives associated with our removal of the tar-like feature adjacent to the Gasco Site. We were unable to convince EPA to allow disposal of the dredged material at a less expensive Subtitle D (non-hazardous waste) landfill but we

argued successfully for a more cost-effective containment system than EPA's project staff had required.

Q. What, if any, role does the LWG play in NW Natural's efforts to control its remediation costs?

A. The LWG has negotiated rates with vendors that are below standard rates. The LWG has also conducted a market analysis to ensure that vendor costs are below market. In addition, the LWG monitors its consultants' work on a regular basis and constantly seeks ways to minimize costs. In 2013, the LWG disputed EPA-directed changes to the Human Health Risk Assessment in part because the changes could have led to higher than necessary remediation costs. The outcome of the dispute led to the production of a final Risk Assessment that both EPA and the LWG can support.

Q. Does NW Natural take internal steps to control its remediation costs?

A. Yes. NW Natural has established a thorough internal process for managing approved tasks and associated costs. Because of the magnitude and complexity of our environmental liabilities, we must maintain a team of highly qualified technical consultants and lawyers. As a result, most of the costs we incur are for external resources.

The long-term nature of our remediation work and the iterative nature of the regulatory process require us to have long-term vendor contracts and purchase orders. When NW Natural's project team identifies a potential vendor, the vendor is directed to NW Natural's Purchasing Department. The Purchasing Department negotiates the terms of the contract, including the rate schedule. The Legal Department reviews the contract to ensure that it meets our standards and requirements. After the contract is executed, we request cost estimates for the work that needs to be done to comply with regulatory requirements. Using the rate schedules in its contract, the vendor provides estimates for the number of hours and materials necessary to perform project tasks. As

the Project Manager, I evaluate these estimates for accuracy and appropriateness. I also review and update all project costs and tasks on a quarterly basis.

Q. Does NW Natural track the spending associated with environmental remediation?

A. Yes. All spending is tracked both by me as the Project Manager and by the Company's Accounting Department to verify that actual costs remain aligned with approved spending limits. Cost tracking includes both project-specific spending as well as spending against the amount the Board of Directors approves each year. NW Natural reports updated estimates of its environmental liabilities quarterly in the 10-Q and annually in the 10-K.

Q. Are the Company's environmental costs subject to outside audit?

A. Yes. The Company provides quarterly cost updates to PricewaterhouseCoopers LLP, which includes those costs in its integrated audit of the Company.

Q. Has NW Natural attempted to recover any of its remediation costs from third parties?

A. Yes. As I mentioned at the beginning of my testimony, Sandra K. Hart's testimony describes the steps NW Natural has taken to recover costs from insurance carriers.

In 2007, the LWG successfully recovered some of its RI/FS costs from PRPs who are not in the LWG and reserved its rights to pursue additional cost recovery in later legal proceedings. NW Natural's share of that recovery was approximately $430,000.

More significantly, NW Natural and 98 other PRPs are participating in a confidential, non-judicial process intended to settle claims for past and future costs related to the Portland Harbor Site. The Company has entered into tolling agreements with approximately 100 additional parties pending the outcome of this settlement process. In April 2009, NW Natural and the other signatories to the RI/FS Consent Order filed litigation in the United States District Court for the District of Oregon against 69 parties who refused to participate in the settlement process or toll claims. Most of

those parties have either joined the settlement process or signed tolling agreements. Those parties have been dismissed from the litigation. Fourteen defendants and one third-party defendant (the United States) remain in the litigation. The federal court has stayed the litigation pending completion of the settlement process.

Finally, NW Natural and Siltronic are working cooperatively to implement the EPA's 2009 Sediment Order under an interim cost sharing arrangement and have entered into tolling agreements in support of settlement discussions related to co-mingled contamination at and from the Gasco and Siltronic operations.

Q. Does this conclude your direct testimony?

A. Yes, it does.

NWN/300
Witness: Sandra K. Hart

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1635

In the Matter of

NORTHWEST NATURAL GAS COMPANY, dba NW Natural,

Mechanism for Recovery of Environmental Remediation Costs.

NORTHWEST NATURAL GAS COMPANY

DIRECT TESTIMONY OF

SANDRA K. HART

March 29, 2013

EXHIBIT 300 – DIRECT TESTIMONY – ENVIRONMENTAL REMEDIATION COST RECOVERY – INSURANCE

Table of Contents

I. INTRODUCTION AND SUMMARY

Q. Please state your name and position with Northwest Natural Gas Company ("NW Natural" or "the Company").

A. My name is Sandra K. Hart. I am the Director of Risk and Land at NW Natural. For the past 13 years, my responsibilities have included the management of the corporate insurance program and environmental insurance recovery.

Q. Please summarize your educational background and business experience.

A. I joined NW Natural in 1985 as an engineer. In 1994, I became Manager of Environmental Services and Occupational Safety, and in 1998 Manager of Risk Environment and Land. Then, in 2009, I became the Director of Risk and Land. I also have experience with environmental site investigation, clean-up and compliance. Prior to joining NW Natural, I worked as an engineer for CH2M Hill. I have a Bachelor of Science degree in Structural Engineering and a Master of Business Administration.

Q. Please summarize your testimony.

A. In my testimony, I:

- Describe the insurance coverage the Company may have to cover the costs of its environmental investigation and remediation of the contamination associated with its historical operations;
- Describe NW Natural's efforts to recover from its historical insurers the costs of the Company's environmental investigation and remediation activities related to past operations; and
- Explain the efforts undertaken by NW Natural to ensure that it achieves the best outcome from its litigation against its insurers, and I explain the status of the insurance recovery litigation.

II. INSURANCE COVERAGE

Q. Please describe what, if any, insurance coverage the Company may have to cover the costs of its environmental investigation and remediation of the contamination associated with its historical MGP operations.

A. From 1929 through 1986, NW Natural carried Excess General Liability (XGL) insurance coverage with various insurance providers—each of which, in NW Natural's view, should be obligated to cover costs associated with its environmental remediation efforts subject to the monetary limits of coverage of their respective insurance policies.

Q. Why does the Company have coverage for environmental remediation only between 1929 and 1986?

A. Prior to the late 1920s, XGL coverage for utilities was generally not available. After 1986, the insurance industry inserted very broad pollution exclusions in their liability policies that exclude coverage for damages associated with most incidents of environmental contamination.

Q. Please describe the levels of coverage provided by the XGL policies the Company maintained between 1929 and 1986.

A. As was typical for utilities and other types of companies during that time period, the XGL policies that NW Natural had in place had varying limits and terms. The total amount of coverage purchased in a given policy year increased over time, from $200,000 in the early 1930s to $40 million in the mid-1980s. In addition, the policies in each of the years attach a self-insured retention (SIR), which acts like a deductible. The amount of the SIR layer also increased over time, from $5,000 in the early 1930s to $250,000 in the late 1970s and $500,000 in 1986. This type of increase in SIR was also typical for utilities and other kinds of companies during this time period. Some of the insurers that issued policies to NW Natural have become insolvent or gone out of business, and, in general, those policies are unavailable for recovery.

Q. What is the potential of obtaining coverage for NW Natural's environmental liabilities from the policies issued by still-solvent insurers?

A. Based on the language of its policies, controlling Oregon law, and the underlying facts, NW Natural believes that each of its historical policies provide coverage for the costs related to the environmental damage that NW Natural is investigating and remediating. However, many of the insurers that issued the policies to NW Natural have refused to provide coverage for the environmental sites and have asserted various defenses to coverage. Nationally, coverage claims relating to remediation costs at environmental sites have been resolved in litigation with mixed results—in some instances the policyholder has prevailed in whole or part, and in other cases the insurer has prevailed in whole or part. Most cases settle prior to verdict because of the uncertainty for each side. In this case, NW Natural cannot predict the outcome of its coverage efforts with certainty.

III. EFFORTS TO RECOVER FROM HISTORICAL INSURERS

Q. What actions has NW Natural taken to obtain payments from these insurance policies?

A. As NW Natural began to learn of its potential environmental liability, the Company undertook efforts to search for, identify, and assemble the historical liability policies that might provide coverage. After NW Natural identified the relevant insurers, the Company provided them notice of its claim for coverage and thereafter kept them informed of ongoing investigation and remediation efforts.

Q. Has the Company made efforts to resolve its claims?

A. Yes. In 2007, NW Natural issued settlement demands to most of the insurers. In 2008, NW Natural withdrew its original demands and then issued revised, higher demands because of Environmental Protection Agency (EPA) actions and positions on some sites that had the potential of driving NW Natural's costs higher. By late 2009, NW Natural

had met with most of its historical insurers to discuss settlement and determined that they were not willing to engage in serious negotiations. Therefore, NW Natural decided to initiate litigation to enforce its right to coverage. In December of 2010, NW Natural filed litigation against its insurers in Multnomah County Circuit Court. The Company filed a First Amended Complaint on January 3, 2011. See Exhibit NWN/301, Hart/1-18.

Q. What remedy is NW Natural seeking from these insurance companies?

A. We are seeking insurance recovery of past investigation and remediation costs, and a declaratory judgment that the insurers are responsible for covering the investigation and remediation costs incurred in the future.

IV. EFFORTS UNDERTAKEN TO ENSURE BEST OUTCOME

Q. What efforts has NW Natural taken to ensure that it achieves the best outcome from its litigation against its insurers?

A. NW Natural conducted a national search for counsel to prosecute its claims. The Company invited eight law firms from across the country, with established and well-regarded insurance recovery practices, to submit proposals to NW Natural detailing their relevant experience and proposed approaches. After screening the proposals, the four firms with the strongest proposals were invited to make presentations to NW Natural's management. Based on the presentations, the written proposals and comments from references, K&L Gates LLP emerged as the strongest firm. K&L Gates is a large, international law firm, with offices throughout the country, including Portland. K&L Gates has a group of lawyers located in its Pittsburgh office that have specialized in litigating environmental coverage claims for over 20 years, with substantial experience handling these types of claims for utilities. For example, K&L Gates obtained a trial verdict on behalf of Washington Natural Gas Company requiring its historical insurers to pay all of that company's environmental investigation and remediation costs arising from a former manufactured gas plant in Tacoma.

Q. Are settlement discussions continuing with the insurance companies even during the litigation?

A. Yes. Moreover, in early March, eleven of the parties participated in in a four day mediation session.

Q. Have these discussions led to any settlements being reached?

A. Yes. To date, a settlement agreement was reached with one insurer, Aegis. Also, as a result of the mediation, NW Natural reached a settlement in principle with General Reinsurance Corporation, Munich Reinsurance America, Inc., Allianz Global Risks US Insurance Company, and Allianz Underwriters Insurance Company. Actual and final settlement is contingent on the parties reaching agreement on all of the terms of a written settlement agreement.

Q. What is the current schedule for resolving the litigation?

A. The Court Scheduling Order calls for the case to be tried in two phases. The first trial began on November 19, 2012 and concluded in early December, 2012. The first trial principally addressed the existence and terms of 37 policies issued by the London Market insurers and two policies issued by St. Paul, with a total $18.7 million in per occurrence limits. The judge ruled that NW Natural "has satisfied its issue in the trial." Consequently, NW Natural has proven that it is entitled to an additional $17.5 million in per occurrence limits that the insurers claimed did not exist. The second trial is scheduled to begin on June 3, 2013 and conclude by the end of the summer. This trial will cover all remaining issues. If the trial schedule is delayed or the losing party appeals the trial court decision, the resolution of the litigation will be delayed.

Q. Does this conclude your direct testimony?

A. Yes, it does.

NWN/301
Witness: Sandy Hart

BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UM 1635

NW NATURAL

Exhibit Accompanying Direct Testimony of Sandy Hart

First Amended Complaint of NW Natural
In Docket 1012-17532

March 29, 2013

IN THE CIRCUIT COURT OF THE STATE OF OREGON

FOR THE COUNTY OF MULTNOMAH

NORTHWEST NATURAL GAS COMPANY d/b/a NW NATURAL,

Plaintiff,

v.

ASSOCIATED ELECTRIC & GAS INSURANCE SERVICES LIMITED (f/k/a General Assurance Services Limited), ALLIANZ GLOBAL RISKS US INSURANCE COMPANY (f/k/a Allianz Insurance Company), ALLIANZ UNDERWRITERS INSURANCE COMPANY (f/k/a Allianz Underwriters, Inc.), CARDIF PROPERTY AND CASUALTY INSURANCE COMPANY (f/k/a Industrial Underwriters Insurance Company), CENTURY INDEMNITY COMPANY (for itself and as successor-in-interest to CIGNA Specialty Insurance Company, formerly known as California Union Insurance Company), CONTINENTAL CASUALTY COMPANY, THE CONTINENTAL INSURANCE COMPANY (as successor-in-interest to Harbor Insurance Company), GENERAL REINSURANCE CORPORATION, MUNICH REINSURANCE AMERICA, INC. (f/k/a American Re-Insurance Company), ST. PAUL FIRE AND MARINE INSURANCE COMPANY, SEATON INSURANCE COMPANY (f/k/a Unigard Security Insurance Company f/k/a Unigard Mutual Insurance Company), STONEWALL INSURANCE COMPANY, CERTAIN UNDERWRITERS AT LLOYD'S, LONDON, CERTAIN LONDON MARKET INSURANCE COMPANIES: ACCIDENT & CASUALTY INSURANCE COMPANY, ADRIATIC INSURANCE COMPANY LTD., THE

No. 1012-17532

FIRST AMENDED COMPLAINT (Declaratory Relief and Breach of Contract)

DEMAND IN EXCESS OF $50,000

CLAIM IS NOT SUBJECT TO COURT ADMINISTERED ARBITRATION

DEMAND FOR JURY TRIAL

K&L GATES LLP
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ALBA GENERAL INSURANCE COMPANY LTD., ANGLO-FRENCH INSURANCE COMPANY LIMITED, BISHOPSGATE INSURANCE COMPANY LIMITED, BRITISH AVIATION INSURANCE COMPANY LTD., BRITISH NORTHWESTERN INSURANCE CO., LTD., BRITISH RESERVE INSURANCE COMPANY LIMITED, CHARTIS PROPERTY CASUALTY COMPANY (f/k/a Birmingham Fire Insurance Company), CIA AGRICOLA DE SEGUROS S.A., CONTINENTAL INSURANCE COMPANY, CX REINSURANCE COMPANY LIMITED, (f/k/a CNA Reinsurance of London), THE DOMINION INSURANCE COMPANY LIMITED, EDINBURGH ASSURANCE COMPANY LIMITED, ENNIA (UK), L'ETOILE, EXCESS INSURANCE COMPANY LIMITED, FIDELIDADE INSURANCE COMPANY OF LISBON, GENERALI-ASSICURAZIONI GENERALI S.P.A. (f/k/a Assicurazioni Generali di Trieste e Venezia), GENERALI FRANCE ASSURANCES, S.A. (f/k/a La Concorde), GENERAL INSURANCE CO. HELVETIA LIMITED, HELVETIA-ACCIDENT SWISS INSURANCE COMPANY LTD., HISCOX INSURANCE COMPANY LIMITED (f/k/a Economic Insurance Company Limited), INSCO LIMITED, INSURANCE COMPANY OF NORTH AMERICA, LLOYD ITALICO, THE LONDON & EDINBURGH INSURANCE COMPANY LIMITED, LONDON & HULL MARITIME INSURANCE COMPANY LIMITED, MARKEL INTERNATIONAL INSURANCE COMPANY LIMITED (f/k/a Terra Nova Insurance Company Limited), NATIONAL CASUALTY COMPANY OF AMERICA LTD., NATIONAL CASUALTY COMPANY, NATIONAL SECURITY, PRUDENTIAL CITY, RIVER THAMES INSURANCE COMPANY, ROAD TRANSPORT & GENERAL INSURANCE COMPANY LIMITED, LA ROYALE BELGE S.A. D'ASSURANCES, THE ROYAL

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SCOTTISH INSURANCE COMPANY LIMITED, THE SCOTTISH LION INSURANCE COMPANY LIMITED, SEGUROS LA REPUBLICA, SOMPO JAPAN INSURANCE INC. (f/k/a Yasuda Fire and Marine Insurance Company (U.K.) Limited), STRONGHOLD INSURANCE COMPANY LTD., THE SWISS NATIONAL INSURANCE COMPANY LTD., THREADNEEDLE INSURANCE COMPANY LTD., TIG INSURANCE COMPANY (as successor-in-interest to International Insurance Company), TRENT INSURANCE COMPANY LIMITED, TUREGUM INSURANCE COMPANY LTD., ULSTER MARINE INSURANCE COMPANY LIMITED, L'UNION DES ASSURANCE DE PARIS, UTILITY SERVICES INSURANCE COMPANY LTD., THE WORLD AUXILIARY INSURANCE CORPORATION LTD., and JOHN DOES 1-5,

Defendants.

Plaintiff Northwest Natural Gas Company, d/b/a NW Natural ("NW Natural"), hereby files this First Amended Complaint against various historical insurers of NW Natural identified below (collectively, the "Insurers"), and alleges as follows:

INTRODUCTION

1.

This is an insurance coverage action for declaratory relief pursuant to Oregon's Uniform Declaratory Judgments Act, OR. REV. STAT. ANN. § 28.010, *et seq.* (2010), and for breach of contract.

2.

NW Natural seeks a declaration that it is entitled to insurance coverage under the insurance policies issued by the Insurers to NW Natural identified on Exhibit 1 (hereinafter, the "Subject

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Policies"). More specifically, NW Natural seeks a declaration that the Insurers must indemnify and reimburse NW Natural for certain amounts arising from liabilities and losses incurred by NW Natural as a result of alleged environmental property damage existing at the sites identified below. A declaratory judgment is necessary to resolve disputes between NW Natural and the Insurers regarding their respective obligations under the Subject Policies to indemnify and reimburse NW Natural regarding such liabilities and losses.

3.

In addition, NW Natural seeks relief and damages based upon the Insurers' breach of their obligations under their respective Subject Policies by failing to provide insurance coverage to NW Natural for liabilities and losses it has incurred and will incur in the future as a result of alleged environmental property damage existing at the sites identified below.

PARTIES

A. Plaintiff

4.

NW Natural is a public utility corporation organized under the laws of the state of Oregon and having its principal place of business in Portland, Oregon.

5.

NW Natural's corporate history dates back to the founding of Portland Gas Light Company in 1859 and its incorporation in October 1862.

6.

In 1892, Portland Gas Company was formed. At or about that time, Portland Gas Company purchased and combined Portland Gas Light Company and East Portland Gas Light Company, which had been incorporated in September 1882.

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7.

In 1910, Portland Gas Company was sold to American Power and Light Company of New York City. The company was reorganized under the name Portland Gas and Coke Company ("PG&C") and incorporated under Oregon law.

8.

By 1951, American Power and Light Company sold its holdings in PG&C, which became a publicly traded company.

9.

In December 1957, PG&C changed its name to Northwest Natural Gas Company.

B. The Insurers

10.

The Insurers are insurance companies, persons or entities that, during all relevant time periods, engaged in the business of providing insurance coverage to customers, including NW Natural under, *inter alia*, the Subject Policies, and/or were authorized to conduct insurance business in Oregon.

11.

The Insurers that issued the Subject Policies to NW Natural listed on Exhibit 1 hereto, and the Insurers' respective places of incorporation and principal places of business, to the extent known or believed, are identified on Exhibit 2 hereto. True and correct copies of excerpts of each of the Subject Policies, to the extent that NW Natural has located such to date, are attached hereto as Exhibit 4 as substitutes for the actual policies, which are too voluminous to attach to this Complaint. Copies of such policies will be made available upon request.

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12.

Defendants, Certain Underwriters at Lloyd's, London, who have participated in, subscribed to, or have reinsured-to-close, directly or indirectly, the syndicate-years-of account identified on Exhibit 3 hereto ("Underwriters"), are those individuals residing in countries around the world, including in various states in the United States, who have subscribed to, or have reinsured-to-close, directly or indirectly, the Subject Policies issued to NW Natural by Underwriters including those identified on Exhibit 3 hereto.

13.

Defendants, John Does 1 through 5 are individuals or entities that have issued the Subject Policies and/or other policies to NW Natural during the relevant time period and whose identities are unknown at this time. These John Does may include individuals residing in countries around the world, including in various states in the United States who have subscribed to, or have reinsured-to-close, directly or indirectly, the Subject Policies issued to NW Natural by Underwriters, including those identified on Exhibits 1 and 3 hereto. Upon identification of those individuals or entities, NW Natural will amend this Complaint to identify them specifically.

C. Jurisdiction and Venue

14.

This Court has personal jurisdiction, pursuant to the Oregon Rules of Civil Procedure, Rule 4, over the Insurers named herein because, upon information and belief, such parties:

(a) are or were licensed or authorized to do business in Oregon;

(b) have, within the relevant time periods, transacted business in Oregon, including the selling of insurance in Oregon, the assumption of insurance policies covering risks in Oregon and/or handling of insurance claims involving risks located in Oregon;

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(c) have agreed in the policies that they have issued or subscribed to in favor of NW Natural to submit to the jurisdiction of any court of competent jurisdiction within the United States, to comply with all requirements necessary to give such court jurisdiction and to have all matters arising under their policies determined in accordance with the law and practice of such court;

(d) have realized, and sought to realize, pecuniary benefit from their business activities in Oregon;

(e) have made, and continue to make, business decisions which have a direct and substantial impact in Oregon; and/or

(f) have authorized agents to transact business in Oregon on their behalf.

15.

To the extent that any Insurer sued in this action is a foreign state or an instrumentality of a foreign state within the meaning of 28 U.S.C. § 1603 (1994), for purposes of this case, NW Natural releases and waives in their entirety any claims that it may have against any such Insurer for claims made in this action.

16.

Venue is proper in this Court because NW Natural and the Underlying Environmental Sites described herein as to which NW Natural seeks coverage are located in Multnomah County, Oregon.

NATURE OF THE CAUSES OF ACTION

17.

From approximately 1860 through 1956, NW Natural's predecessors-in-interest ("NW Natural's predecessors") operated various facilities that manufactured, stored and/or

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distributed gas and various by-products. As they relate to the causes of action brought herein, these facilities may be characterized as former manufactured gas plant ("MGP") sites and former remote gas holder stations associated with the MGPs. Various residuals from the operation of each of these facilities have allegedly caused environmental damage to the soil at, and the groundwater beneath, the sites of these facilities, as well as to the soil, groundwater, sediments, and/or natural resources at other sites, including the Portland Harbor Site. These sites, and other environmental sites identified herein, shall collectively be referred to herein as the "Underlying Environmental Sites."

18.

NW Natural is liable or allegedly liable under the laws of the State of Oregon and/or the United States to investigate and remediate alleged environmental contamination and property damage occurring at and around each of the Underlying Environmental Sites. NW Natural is currently investigating and remediating such contamination and property damage pursuant to orders and directives of, or agreements with, the Oregon Department of Environmental Quality ("ODEQ") under Oregon law and the United States Environmental Protection Agency ("USEPA") under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §§ 9601 *et seq.* (1995) ("CERCLA"), including natural resource damages ("NRD") pursuant to sections 107 (a)(4)(A) and (C) of CERCLA at certain of the Underlying Environmental Sites. Pursuant to these authorities, NW Natural has been required to pay, and will in the future be required to pay, monies to investigate and remediate the Underlying Environmental Sites.

19.

In breach of the Subject Policies, the Insurers have failed to reimburse and indemnify NW Natural's costs for its investigation and remediation of the Underlying Environmental Sites.

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A. The MGP Sites and Related Gas Holder Stations

20.

NW Natural's predecessors owned and operated the following MGPs (the "MGP Sites"):

(a) **Portland MGP Site** – This facility was located on an approximately 6 acre area in downtown Portland presently bounded by NW Flanders St. to the north, the Willamette River to the east, NW Everett St. to the south, and NW 2nd Avenue to the west. The gas plant began operations in 1860 and ceased operations in 1913. Related gas holder stations include the one located at NW 6th Avenue and NW Flanders Street in Portland and the one located at NW Couch Street and NW 14th Avenue in Portland.

(b) **East Portland MGP Site** – This site was located on an approximately 12,000-square foot area at the southwest corner of SE 3rd Avenue and SE Ankeny Street. The MGP operated at this site from approximately 1883 until 1892.

(c) **GASCO Site** – This site is located on NW St. Helens Road in Linnton, Oregon and occupies approximately 90 acres. PG&C purchased the property in 1910 and NW Natural still owns approximately 45 acres of the property today. The remainder of the property has been owned by Siltronic Corporation since 1978. The MGP manufactured gas at this site from 1913 to 1956. A third-party operated a tar distillation and refining plant on the site after 1956. Related gas holder stations included one located at N. Alberta and N. Kerby Avenue in Portland and three gas holders located at 2630 SE 9th Avenue in Portland, which is now the location of NW Natural's Central Service Center.

21.

The foregoing former MGP facilities used different processes to manufacture gas for distribution to individual customers, businesses and municipalities.

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22.

In manufacturing gas, these MGP facilities generated various residuals, including, but not limited to, tars and lampblack. At each of the Underlying Environmental Sites, these and other residuals relating to the gas manufacturing processes are alleged to be present in the soil, groundwater, surrounding sediments and/or natural resources. Under the authorities identified above, NW Natural is liable for the investigation and remediation of these Sites.

B. Other Sites

23.

At various times, residuals from NW Natural's predecessors' MGP Sites were allegedly discharged or released at, or migrated to, other sites as identified below (the "Other Sites") and those residuals are alleged to be present in the soil, groundwater, sediments, natural resources, and/or surrounding property. Under the authorities identified above, NW Natural is liable for the investigation and remediation of these sites.

24.

The Other Sites are as follows:

(a) **The Portland Harbor Site** – This site encompasses the Portland Harbor Study Area and is located along a 9.9-mile long reach of the lower Willamette River between downtown Portland and 2 miles upstream of the confluence with the Columbia River. The GASCO Site is located along the western bank of the lower Willamette River between mile 6 and 7.

(b) **Oregon Steel Mills Site** – This site is located at 14400 N. Rivergate Boulevard in Portland, Oregon. The property is approximately 145 acres and was used by the US Army Corps of Engineers and the Port of Portland to dispose of dredged material from the Willamette River from the 1940s to the 1960s. The site also involved a disposal facility operated

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by the Port of Portland and Shaver Transportation at which NW Natural is alleged to have disposed of MGP wastes. Oregon Steel Mills, Inc. sued the Port of Portland in 2002 for past remediation response costs, for contribution, and for declaratory relief for future costs. The Port of Portland filed claims against 11 third-party defendants, including NW Natural, based on the alleged disposal of wastes associated with the GASCO facility.

(c) **Central Service Center Site** – This site, originally the location of three gas holders related to the GASCO Site, was redeveloped in 1978 for NW Natural's Central Service Center. In addition to MGP-related residuals, other residuals from the operation of the Central Service Center are alleged to be present in the soil, groundwater, surrounding sediments and/or natural resources.

25.

On December 1, 2000, the Portland Harbor Site was designated a Superfund Site and in February 2001, the ODEQ, USEPA and other governmental parties signed a memorandum of agreement for the management of this site.

26.

NW Natural is named as a Potentially Responsible Party regarding the Portland Harbor Site as the GASCO Site is an alleged source of contamination to the harbor.

27.

The USEPA is also seeking to impose additional liability on NW Natural under federal law for response costs and/or NRD at the Portland Harbor Site pursuant to sections 107(a)(4)(A) and (C), respectively, of CERCLA, which NRD is "property damage" under the Subject Policies.

28.

The underlying environmental claims and liabilities relating to the Underlying

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Environmental Sites - MGP Sites and Other Sites - shall be collectively referred to herein as the "Underlying Environmental Claims."

29.

NW Natural has been legally obligated to expend in excess of $40 million in connection with investigation and remediation of the Underlying Environmental Claims. Further, based on the information currently available, NW Natural believes and avers that it will incur millions of dollars more in investigating and remediating the Underlying Environmental Claims in the future.

C. The Subject Policies Issued to NW Natural

30.

At various times during the period from at least 1938 through 1986, the Insurers, in consideration of premiums paid by or on behalf of NW Natural, sold policies of excess liability insurance to NW Natural. Attached hereto as Exhibit 1 is a list of the Subject Policies sold by each Insurer to NW Natural, along with the relevant policy numbers and policy periods.

31.

By issuing the Subject Policies, the Insurers undertook, among other things, to indemnify NW Natural in connection with liabilities, and related costs, arising from property damage, such as the Underlying Environmental Claims.

COUNT ONE: DECLARATORY JUDGMENT

32.

The averments in each of the preceding paragraphs are incorporated by reference as if fully set forth herein at length.

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33.

NW Natural's actual and potential liability arising out of the Underlying Environmental Claims, as well as NW Natural's costs of defending against such claims, is within the coverage provided by the Subject Policies.

34.

With respect to NW Natural's liability arising out of the Underlying Environmental Claims, an accident or occurrence, or personal injury, or property damage or other triggering event within the meaning of the Subject Policies has taken place at each of the Underlying Environmental Sites during the policy periods of the Subject Policies.

35.

All conditions precedent, if any, to recovery under the Subject Policies have been satisfied, waived or are otherwise inapplicable.

36.

To date, the Insurers have failed to provide coverage under the Subject Policies.

37.

An actual controversy currently exists among NW Natural and the Insurers regarding the Insurers' duties and obligations under the Subject Policies. Specifically, NW Natural contends, and, upon information and belief, Insurers apparently dispute, that:

(a) Each Insurer has a duty to indemnify and pay all sums that NW Natural is obligated to pay by reason of the Underlying Environmental Claims, subject to its policies' limits of liability, and each Insurer is jointly and severally liable for such sums up to the limit of its policies;

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(b) Through their policies, the Insurers have a duty to reimburse NW Natural for costs arising from NW Natural's defense of the Underlying Environmental Claims, and each Insurer is jointly and severally liable for such costs, subject to the limits of its policies; and

(c) NW Natural is entitled to select the insurance policy(ies) and policy years that it will access to provide coverage to NW Natural such defense and/or indemnity payments.

38.

A determination by this Court of the respective rights, duties, and obligations of NW Natural and the Insurers is necessary and proper to terminate some or all of these disputes and controversies and/or to avoid prejudicing NW Natural's rights with respect to the Insurers and to allow the parties the opportunity to assess their respective positions.

39.

Pursuant to Oregon's Uniform Declaratory Judgments Act, OR. REV. STAT. ANN. § 28.010, *et seq.* (2010), NW Natural is entitled to a declaration by this Court of its rights and the Insurers' duties, and a judicial declaration is necessary as to NW Natural's rights and the Insurers' duties, regarding the Underlying Environmental Claims.

WHEREFORE, NW Natural demands judgment in its favor against Insurers:

(a) declaring and adjudging the rights and obligations of the parties under the Subject Policies with respect to NW Natural's past and future liabilities and related expenses arising from the Underlying Environmental Claims;

(b) requiring each Insurer on a joint and several basis to indemnify NW Natural for, or pay on behalf of NW Natural, all liability, loss, and/or expense, including defense costs, caused by reason of the Underlying Environmental Claims;

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(c) enjoining the Insurers from failing and refusing to indemnify NW Natural for, or pay on behalf of NW Natural, all liabilities, losses and expenses that have been and will be incurred with respect to any such Underlying Environmental Claim;

(d) granting NW Natural specific performance of the contracts of insurance issued by the Insurers;

(e) for money damages in an amount to be determined at trial, together with prejudgment and post-judgment interest;

(f) for costs of suit;

(g) for all counsel fees, expert fees and other costs relating to the litigation of this matter; and

(h) for such other and further relief, including any appropriate equitable relief, as the Court may deem just and proper.

COUNT TWO: BREACH OF CONTRACT

40.

The averments in each of the preceding paragraphs are incorporated by reference as if fully set forth herein at length.

41.

The Insurers accepted premiums from NW Natural and issued the Subject Policies promising, among other things, to indemnify NW Natural for liabilities and related costs and expenses, such as those arising from the Underlying Environmental Claims.

42.

NW Natural has already incurred financial losses in excess of $40 million arising out of the Underlying Environmental Claims.

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43.

All conditions precedent, if any, to recovery under the Subject Policies have been satisfied or waived.

44.

With respect to such financial losses, the Insurers, in breach of their respective insurance policies, have failed to provide NW Natural with indemnification as required under the terms of the respective Subject Policies.

45.

By their actions, the Insurers have acted in a manner inconsistent with the terms and conditions of the Subject Policies such as to constitute a breach of those Policies.

46.

As a result of the Insurers' breach of their respective insurance policies by wrongfully failing to accept responsibility pursuant to the terms and conditions of the policies, the Insurers are liable to NW Natural for damages, in an amount yet to be ascertained, for all costs, both disbursed and incurred to date, and to be incurred in the future, in connection with the liabilities and the investigation and remedial work performed at the Underlying Environmental Sites, together with the costs and disbursements of this action, including, but not limited to, reasonable attorney's fees and pre-judgment and post-judgment interest.

WHEREFORE, NW Natural demands judgment in its favor against the Insurers:

(a) requiring each Insurer to indemnify NW Natural for, or pay on behalf of NW Natural, all liabilities and expenses caused by reason of the Underlying Environmental Claims;

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(b) enjoining the Insurers from failing and refusing to indemnify NW Natural for all liabilities and expenses that have been and will be incurred with respect to any such claim;

(c) granting NW Natural specific performance of the contracts of insurance issued by the Insurers;

(d) for money damages in an amount to be determined at trial, together with pre-judgment and post-judgment interest;

(e) for costs of suit;

(f) for all counsel fees, expert fees and other costs relating to the litigation of this matter; and

(g) for such other and further relief, including any appropriate equitable relief, as the Court may deem just and proper.

DEMAND FOR JURY TRIAL

Pursuant to Oregon Rules of Civil Procedure 50 and 51, NW Natural hereby demands a trial by jury as to all counts set forth in the above Complaint.

DATED this 3rd day of January 2011.

K&L GATES LLP

By Laura R. Salerno

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NWN/400
Witness: Andrew Middleton

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1635

In the Matter of

NORTHWEST NATURAL GAS
COMPANY, dba NW Natural,

Mechanism for Recovery of
Environmental Remediation Costs.

NORTHWEST NATURAL GAS COMPANY

DIRECT TESTIMONY OF

ANDREW MIDDLETON

March 29, 2013

EXHIBIT 400 – DIRECT TESTIMONY - ENVIRONMENTAL REMEDIATION HISTORY

Table of Contents

I. INTRODUCTION AND SUMMARY

Q. Please state your name and position.

A. My name is Andrew C. Middleton. I am President of Corporate Environmental Solutions LLC.

Q. On whose behalf are you appearing in this proceeding?

A. I am appearing on behalf of Northwest Natural Gas Company ("NW Natural" or the "Company").

Q. Please describe your educational and professional background.

A. I hold a Bachelor of Science degree in Civil Engineering from Virginia Polytechnic Institute and State University (awarded 1971), a Master of Science degree in Sanitary Engineering from Virginia Polytechnic Institute and State University (awarded 1972), and a Ph.D. in Environmental Engineering from Cornell University (awarded 1975). Since 1975, I have taught environmental engineering at universities, worked for industry on environmental matters, and worked as an environmental consultant.

My industrial experience included a large number of environmental projects on facilities involving the production, processing, and handling of tar and tar chemicals, including ones on industrial wastewater treatment and industrial site investigation and remediation. As an environmental consultant, I have worked on at least 300 manufactured gas plant (MGP) sites, including visits to at least 145 sites. My scope of work on the vast majority of the 300 sites included a review of historical information about them. In the course of my research concerning these 300 MGPs and the manufactured gas industry in general, I have also seen and reviewed information concerning numerous other plants. I have testified on six occasions before public utility commissions regarding manufactured gas plants. I have also testified about MGPs in a number of lawsuits across the United States in depositions and affidavits, as well as twice in court where the courts recognized me as an expert on manufactured gas plants.

At *NWN/404, Middleton, 1-16* is my curriculum vitae describing my background in more detail.

Q. Please summarize your testimony.

A. In my testimony, I:

- Review the history and evolution of the manufactured gas industry—how and why it developed, its general characteristics, and why it declined;
- Identify the major gas manufacturing processes and the residual streams generated in gas manufacture;
- Describe the demolition and dismantling practices of gas plant equipment and vessels; and,
- Describe the state of gas industry knowledge regarding the potential environmental consequences, as understood today, of
    - the operation of manufactured gas plants;
    - the disposition of residuals from gas manufacture; and,
    - the demolition and dismantling of manufactured gas plants.

Second, my purpose is to:

- Review the history of gas manufacture in Portland at MGP sites now connected with NW Natural ("Portland MGP Sites");
- Identify the residual streams generated by this gas manufacture and the disposition of those streams;
- Describe the demolition and dismantling of the gas manufacturing and storage facilities in Portland; and,
- Compare these to the practices of the gas industry during the comparable time frames.

II. HISTORY OF THE MANUFACTURED GAS INDUSTRY

Q Please provide an overview of the history of gas manufacture in the United States.

A. Although "gas" was first named in 1609, the first gas company was not founded until over 200 years later in London in 1812. The first U.S. gas company was founded in Baltimore in 1816. A century later, by 1920, the U.S. had over 1,000 manufactured gas companies. However, by 1970, utility-owned or operated manufactured gas plants were almost non-existent, with manufactured gas having been replaced by natural gas across the U.S. The 150-year period from 1816 until the mid-1960s defines the era of manufactured gas ("MGP Era").

During the MGP Era, the U.S. manufactured gas industry began, matured, and ended. Various gas-making processes, gas storage vessels, and gas purification equipment were developed and modified throughout much of the MGP Era.

Q. How was gas manufactured?

A. Three types of gas-making processes generally dominated the manufacture of gas in the United States during the MGP Era: coal gas, carburetted water gas (also known as just "water gas") and oil gas. Coal gas manufacture, which began in 1816, had two primary process configurations: retorts and byproduct coke ovens. In either case, bituminous coal was heated to a high temperature in a closed vessel in the absence of air. This resulted in the volatile portion of the coal being driven off as gas which was cooled and purified through various processes. Retorts were smaller vessels more widely used by the gas industry than the larger coke ovens. The purified gas was stored in gas holders prior to its distribution. The remaining part of the coal was coke, which was a high carbon material used as fuel, in metallurgical processes, or as feedstock to the carburetted water gas process. Coal gas was manufactured in retorts at two of the Portland MGP Sites.

Carburetted water gas manufacture, which began in the 1870s, made gas from coal or coke and oil in three cylindrical vessels. The process was cyclical alternating in vessel heating and in making gas. By the early 1900s, the carburetted water gas process was widely used in the gas industry. As with coal gas, the carburetted water gas was cooled and purified before storage. Carburetted water gas was manufactured at one of the Portland MGP Sites.

Oil gas manufacture had three general process configurations: small-scale oil gas, West Coast oil gas and high-Btu oil gas.[1] These processes made gas from oil or a fraction of oil often in conjunction with the use of steam. There were many equipment configurations for the small scale oil gas process, which was used predominantly in the 1800s, but not at the Portland MGP Sites. The West Coast oil gas ("Oil Gas") process was used in major installations beginning around 1900 on the West Coast and continuing throughout the MGP Era. This process relied on one or two vessels operated in alternate heating and gas making cycles. The hot gas was cooled and purified before storage. The other major oil gas process was the high Btu oil gas process used later in the MGP Era. This process relied on Oil Gas equipment or modified carburetted water gas equipment. It operated similarly to the Oil Gas process, but the feedstocks were manipulated to produce a heat content of around 1000 Btu so that it could be mixed with natural gas in contrast to the other major processes, which produced gas with a heat content in the range of 500-600 Btu. Oil Gas was manufactured at two of the Portland MGP Sites and high Btu oil gas at one site.

[1] It should be noted that in this document "Btu" stands for British thermal unit, which is a measure of heat content. As used here, "Btu" generally means the heat content of the gas per cubic foot of gas. For example, a reference to "530 Btu gas" means that the heat content of the gas was 530 British thermal units per cubic foot of gas, which was generally the approximate Btu value of manufactured gas. Natural gas has a Btu value of around 1000. High-Btu oil gas had a Btu value around 1000 to be compatible with natural gas.

More detailed descriptions of retort coal gas, carburetted water gas, and Oil Gas are provided below in regard to the types of processes that were used at the Portland MGP Sites.

In addition, there were at times other gas-making processes used less frequently than those discussed above (*e.g.*, refinery gas reforming, small-scale oil gas manufacture, petroleum coking, or rosin gas manufacture). Petroleum coking was used at one of the Portland MGP Sites and is described below in regard to that site.

Q. What was generated by gas manufacture in addition to the gas itself?

A. In addition to gas, the gas-making processes also generated solid and liquid residuals. Depending on the particular gas-making process, these residuals included tar, lampblack, light oil, ammonia, ash, clinker, residuals from sulfur removal, and/or wastewater.

Q. How was manufactured gas purified?

A. After its manufacture by one of the above processes, gas was purified to recover byproducts and to remove residuals not suitable to be distributed with the gas. *NWN/401, Middleton/1* is a general overview of a typical gas manufacture process diagram showing purification steps. As described above, the first step in purification of the hot gas was its quenching (*e.g.*, hydraulic main for coal gas and wash box for carburetted water gas and Oil Gas). Further removal of tar not removed in the quench step was accomplished generally by the use of condensers and scrubbers. Additional equipment, such as tar extractors or Cottrell precipitators, was used at some plants as it became commercially available. At coal gas plants, ammonia removal, typically through water absorption, was the next step. At some coal gas plants, absorption of ammonia into sulfuric acid was used. Depending on the process and scale of operation, light oil and naphthalene may have also been removed typically by oil scrubbing.

The most common last step before gas storage was hydrogen sulfide removal. Prior to the 1880s, lime absorption was the typical process. In the 1880s and afterwards, iron-oxide beds became the dominant process. Around 1920 and afterwards, some larger plants used liquid sulfur removal. In the case of coal gas and Oil Gas plants using crude oil, hydrogen sulfide removal also accomplished cyanide removal from the gas.

After hydrogen sulfide removal, the gas went into storage prior to its distribution.

Q. How was gas stored?

A. There were three general types of gas holders used to store gas: 1) low-pressure, water-seal; 2) waterless, low-pressure; and, 3) high-pressure.

The low-pressure, water-seal gas holder consisted of a water tank, the holder itself, which could have had multiple telescoping lifts, and structural components and piping equipment. *NWN/402, Middleton/1* is a picture of a low-pressure, water-seal holder with an above-ground steel water tank. The water tank was filled with water which sealed the gas within the holder. The holder itself moved up and down within its superstructure as gas was added or removed from it.

The waterless, low-pressure holder consisted of a very large, vertical tank with a disk floating on the gas inside. The purpose of the disk was to contain and pressurize the gas. The disk moved up and down in the interior of the tank as gas was added and removed, respectively. The seal between the perimeter of the disk and the inside of the holder was typically wetted with recirculating tar.

High pressure holders were either spherical (*e.g.*, the Hortonsphere), horizontal cylinders (a.k.a. "bullet tanks" like current propane storage cylinders) or vertical cylinders. These tanks received gas from compressors and stored the gas at higher pressures (*e.g.*, 30-60 pounds per square inch) than the low-pressure holders. These

were mechanically sealed, pressurized tanks in contrast to the low pressure, water-seal holders.

Gas holders ranged in size from small (*e.g.*, 25,000 cubic feet in an early low-pressure water seal) up to very large (*e.g.*, 20 million cubic feet for waterless holders of the 1920s and afterwards).

Q. What was the general disposition of residuals from gas manufacture?

A. The gas-making processes produced various residuals in addition to manufactured gas. Residuals included both byproducts and wastes. Byproducts were materials that could be sold or beneficially used at the MGP. Wastes were the converse—materials that could not be sold or used beneficially. There were three general methods for disposition of these residuals:

- Sale or Use as Byproducts: Various markets existed at different times for byproducts. These markets changed according to external factors. Byproducts could also be used by a gas company directly or as feedstocks to other manufacturing processes to create more valuable byproducts.
- Use as Fuel: If residuals had sufficient energy content and had physical and chemical characteristics that could reasonably facilitate use as fuel, they could be burned to generate heat for the gas manufacturing process or in the boiler house to generate steam.
- Disposal: If residuals could not be sold or used as byproducts or fuel, they became wastes for disposal.

The viability of byproduct recovery was dependent on several factors, including: economical technologies had to be available to recover byproducts that would meet market specifications; sufficient quantities of material had to be produced to warrant recovery; and there had to be a market for the byproducts. The principal motivation for byproduct recovery was to generate added revenue, reducing the cost of gas to the

consumer, thereby making manufactured gas less costly. As part of their oversight role on behalf of the gas consumer, public service commissions often received reports on the recovery and sale or use of byproducts from manufactured gas companies within their respective jurisdictions.

Q. What was the typical disposition of coke?

A. Coke from coal carbonization was a high-carbon content byproduct sold for use as fuel or in metallurgical processes or used as fuel at the MGP or at the MGP as feedstock to the carburetted water gas process. Petroleum coke was a high-carbon, low-ash coke that was sold, for example to be used in the manufacture of aluminum.

Q. What was the typical disposition of tar?

A. Tar from any of the processes was a byproduct sold for use in making commercial products (*e.g.*, road tar and tar chemicals), used as fuel at the MGP, or used as a feedstock for producing commercial products at the MGP (*e.g.*, road tar and tar chemicals). As necessary, tar was dehydrated where practical, with the resulting tar sold or burned as fuel. Various dehydration processes were available to generate lower water content tar, including heating and centrifugation methods. None, however, proved to be completely practical on every high water content tar. If a high water content tar could not be reasonably treated or the tar could not be sold or burned, it was typically stored in tanks, gas holders, or onsite ponds, or was disposed of as a waste.

Q. What were commercial uses of tar?

A. Tar is a complex mixture of hundreds of organic chemical compounds, including many polycyclic aromatic hydrocarbons. It had and still has many beneficial uses. Various companies outside of the gas industry purchased tar during the MGP Era to refine it into commercial products. The primary refining process for tar was distillation into different fractions. The commercial products included creosote as a preservative for railroad ties and utility poles, road tar, bitumen used for tar roofs, tar coatings, and tar pitch used in

the manufacture of aluminum. Some gas companies refined the tar at the MGP and sold the resulting commercial products directly to end users such as state or county road departments.

Substantial volumes of tar were put on the ground in paving roads and streets or for dust suppression on roads and streets, including at locations in Oregon. For example, application rates were up to two gallons of tar binder per square yard of road. On a 20-foot wide road, this would be 23,000 gallons of tar per mile of road. In 1913, the Barrett Company stated that its product, Tarvia, had been used successfully on over 50 million yards of roadways and pavements in this country. For a 20-ft wide road, this quantity in square yards equates to over 4,000 miles of roads and streets. At an application rate of two gallons per square yard, this would equate to 100 million gallons of tar placed on roads and streets.

Currently, coal tar (there is no current production of carburetted water gas or Oil Gas tar) remains a commercial product used for a variety of purposes, including production of creosote, roofing bitumen, tar pitch for the aluminum industry, and driveway sealer. In addition, certain shampoos (*e.g.*, Westwood-Squibb Sebutone® tar shampoo) contain a USP-grade of coal tar.

Q. What was the typical disposition of lampblack?

A. Lampblack was very fine carbon particles with low ash content. Lampblack from the Oil Gas process was typically used at the MGP as fuel or sold as fuel or a feedstock in certain manufacturing processes. As discussed in further detail below, the Portland Oil Gas MGPs used lampblack to make briquettes which they then sold as fuel. If neither of these uses were practical, lampblack could have been disposed on onsite at the MGP or offsite at a waste disposal site.

Q. What was the typical disposition of ammonia?

A. Ammonia from a coal gas process was typically recovered and sold as a chemical source of ammonia or sold or given away as fertilizer. As an example of a commercial use, in the early days of refrigeration, ammonia was the gas used in the compressor equipment.

Q. What was the typical disposition of light oil?

A. In the manufactured gas industry, "light oil" was a liquid recovered from the gas-making process that was made up primarily of volatile aromatic hydrocarbons (*e.g.*, benzene and toluene). Light oil was less dense than, and therefore floated on, water. Without being refined, light oil could be used as fuel or sold as commercial product for use as a feedstock in chemical manufacture. It could be refined into motor fuel for mixing with gasoline or for use by itself. It could also be distilled into its different fractions, thereby serving as a source for commercial chemicals such as benzene. Light oil recovered from the gas of any of the processes was typically sold as a commercial product, used at the MGP as fuel or processed at the MGP into other commercial products (*e.g.*, motor fuel).

Q. What was the typical disposition of materials from sulfur removal?

A. There were two general types of material mixtures resulting from sulfur removal: spent lime primarily in the 1800s and spent iron oxides from the 1880s until the end of the MGP Era. In addition, there was elemental sulfur recovered from certain liquid sulfur removal processes from the 1920s until the end of the MGP Era. This typical disposition of these materials was as follows:

<u>Spent Lime</u>

Spent lime was a mixture of wet lime that had reacted with hydrogen sulfide (and in the case of coal gas, hydrogen cyanide) to form chemical compounds of sulfide (and cyanide in the case of coal gas). Its use was predominantly before the 1880s when iron

oxide sulfur removal was developed; however, its use afterwards continued at some MGPs. It was sold or given away as a soil conditioner or disposed of as a waste.

Spent Iron Oxides

Spent iron oxide was a mixture of iron compounds, sulfur compounds, and elemental sulfur, and the medium on which the iron oxide had originally been fixed. This medium was often wood chips or wood shavings, but it could have been other materials (*e.g.*, corn cobs) depending on the materials available to the MGP. The purpose of the medium was to provide porosity together with a surface for the iron oxide so that the hydrogen sulfide containing gas could flow through a bed of the material and have the sulfide react with the iron. In the case of coal gas and of Oil Gas using crude oil, the spent iron oxide also contained iron cyanides, as the iron would react with the hydrogen cyanide present in these manufactured gases. Iron cyanides typically converted to Prussian blue or ferric ferrocyanide (FFC), which is a stable compound. Commercially, Prussian blue is used as a blue pigment.

The sulfide removal capacity of the iron oxide could be regenerated several times (known as revivification in the gas industry). Revivification was accomplished by removing the iron oxides and placing them on the MGP site for exposure to air or by adding air to the gas entering the purification process. However, at some point no further revivification could be attained and they became "spent."

The spent oxides were typically used as fill materials, disposed of as a waste, or sold or used as sources of chemicals. An example of this market is the appearance in the 1910s in Brown's Directory of advertisements seeking to purchase spent oxide.

Elemental Sulfur

Liquid sulfur purifiers were developed in the 1920s for use at larger scale MGPs. The purification process was to scrub the gas with a solution that would absorb the hydrogen sulfide and then treat the scrubber solution to remove the sulfide so the

solution could be recycled to the scrubber. In certain of these processes, elemental sulfur was recovered.

Elemental sulfur from liquid sulfur purifiers was typically sold as a commercial product or disposed of as a waste if it was not saleable.

Q What was the typical disposition of ash and clinker?

A. Ash resulted from heating the retort coal gas process by burning coke or the burning of coal or coke in the boiler house to generate steam. It consisted of the chemical compounds in coal which did not combust. Clinker was a residual of the carburetted water gas process, being the remnants of the coal or coke that did not burn or react with steam in the cyclical process in the generator vessel. It consisted of the non-combustible compounds in coal or coke along with unreacted carbon. Clinker had a slag-like appearance.

Ash and clinker were not generally marketable in the U.S. Sometimes, ash was used in building materials and clinker was used in sports running tracks. The majority of ash and clinker was used as fill, or disposed of as a waste.

Q What was the typical disposition of wastewater?

A. Wastewater was the excess water from the gas-making and purifying processes not recycled to the process. Substantial amounts of water were recirculated for hot gas quenching, gas scrubbing, and gas cooling. Typically, the excess water (*i.e.*, wastewater) became an effluent discharged to surface waters, to local municipal sewerage systems or to the MGP site itself, where its fate depended on the local site hydrologic conditions.

Q. What happened if residuals from an MGP had no market or economic use during some time period in which the MGP operated?

A. If there was no market or economic use for any of the residuals produced, they became wastes for disposition by the means contemporary to the situation at the time.

Q. What general waste disposal practices did the manufactured gas industry employ?

A. In the manufactured gas industry, as in other industries during the MGP Era, when residuals could not be recovered and sold or used as fuel or byproducts, they became wastes for disposal. Wastewaters were typically discharged as effluents to surface waters, municipal sewerage systems, or the MGP site itself. Solids were generally disposed of on land. For example, unusable tar was disposed of in ponds or low-lying areas onsite or offsite. These disposal methods were widely practiced during the MGP Era by MGPs, other types of industry, and municipalities, and were considered to be acceptable and proper. Indeed, due to the state of the technology at that time, there were no other feasible means of disposal.

Q. How were MGP residuals released at MGP sites?

A. In addition to waste disposal practices, there were several activities related to the storage and transfer of liquids at an MGP that sometimes resulted in releases of residuals to an MGP site. As liquid byproducts, such as tar, were produced, they were pumped around the plant through piping networks to above and below-grade processing and storage vessels. Accidental leaks and spills from pipes, pump seals and valves occurred. These incidents resulted in releases of liquids to the site. In addition, leaks and spills of liquids from above- and below-ground tanks, pits, and other vessels, such as gas holders, sometimes also occurred, causing liquids to reach the surface or enter the subsurface of the site.

The revivification process for iron oxides from gas purification was also a means through which residuals or their chemical constituents could have reached the surface of the site. One means to revivify oxide was by spreading it in thin layers on the ground so that air could oxidize the iron sulfide to iron oxide, its reactive state, and sulfur (*i.e.*, *ex situ* revivification). When the oxides could no longer be revivified, they were often

removed from the purifier boxes and placed on the ground. Depending on the circumstances, the oxide might be stored on the ground at the MGP for extended periods of time. Eventually, if the oxides could not be sold or used as the source of saleable chemicals, they might be used as fill or disposed of on other parts of the site or in offsite landfills.

Related to iron oxide handling, in the late 1800s and into the 1900s, there were newspaper articles about people bringing their children to gas plants when the purifying boxes were being opened to change out the media. According to these articles, breathing the vapors from the spent oxide boxes brought relief to those suffering from croup, colds, and whooping cough.

Q. How were MGPs demolished and dismantled?

A. MGPs were taken out of service throughout the MGP Era for various reasons. Some plants reached the end of their useful lives and were not replaced. Some were closed when gas could be more economically provided by other larger plants on a regional basis. Many were closed when the introduction of natural gas made them obsolete. Some carburetted water gas plants were converted to high-Btu oil gas plants for peak shaving during the 1940s and thereafter before being closed permanently. Peak-shaving equipment operated intermittently for short periods of time to provide gas during a period of high demand (*e.g.*, very cold winter days).

Once taken out of service, the plants were dismantled in whole or in part for various reasons. One purpose was to reduce their assessed value for tax purposes. Another was to allow for reuse or redevelopment of the land.

The procedures for taking a plant out of service generally entailed dismantling and demolishing all of the above-ground structures and leveling the site, except where certain buildings were left for future use. Below-ground tanks were filled with building debris or other material to bring them to ground level. Bulk liquids removed from tanks

were disposed of either onsite or offsite and sludge layers were often left behind in tanks that were not completely removed (*e.g.*, below grade water tanks of gas holders of below grade tar separators). Below-grade pipes were left in place along with the liquids they might contain. Salvageable materials, such as steel from tanks, were recovered. Solid wastes from above-ground vessels, such as iron oxides, were used as fill or disposed of either onsite or offsite.

Q. How did current environmental impacts result from historic MGP activities and practices?

A. Typical operating, disposal, and demolition-dismantling practices during the MGP Era at former MGP sites resulted in environmental contamination of soil, groundwater, or stream sediments as it is defined today (*i.e.*, in 2011), which may require remediation under current state or federal laws and regulations. Additionally, post-MGP activities sometimes also resulted in releases of chemicals or spreading of chemicals left behind at the cessation of MGP activities.

Beginning around the 1970s, analytical technologies became commercially available to measure relatively low concentrations of chemical constituents in water, soil, and sediments which provided a basis to begin assessing impacts. A number of organic or inorganic chemicals may possibly be present in now measurable concentrations in soils, groundwater and sediments at or near a former MGP site as a result of historic gas plant activities. Organic chemical compounds include the following groups: volatile aromatics (*e.g.*, BTEX), phenolics, and polycyclic aromatic hydrocarbons (*i.e.*, PAHs). It should be noted that these groups of compounds generally represent the chemicals possibly present at MGP sites, but they may not represent what actually will be discovered at any specific location. Current testing at a specific MGP site may or may not find any or all of these chemical compounds.

Q. How did consideration of the environment change after the end of the MGP Era?

A. The MGP Era had ended by the first Earth Day in 1970, the year that began the modern era of environmentalism ("Environmental Era"). From 1970 onward, the U.S. Congress enacted a series of laws revolutionizing the U.S. approach to environmental regulation and management of air quality, water quality, solid waste, industrial sites, and historic disposal facilities. A national understanding of the impact of historic industrial operating and disposal activities on soil and groundwater quality evolved in the 1970s, resulting in the passage of the "Superfund" Act in December 1980. Laws, regulations and guidance issued under Superfund and state counterparts formed the foundations of the then new environmental field of site remediation. Application of the site remediation process to MGP sites generally began in the 1980s and continues through the present as a significant post-MGP Era effort by those held responsible for MGP sites.

Q. During the MGP Era, what was the gas industry's knowledge of environmental impacts as they are understood currently (2011)?

A. Manufactured gas plants' operating, waste disposal, and demolition-dismantling practices were consistent with the practices of other industries, governments, and individuals throughout the U.S. During the MGP Era and prior to the Environmental Era, these practices throughout industry and society as a whole were generally regulated by the principle of nuisance control (*e.g.*, controlling offenses to the senses, such as smoke and odors in the air, objectionable tastes in the water, or soot deposition). Nuisances were considered temporary problems and were dealt with as discrete and separate situations in a manner so as to eliminate the immediate offensive condition.

From 1816 until the present, surface water has been accepted as the proper receptor of wastewaters. Discharge of wastewater to surface waters (*e.g.*, rivers) was common for industries and municipalities during the MGP Era and continues to be so today. The required degree of treatment of wastewaters throughout this time period has

changed significantly, especially during the Environmental Era after passage of the amendments to the Clean Water Act in 1972. In 1972, regulations promulgated under the Clean Water Act mandated controls on wastewater discharges across the U.S. based on best practical treatment and subsequently best available treatment. Since 1972, there has been increasing limitations placed on wastewater discharges based on current understandings of impacts to rivers with respect to present water quality standards. These Environmental Era requirements have also extended to stormwater discharges and runoff from agricultural lands. Present-day regulation of wastewater discharges contrasts greatly to the situation during the MGP Era.

From 1816 until the 1970s, land was accepted as the final receptor for many kinds of wastes. Solid and liquid wastes from industries and municipalities were disposed of in open dumps either onsite or offsite, and/or in low-lying areas onsite. In the 1970s, the requirements for land disposal of waste began to change significantly.

There are several significant examples of industries, other than the manufactured gas industry, that also followed these disposal practices prior to the 1980s. In the iron and steel industry, solid wastes from byproduct coke plants were disposed of on land, either onsite or offsite. These wastes consisted primarily of ash, sludges from cleaning of process tanks and vessels, and spent oxides or other gas cleaning solids (*e.g.*, off-specification sulfur). Additionally, in the petroleum refining industry, oily sludges were disposed of on land. In the wood-treating industry, waste liquids were disposed of in onsite ponds. Additionally, sludges from cleaning of tanks and vessels were disposed of in onsite dump areas. All these practices continued until the 1980s, when regulations promulgated under the 1976 Resource Conservation and Recovery Act (RCRA) mandated controls on land disposal of wastes across the U.S. These Environmental Era regulations have also required for treatment of certain wastes prior to land disposal and for incineration of certain wastes.

Municipal garbage, trash, and sludges from sewage treatment plants were disposed of in open dumps. These practices remained in effect in the U.S. until the 1970s and 1980s, when regulations began to systematically phase them out, in favor of sanitary landfills or controlled land application, in the case of sewage sludges.

Q. What do you consider to be the definition of a reasonable industry practice with respect to the operation of an industrial facility like an MGP and to the disposition of residuals from such a facility?

A. I consider an activity to be a reasonable practice if the activity was one which a reasonable business person, given the context of the legal standards and state of knowledge at the time of the activity, would have engaged in.

III. GAS MANUFACTURE AT THE PORTLAND MGP SITES

Q. Please describe the history of gas manufacture at the Portland MGP Sites?

A. As an overview, gas manufacture began in 1860 and continued until the fall of 1956. Three gas manufacturing processes were used at the Portland MGP Sites: coal gas, carburetted water gas, and Oil Gas. During the fall of 1956, Portland Gas & Coke Company (PGCC) converted to natural gas distribution. Afterwards, the Oil Gas equipment was converted to high Btu oil gas and maintained for standby and peak shaving until 1958.

The beginning was in 1859 when the Oregon territorial legislature granted a franchise for gas manufacture in Portland. A coal gas plant was constructed in downtown Portland on the west bank of the Willamette River and it began operation in 1860 as an unincorporated enterprise that provided gas for gas lighting. In 1862, the newly incorporated Portland Gas Light Company (PGLC) took over the franchise and plant. PGLC operated until 1892 when it was purchased by the newly formed Portland Gas Company (PGC).

In 1892, PGC also purchased the East Portland Gas Light Company (EPGLC) which had been formed in 1882. EPGLC had constructed a relatively small gas plant in East Portland at that time which, according to Brown's Directory editions at the time, produced coal gas. PGC ceased gas manufacture at this plant around 1892 with the construction of a pipeline across the Willamette River to supply gas to East Portland. This plant was subsequently demolished and dismantled to make way for new developments on its site. There are no surface remnants of the original plant left on the site.

The PGC gas plant in downtown Portland continued to manufacture coal gas until around 1897, when carburetted water gas apparatus was added to the plant. Both coal gas and carburetted water gas manufacture continued until 1906 when the carburetted water gas apparatus was converted to Oil Gas manufacture. PGC eventually recovered the lampblack from the Oil Gas manufacture for fuel and for production of lampblack briquettes. This plant ceased operation in 1913. It was subsequently demolished and dismantled to make way for new developments on its site. There are no surface remnants of the original plant left on the site.

In 1910, the American Power & Light Company formed PGCC, acquiring the gas business from PGC. In 1912-13, PGCC constructed a new Oil Gas plant at Linnton on the west bank of the Willamette River, several miles northwest of downtown Portland. In 1913, operations began at this new plant, negating the need to operate the downtown plant.

E.L. Hall of PGCC, in a 1916 paper, described the rationale for building a new gas plant as follows:

> Due to the phenomenal growth since the Lewis and Clark Exposition in 1905, the old site of the gas works at Front and Everett Streets, consisting of a few city blocks on the water front, became inadequate to

> take care of the continuous additions to plant and machinery, while the business center drawing its cordon tighter around the manufacturing activities, brought about increased complaints against the smoke and odor in connection with manufacturing operations. Growing inefficiency and inadequacy of the old machinery, most of which had been in use for many years, called for a reconstruction of the plant. It was, therefore, decided in 1910 that the time had come to move the manufacturing plant to the outskirts of the city.

In the citation above, Hall's mention of complaints against smoke and odor provide an example of nuisance issues related to manufactured gas operations. Hall closed this paper with a conclusion about "Operating Efficiencies:"

> The new plant effects a saving over the old plant approximating $45,000.00 per annum, or practically 15 per cent, accounted for principally in fuel and labor.
>
> The new plant also manufactured lampblack briquettes on a significant scale for sale as fuel in the Portland area. This planned briquette manufacture was a significant aspect of the economics of the new plant. The plant also stored tar recovered from the oil gas process, which it then either sold or used as fuel at the plant. In the 1920s, the plant installed equipment to recover light oil and process it into motor fuel and to process tar into a variety of products. These tar products included road tar used across Oregon, including in Multnomah County. In 1941, PGCC installed petroleum coke ovens to generate gas and petroleum coke. Petroleum coke was in demand by aluminum smelting plants, particularly those located in Vancouver, Washington. Aluminum manufacture was a primary industry in support of the war effort of World War II.

Production of gas, petroleum coke, and also of pitch from tar at this plant provided significant support of the war effort.

PGCC operated this facility producing gas and commercial byproducts until 1956, when natural gas pipelines reached Portland. At that time, the Oil Gas plant at Linnton was placed on standby for a few years to be available for peak shaving.

In the 1960s, demolition and dismantling of the gas plant began in order to make way for the installation of the liquefied natural gas (LNG) tank, which began operation in 1969. Renovation of the surface of the MGP site at Linnton continued into at least the 1970s to bring it more or less to its present general topographical condition. The only remnants of the original MGP are the office building, now vacant, and the tar processing facility, which was first leased to a third party in 1965. Third party leasing of this part of the site has continued to the present (2011).

In addition to the two primary MGPs (the one in downtown Portland and the one at Linnton), there were gas holders located in other parts of Portland, the small MGP in East Portland, which remained a gas holder site, and several motor fuel filling stations operated by the gas companies. As the gas holders and filling stations became obsolete, these facilities ceased operation. Afterwards, they were demolished and dismantled and then sold or redeveloped. For example, the Central Service Center of NW Natural is the site of three former gas holders.

Finally, beginning in the 1910s, PGCC began supplying Vancouver, Washington with manufactured gas, acquiring the Vancouver gas business in the 1920s and continuing to supply gas to Vancouver to the present (2011).

NWN/402, Middleton/2-7 are 1879 and 1890 panoramic maps from the Library of Congress collection on which enlargements of the earlier gas plants and holders have been superimposed showing the map artists' rendition of these facilities. *NWN/402, Middleton/8-14* are pictures from a 1916 paper of the new gas plant at Linnton.

NWN/403, Middlton/1 is a drawing from a 1916 paper showing the layout of the new gas plant at Linnton.

Q. When and where was the coal gas process used?

A. The downtown Portland MGP, starting in 1860, made coal gas in retorts. It was a relatively small plant with six retorts and a daily capacity of 40,000 cubic feet. As a reference point, this capacity would have required the processing of around four tons of coal per day. Coal was brought in from Vancouver Island, British Columbia, and from across the Pacific Ocean. Coal gas continued to be listed as a process through the 1904 edition of Brown's Directory.

Q. Please describe retort coal gas manufacture.

A. In the U.S., retort coal carbonization began around 1816 and was used in various parts of the country into the 1950s.[2] This was the original coal gas process producing gas and coke from coal in heated vessels called retorts. Coke is the remnant of coal remaining after the volatile materials in the coal have been driven off by heating. Coke is predominantly carbon with only the substances making up the ash of coal present other than carbon. Coal gas manufacture in retorts occurred at the downtown Portland MGP from 1860 until probably around 1904, but no longer than until 1906. In addition, the East Portland MGP used coal gas from around 1882 until 1892.

In the coal gas process, coal was carbonized at high temperature in the absence of oxygen, driving off around 30 percent of the weight of the coal as gas and residuals. *NWN/403, Middleton/2* is a schematic diagram of the coal gas process. Bituminous coal was added to a closed vessel (retort) and heated. The gas emanating from the closed vessel was immediately quenched with water, which cooled it and condensed coal tar.

[2] In the 1890s, byproduct coke ovens were first installed in the U.S. These ovens were a much larger scale version of retorts for large capacity coal gas and coke manufacture. Byproduct coke ovens are still used in the U.S. to manufacture coke for metallurgical processes. From the 1970s to the present, I have worked at a number of operating byproduct coke plants regarding treatment of their wastewaters.

Quenching occurred in a hydraulic main, which was a pipe continuously flowing with water and also receiving the hot gas from the retorts. The resulting coal tar and water mixture flowed to quiescent basins for separation, with substantial recycle of the water phase and recovery of the tar phase. Following quenching, the coal gas went through further purification steps to remove remaining tar, ammonia, sulfur, and cyanide, and then into the storage and distribution system.

The residuals generally produced from retort coal gas manufacture were coke, coal tar, ammonia, ash, wastewater, and materials from sulfur removal. In some retort operations, additional residuals may have also been recovered from the gas, such as light oil.

Q. When and where was the carburetted water gas process used?

A. Around 1897, carburetted water gas equipment was added to the downtown Portland MGP. This equipment was likely the Lowe carburetted water gas process because it was provided by the United Gas Improvement Company (UGI) of Philadelphia. This equipment was added in response to the flood of 1894, which had flooded the plant and completely disrupted service. The new carburetted water gas equipment was placed at a higher elevation to be out of the flood prone area of the plant. By 1905, the daily gas manufacture had increased to around 960,000 cubic feet, substantially up from the rate in 1860. Carburetted water gas equipment continued in service until 1906.

Q. Please describe carburetted water gas manufacture.

A. In the 1870s, T.S.C. Lowe invented the carburetted water gas process, and it rapidly became the dominant process in the U.S., surpassing coal carbonization. In many locations, coal gas and carburetted water gas were both used at the same time. Carburetted water gas manufacture occurred at the downtown Portland MGP from around 1897 until 1906.

Carburetted water gas manufacture required coal or coke plus a petroleum oil to generate a suitable gas. *NWN/403, Middleton/3* is a schematic diagram of the carburetted water gas process. True water gas (also referred to as blue gas) was first made by reacting red-hot coal or coke with steam in a generator, the first of three vessels used in the process. To generate sufficient heating or illuminating capacity to be distributed to the public, true water had to be carburetted. This was accomplished by passing the true water gas into a second vessel, the carburetter, where it was sprayed with petroleum or a petroleum fraction. The petroleum or petroleum fraction vaporized and was then permanently converted to gas in the third vessel, the superheater.

As with coal carbonization, the gas was immediately quenched upon exiting the gas generation equipment in a wash box to cool it and condense carburetted water gas tar. The resulting tar and water mixture flowed to quiescent basins for separation, with substantial recycle of the water phase and recovery of the tar phase. Following the wash box, carburetted water gas went through further purification steps to remove remaining tar and sulfur and then flowed into the storage and distribution system.

Carburetted water gas manufacture was more flexible in operation than coal gas manufacture, and it also converted most of the coal or coke to gas. By around 1900, carburetted water gas facilities were very popular and became dominant in many communities.

The carburetted water gas process produced the residuals carburetted water gas tar, clinker, materials from sulfur removal and wastewater. At some carburetted water gas plants, additional residuals (*e.g.*, light oil) may also have been recovered.

Carburetted water gas tar was similar, but not identical, to coal tar produced by the coal gas process. The principal difference resulted from the use of petroleum in the gas manufacturing process.

Q. When and where was the Oil Gas process used?

A. In 1906, carburetted water gas manufacture at the downtown Portland MGP was discontinued due to the price of coal used in the generator. The carburetted water gas equipment was modified to produce Oil Gas from crude oil. Oil Gas was made from 1906 until the downtown Portland MGP ceased operations with the startup of the new oil gas plant at Linnton.

On October 27, 1913, the new Oil Gas plant at Linnton began operation. This plant used a single shell Oil Gas process with five gas machines installed at that time. Each Oil Gas set (*i.e.*, single Oil Gas machine) had a gas production capacity of two million cubic feet per day. Subsequently, additional Oil Gas machines were added to further increase the capacity of the plant. The operation of the Oil Gas machines was modified at times as necessary to respond to changing conditions. For example, in 1935, the single-shell generators were cross-connected in pairs to enable the plant to use a high-carbon fuel oil available at lower cost, as described by William Q. Hull and W.A. Kohlhoff in a 1952 paper in Industrial and Engineering Chemistry. In the fall of 1956, PGCC converted to natural gas, thereby ending base load manufacture of gas. Afterwards, the Oil Gas equipment was converted to high Btu oil gas and maintained for standby and peak shaving until 1958. In 1958, the MGP at Linnton was mothballed for future emergency use.

The Linnton plant was one of the larger gas manufacturing plants in the U.S. *NWN/403, Middleton/4* is a graph of the annual production at the Linnton plant from 1914 through 1953. Annual gas production during this time period ranged from a low of 1.5 billion cubic feet in 1915 up to a high of 10.5 billion cubic feet in 1948. The 1949-50 edition of Brown's Directory of American Gas Companies listed manufactured gas production for calendar year 1948 from which examples can be taken. The listed 1948 annual production amounts of the western cities of Seattle and Honolulu, which were

producing Oil Gas at the time, were 3.6 and 2.4 billion cubic feet, respectively. There was also 0.8 billion cubic feet of carburetted water gas production listed for Seattle in that year bringing the total to 4.4 billion cubic feet. Contrastingly, the listed 1948 annual production for a smaller eastern city, Holyoke, Massachusetts, was 0.4 billion cubic feet of carburetted water gas. The 1948 Linnton production of 10.5 billion cubic feet was multiples of these example cities.

Q. Please describe Oil Gas manufacture.

A. Oil gas manufacture was with the large scale oil gas process (*i.e.*, Oil Gas) and the high-Btu oil gas process.

The Oil Gas processes, also known as Pacific Coast oil gas, were first developed in the 1890s with the first major oil gas plant beginning operation in 1902 in Oakland, California. Oil Gas manufacture was economically beneficial in situations where crude oil was more readily available and less costly than coal, such as on the West Coast of the U.S. in the 1900s. Oil Gas manufacture occurred at the downtown Portland MGP from 1906 until 1913, using modified carburetted water gas equipment. Oil Gas manufacture occurred at the Linnton MGP from 1913 until 1956 using single shell oil gas equipment modified at times during this period to accommodate change feedstocks and situations.

NWN/403, Middleton/5 is a schematic diagram of the Oil Gas process. The process was cyclical and it relied on one (single-shell Oil Gas) or two vessels (two-shell Oil Gas) filled with firebrick in a manner to create gas-passageways. In the first cycle, oil was burned in the vessels to heat the firebrick to a high temperature. In the second cycle, manufacture of Oil Gas occurred by injection of steam and additional oil into the hot vessels which caused a reaction to form gas.

As with the carburetted water gas process, the hot gas exited the vessel into a wash box, in which it was quenched with water. This quenching caused, depending on

the process, lampblack and/or Oil Gas tar to separate from the gas. The relative proportions of lampblack and tar in the hot gas depended on the operational conditions of the Oil Gas process. For example, the Oil Gas process could be configured and operated to produce more lampblack and less tar. Also, depending on the configuration and operation of the wash box, the degree of separation of lampblack and tar could be affected. For example, primary removal of lampblack from the gas could be accomplished in the wash box with tar removal in subsequent purification steps by the design and operation of the wash box. The resulting lampblack and water mixture or Oil Gas tar and-water mixture flowed to quiescent basins or other processes for separation of the water and recovery of the lampblack and tar.

Following the wash box, gas was further purified to remove remaining tar and sulfur. In the case of Oil Gas plants using crude oil as a feedstock, purification downstream of the wash box would also have removed some cyanide.

The Oil Gas process generally produced the residuals oil gas tar, clinker, materials from sulfur removal, and wastewater. At some Oil Gas plants, additional residuals (*e.g.*, light oil) were recovered.

After conversion to natural gas in 1956, PGCC used the high Btu oil gas process until 1958 for peak shaving. The high-Btu oil gas process was generally developed for application when gas companies were switching from manufactured gas to natural gas. High Btu oil gas was a modification of Oil Gas manufacture that resulted in the manufactured gas having a heat content of around 1000 Btu per cubic foot, thus allowing it to be compatibly mixed with natural gas. Typically, the role of this process was to be on standby such that during periods of peak demands (*e.g.*, colder winter times), it could be activated to supplement natural gas supplies. This process was often used just a few days a year. The high Btu oil gas process could be developed either by modifying a

carburetted water gas process or a regular Oil Gas process. Its operation was similar to that of the Oil Gas process, as were the residuals it produced.

Q. When and where was the petroleum coking process used?

A. In 1941, four petroleum coke ovens (Knowles Coke Ovens) were added at the Linnton facility to produce gas and petroleum coke. The high Btu content (around 1000 Btu) of the gas from these ovens was reformed downward to meet required Btu content of 570 Btu. These ovens operated until 1953, after which they were dismantled.

Q. What was petroleum coking?

A. The process of petroleum coking is analogous to that of coking coal (*i.e.*, coal gas manufacture), except that petroleum or petroleum fractions were subjected to high temperature heating in the absence of air. This resulted in the production of gas and residuals. The coking apparatus was constructed to facilitate the treatment of liquids rather than solids as in the case of coal gas manufacture. Petroleum coking gas manufacture occurred at the Linnton MGP from 1941 until 1953 using Knowles Coke Ovens. The gas was purified for removal of tar and sulfur. The general residuals from petroleum coking were tar and petroleum coke. At some oil gas plants, additional residuals (*e.g.*, light oil) may also have been recovered.

Q. What residuals were generated by gas manufacture at the Portland MGP Sites and what was the disposition of those residuals?

A. I will first discuss the residuals generated by the respective gas manufacturing processes used at the Portland MGP Sites. The next topic will be the fate of any of the residuals not usable or saleable. Finally, since wastewater was a residual common to all of the processes, its consideration will be made separately at the end.

- **Coal Gas:** As discussed above, typically, the primary residuals of coal gas manufacture were coke, coal tar, ammonia, spent purifier materials, and ash. As often happens for MGPs of this time frame, company records of the disposition of

residuals have not been found to date (2011) with respect to coal gas manufacture in Portland. The disposition of these likely included:

- Coke: use as fuel at the MGP or sale as a commercial byproduct (*e.g.*, fuel);
- Coal Tar: use as fuel at the MGP, sale as a commercial byproduct, or use as a paint at the MGP;
- Ammonia: sale as a commercial byproduct;
- Spent purifier materials:
  - Spent lime (prior to the 1880s): sale or giveaway as a byproduct or disposal on land;
  - Spent iron oxides (1880s and afterwards): sale or giveaway as a byproduct, or use as fill material; and
- Ash: sale or giveaway as a byproduct.

- **Carburetted Water Gas:** As discussed above, typically, the primary residuals of carburetted water gas manufacture were carburetted water gas tar, spent purifier materials, and clinker. Company records on the disposition of these residuals have not been found to date (2011). The disposition of these likely included:
  - Carburetted Water Gas Tar: use as fuel at the MGP or sale as a commercial byproduct;
  - Spent purifier materials: likely spent iron oxides (since 1880s and afterwards), for sale or giveaway as a byproduct or use as fill material; and
  - Clinker: sale or giveaway as a byproduct.
- **Oil Gas (Downtown Portland MGP):** As discussed above, typically, the primary residuals of oil gas manufacture were lampblack, oil gas tar, and spent purifier materials. Some records on lampblack disposition at the plant have been found. The disposition of these likely included:

- Lampblack: first mixed with sawdust and burned as boiler fuel and subsequently briquetted for sale as fuel;
- Oil Gas Tar: to the extent it was not recovered with the lampblack, use as fuel at the MGP or sale as a commercial byproduct;
- Spent Purifier Materials: likely spent iron oxides (since after 1880s), for sale or giveaway as a byproduct or use as fill material; and
- Clinker: sale or giveaway as a byproduct.

- **Oil Gas (Linnton MGP):** As discussed above, typically, the primary residuals of oil gas manufacture were lampblack, oil gas tar, and spent purifier materials. In addition, this MGP recovered light oil from the gas. Records regarding the disposition of these residuals have been found. Based on these records, the disposition of these residuals was as follows:
  - Lampblack: predominantly pressed into briquettes for sale as fuel, but some sales occurred in bulk for use as a chemical feedstock; lampblack not pressed into briquettes was stored on site and eventually sold in the late 1940s and early 1950s in bulk to local industry as well as elsewhere;
  - Oil Gas Tar: separately recovered from the lampblack and initially used as fuel in the boiler with some sold; and subsequently processed into commercial products at the MGP (*e.g.*, road tar, pitch) which were sold;
  - Light Oil: processed into commercial products at the MGP (*e.g.*, motor fuel, chemicals) which were sold, including some sales of motor fuel at company-owned filling stations for a period of time; and
  - Spent Purifier Materials: spent iron oxides placed on the MGP site until its demolition and dismantling in the 1960s and 1970s; some recovery of yellow prussiate of soda was done during World War I; some sulfur recovery was done in the time frame of the late 1930s.

- **Petroleum Coking (Linnton MGP):** As discussed above, typically, the primary residuals of petroleum coking were petroleum coke, tar, light oil, and spent purifier materials. Records regarding the disposition of these residuals have been found. Based on these records, the disposition of these residuals was as follows:
  - Petroleum Coke: sold to aluminum smelters for electrode manufacture;
  - Tar: processed into commercial products at the MGP (*e.g.*, road tar, pitch) which were sold;
  - Light Oil: processed into commercial products at the MGP (*e.g.*, motor fuel, chemicals) which were sold including some sales of motor fuel at company-owned filling stations for a period of time; and
  - Spent Purifier Materials: the gas from petroleum coking was purified of sulfur after consolidation with oil gas; see the discussion above for the disposition of the spent purifier materials.
- **Unusable, Unsalable Residuals:** If, because of market conditions, any of the residuals discussed above, which were typically commercial byproducts or beneficially used, could not be sold or used, they became waste for disposal by the means contemporary to the situation at the time. In addition, if there were other residuals such as sludge from tanks or from residuals processing, which were unusable and unsalable, these were waste for disposal by the means contemporary to the situation at the time. These means contemporary to the operation of the Portland MGP Sites included disposal on land onsite at the MGP or offsite.
- **Wastewater:** Manufactured gas plants used water for quenching, condensing, and scrubbing of the gas in the purification process, quenching of hot coke, cooling, and for boiler water. Such water use, in part, resulted in tar-water and lampblack-water mixtures. A plant would typically attempt to separate tar and lampblack from these mixtures using quiescent basins or filters. A substantive amount of the water

recovered by such separation was typically recycled to the quenching and scrubbing processes. Any excess water became a wastewater effluent for disposition. Generally, disposition of the effluent was directly to surface waters, to municipal sewers, or to drainage ditches, channels, or areas of the plant which, in turn, could have led to surface waters. In the case of the downtown Portland MGP and the Linnton MGP, effluent was discharged to plant sewers that went to the Willamette River or to drainage channels connected to the Willamette River. At the Linnton MGP, in its later years, effluent passed through settling lagoons prior to discharge to the Willamette River. At the Linnton MGP, some wastewater was discharged to areas of the plant which may have been connected to the drainage channels on the site.

Q. What are examples of technical efforts made by PGCC to improve gas manufacture or residuals processing?

A. Examples of technical efforts made by PGCC to improve gas manufacture or residuals processing include the following:

- In 1916, E. L. Hall of PGCC described the rationale for the oil gas plant at Linnton as one that produced substantial amounts of byproducts. He presented general ways to accomplish the goal of producing "the greatest number of B.t.u.'s per dollar." First was by "elimination of all by-products, *i.e.*, by conversion of all the raw material into gas." The second was "by production simultaneously with the gas of the largest amount of merchantable by-products on the theory that weight for weight the latter are worth more than the raw material." He went on to say that the first method had been developed by E. C. Jones in San Francisco, but it had not yet been able to completely eliminate lampblack generation. He characterized the second method as more universal and exemplified in Los Angeles, San Diego, Oakland, and, notably, Portland, in so far as byproducts are marketed. He went on

to say, "Nearly all other oil gas plants produce lampblack, but have not sufficient volume to briquette. . . . Where there is a good fuel market and oil is cheap, it will unquestionably pay to produce by-products." The technical effort by PGCC in planning the new MGP at Linnton resulted in the specific configuration of the overall plant including the intentional production of lampblack as the dominant byproduct with its disposition to be sale of briquettes as fuel in the Portland market in pursuit of the goal of producing "the greatest number of B.t.u.'s per dollar."

- In 1924, Russell Ripley and Sigmund Schwarz applied for a patent entitled "Process for the Recovery of Gas Tars from Their Emulsions with Water," and this patent was granted in 1929. Their invention was the means to recover salable tar from the "heavy viscous hydrocarbon emulsions with water which are byproducts in the manufacture of city gas from crude petroleum. . . ." Generally, the process involved addition of sodium hydroxide to the emulsion, followed by heating under pressure. This process prepared oil gas tar made at Linnton for further processing into higher value commercial byproducts such as road tar, thereby decreasing the cost of gas generation. Prior to this, the higher water content tar had been burned in the boiler as a primary means of disposition.
- In 1925, Professor S.H. Graf of Oregon Agricultural College ("OAC", the predecessor to Oregon State University) investigated the use of 620 BTU gas tar primarily for use as a road binder and issued a report on this date. He concluded that the tar was suitable for this use and described its preparation to attain ASTM standards on road tar. He also concluded that this tar appeared "wonderfully adapted to painting concrete for damp proofing." Subsequent to this, Professor Graf followed up with reports on the treatment of macadam road surfaces with tar from the Linnton MGP. One of the road surfaces was at the MGP itself. The basis of his reports included interviews with municipal staff.

Q. How did the environmental conditions presently under investigation and remediation at these MGP sites result from past manufacture of gas?

A. The environmental conditions that at present (2011) require investigation include the presence in soil, groundwater, surface water, and river sediments of certain chemicals (*e.g.*, benzene, naphthalene, polycyclic aromatic hydrocarbons, cyanide) or materials (*e.g.*, oil, tar, lampblack). Where concentrations exist that pose unacceptable risks by present standards, remediation of soil, groundwater, and river sediments will likely be required. The means by which these chemicals reached their present locations at the MGP sites include leaks or spills of MGP residuals, placement of MGP residuals directly onto the sites, migration of these chemicals from where they first reached the site, and the reworking of site soils in redevelopment activities. In the case of river sediments, the means included discharges or spills to the river, transport of the chemicals from the uplands to the river or through reworking of river sediments by natural water flow, or by dredging activities. It is also important to understand that other parties are likely possible sources of some of these same chemicals, especially in the river sediments as numerous industrial and municipal wastewaters were discharged to the Willamette River throughout the time period that gas was manufactured in Portland.

Q. How would you characterize the residuals handling and disposition practices of the MGPs in Portland?

A. Based on my review of the history of gas manufacture in Portland, I believe the practices at the Portland MGP Site for handling and disposition of residuals from gas manufacture were fully consistent with those of other MGPs, other industries, and municipalities in the Portland area and across the country during the MGP Era, and were reasonable and prudent in view of the circumstances and information available at the time.

Q. How would you characterize the demolition and dismantling practices of the MGPs in Portland?

A. Based on my review of the history of the Portland MGP Sites, I believe the Portland MGP practices for demolition and dismantling practices were fully consistent with those of other MGPs and other industries in the Portland area and across the country during the MGP Era, and were reasonable and prudent in view of the circumstances and information available at the time.

Q. On what did you rely to answer the questions about gas manufacture in Portland?

A. I relied on my training as a civil, sanitary, and environmental engineer; experience with manufactured gas, byproduct coke oven and tar distillation plants, sites or projects; and my more than 35 years of experience as a consulting engineer, an industrial environmental engineer, an industrial environmental manager and executive, and a university professor and researcher, in addition to historical documents that provide information on manufactured gas in Portland.

Q. Does this conclude your direct testimony?

A. Yes, it does.

NWN/401
Witness: Andrew Middleton

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

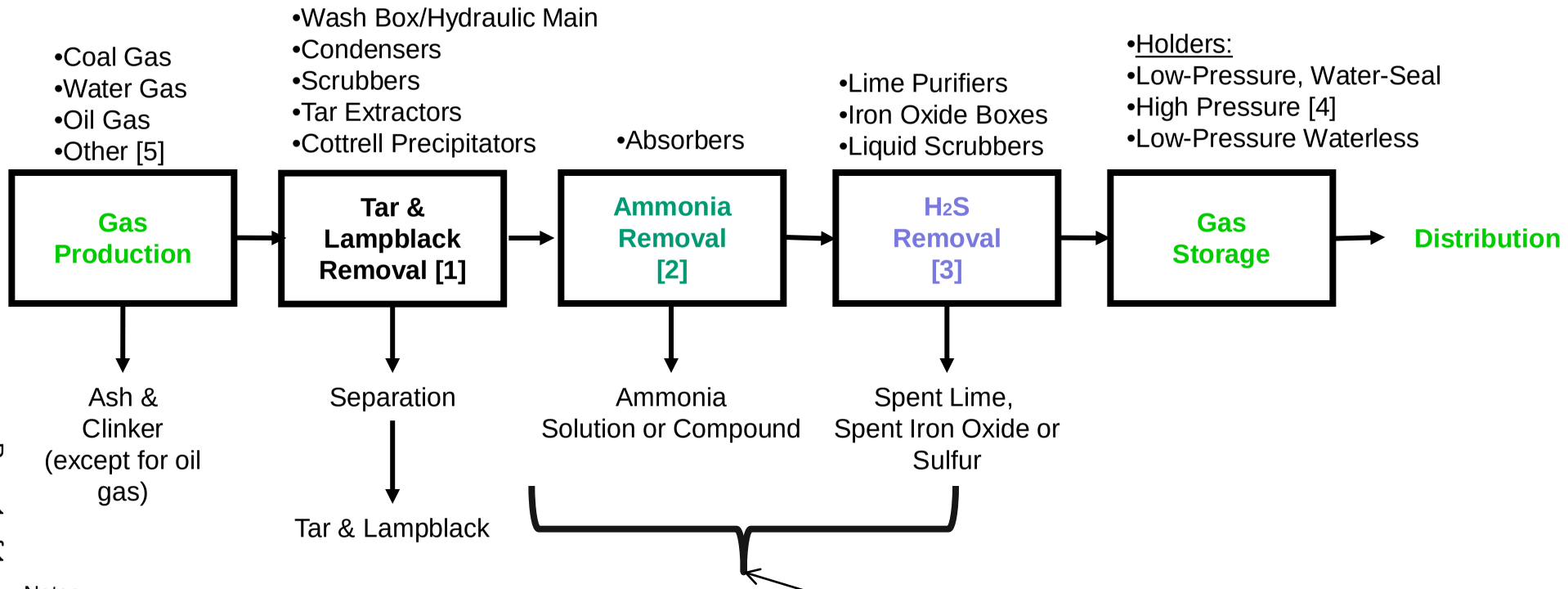
UM 1635

NW NATURAL

Exhibit Accompanying Direct Testimony of Andrew Middleton

Schematic Diagram of the Overall General
Gas Manufacturing, Purification and Storage Processes

March 29, 2013



Notes:

[1] Not all of these processes were necessarily at an MGP; water gas included a relief holder in this step to equalize gas flow from cyclical production; lampblack removal was for oil gas manufacture

[2] In coal gas processes only; water gas and oil gas did not typically contain significant ammonia

[3] For coal gas and oil gas using crude oil, cyanide would also be removed here; water gas did not typically contain significant cyanide

[4] Pressurization of manufactured gas generated condensate

[5] Depending on which other process, the gas purification steps may have varied from this diagram

Exhibit 2: Schematic Diagram of the Overall General Gas Manufacturing, Purification and Storage Processes

NWN/402
Witness: Andrew Middleton

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

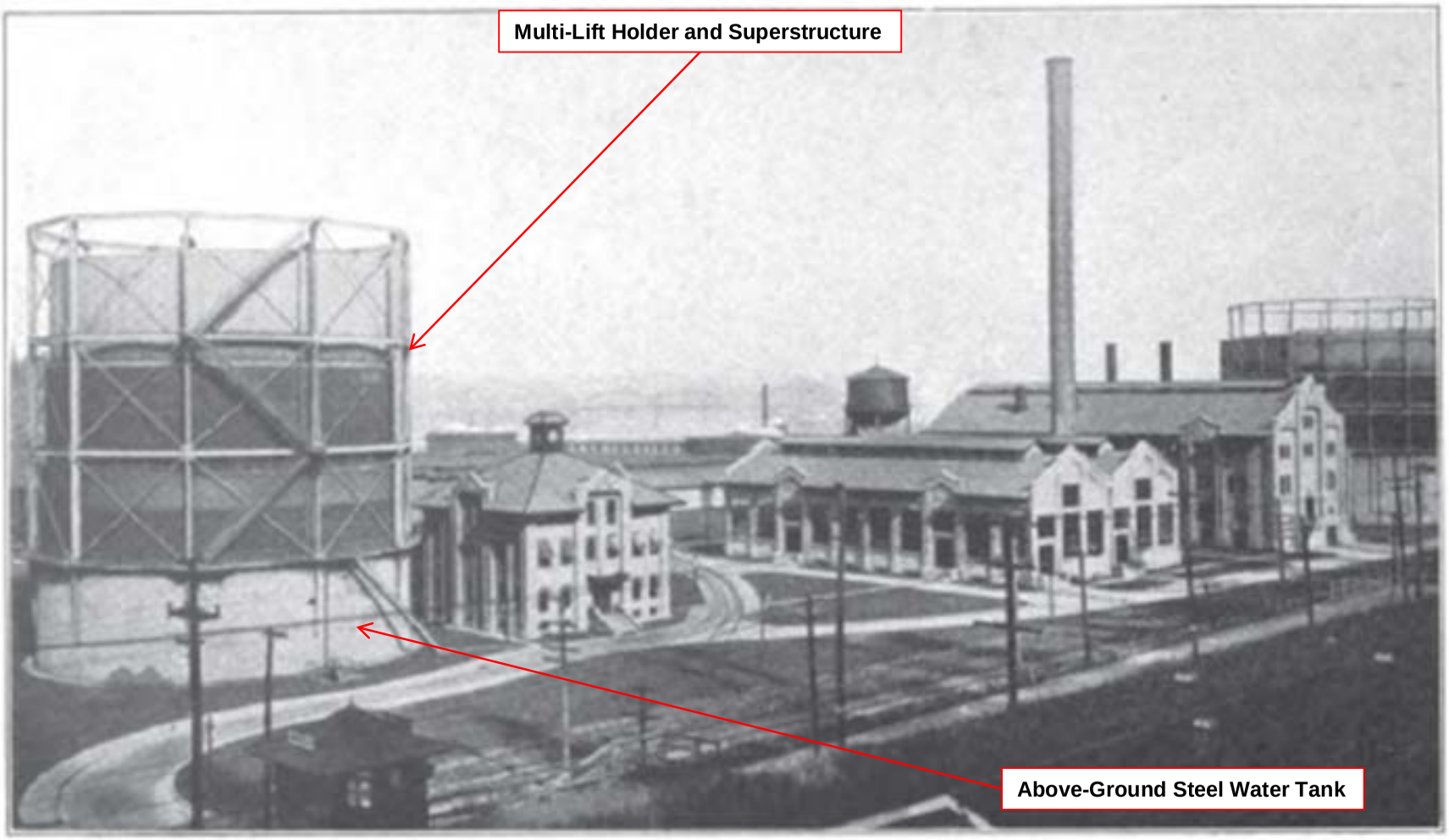
UM 1635

NW NATURAL

Exhibit Accompanying Direct Testimony of Andrew Middleton

Photographs of MPG Sites

March 29, 2013



BUILDINGS AND GROUNDS.

Exhibit 3: Picture of Portland Gas & Coke Low Pressure, Water-Sealed Gas Holder at Gasco Plant (From Hall 1916)

Exhibit 4: 1879 Panoramic Map Showing Downtown Portland MGP and Location of Remote Holder at NW Flanders and 6th

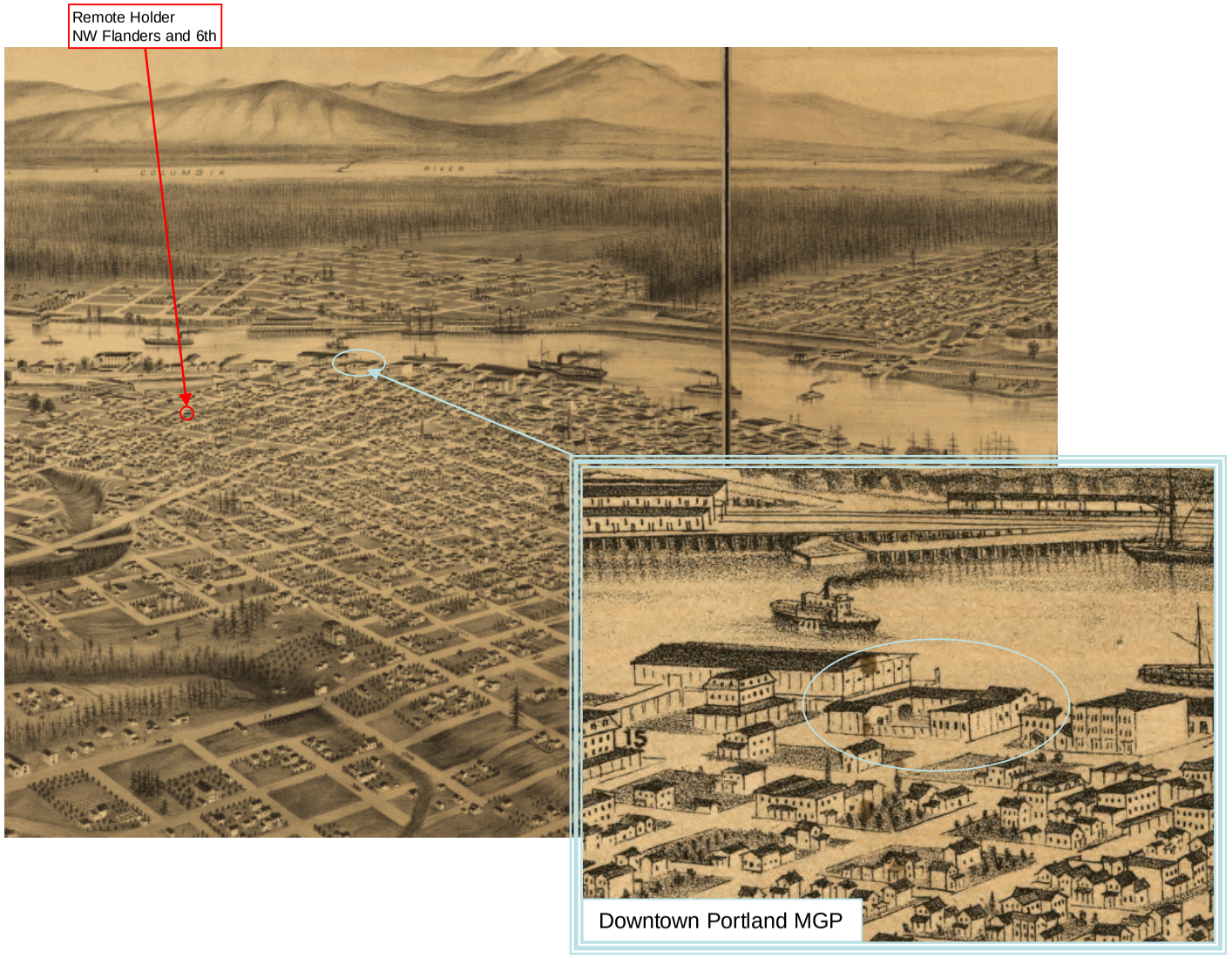


Exhibit 5: 1879 Panoramic Map Showing Downtown Portland MGP and Location of Remote Holder at NW Flanders and 6th

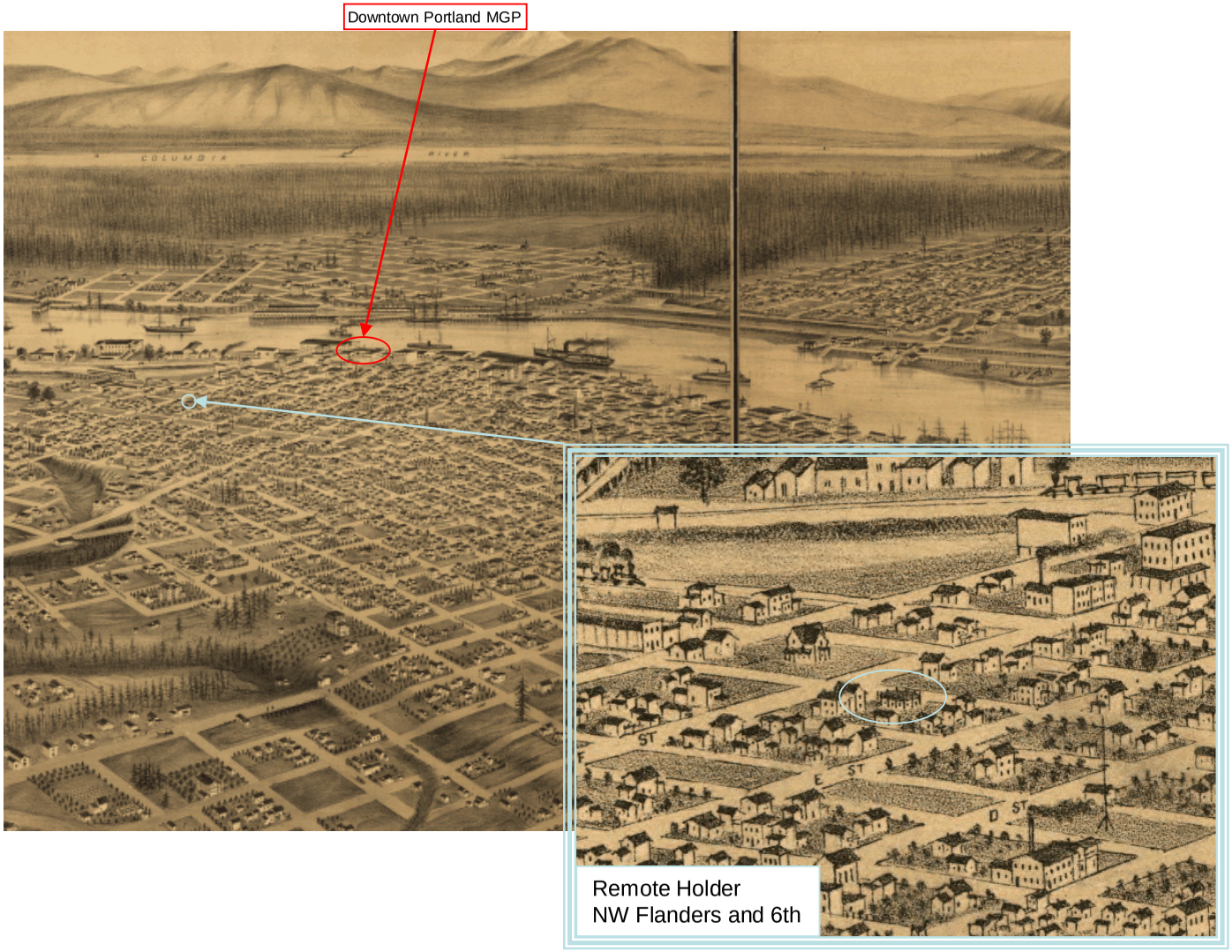


Exhibit 6: 1890 Panoramic Map Showing MGPs and Remote Holders with an Enlargement of the Downtown Portland MGP

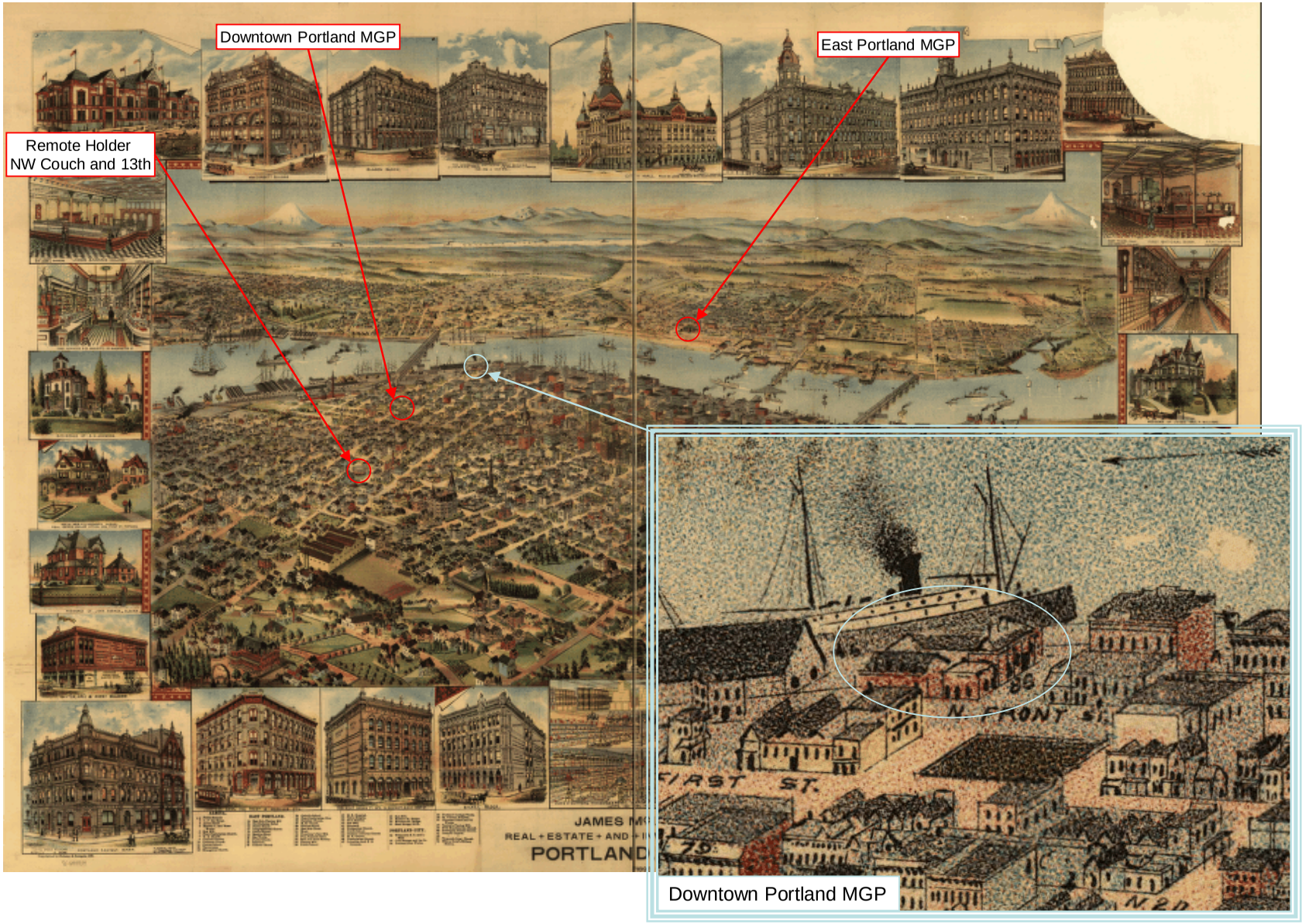


Exhibit 7: 1890 Panoramic Map Showing MGPs and Remote Holders with an Enlargement of the East Portland MGP

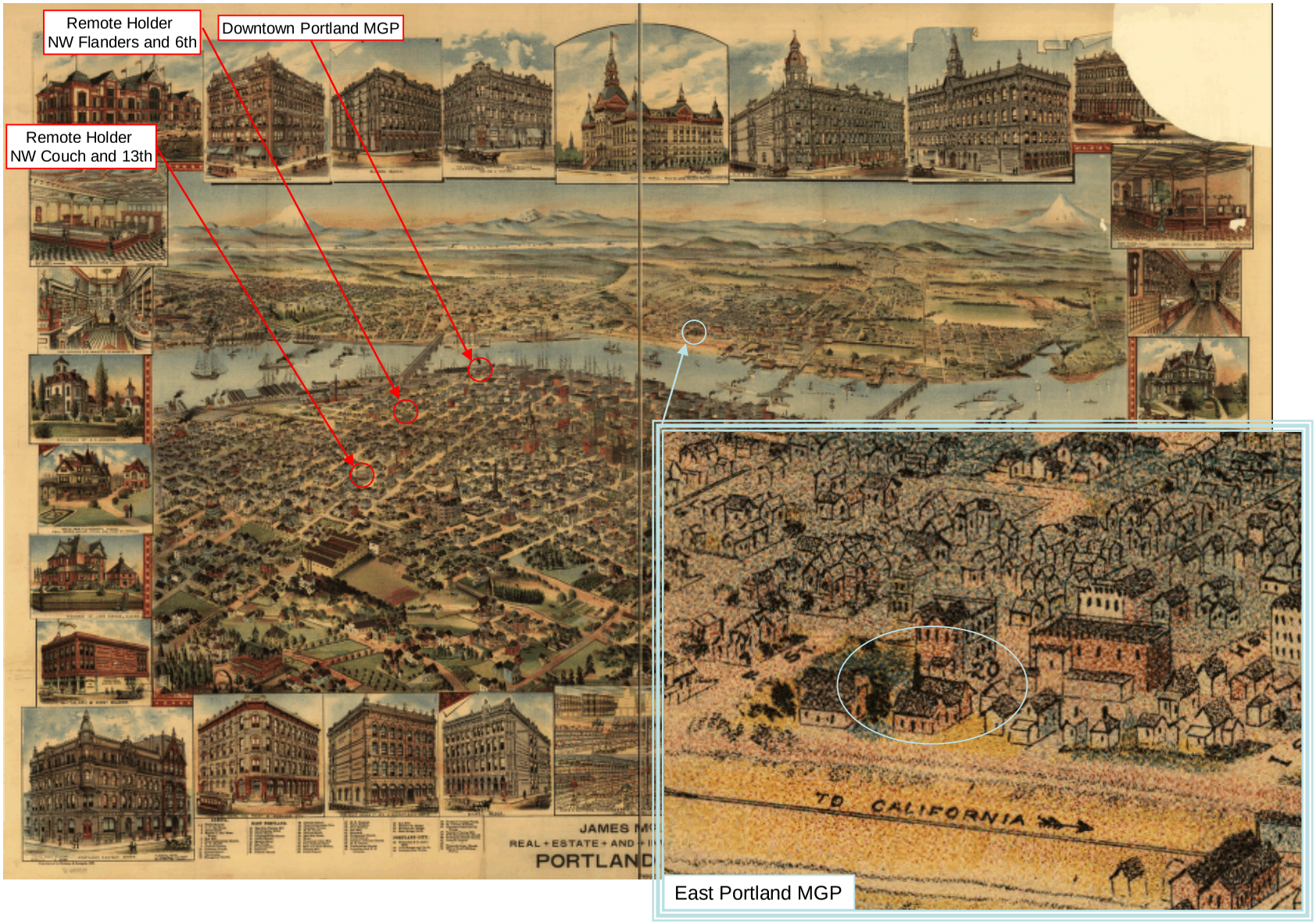


Exhibit 8: 1890 Panoramic Map Showing MGPs and Remote Holders with an Enlargement of the Remote Holder NW Flanders and 6th

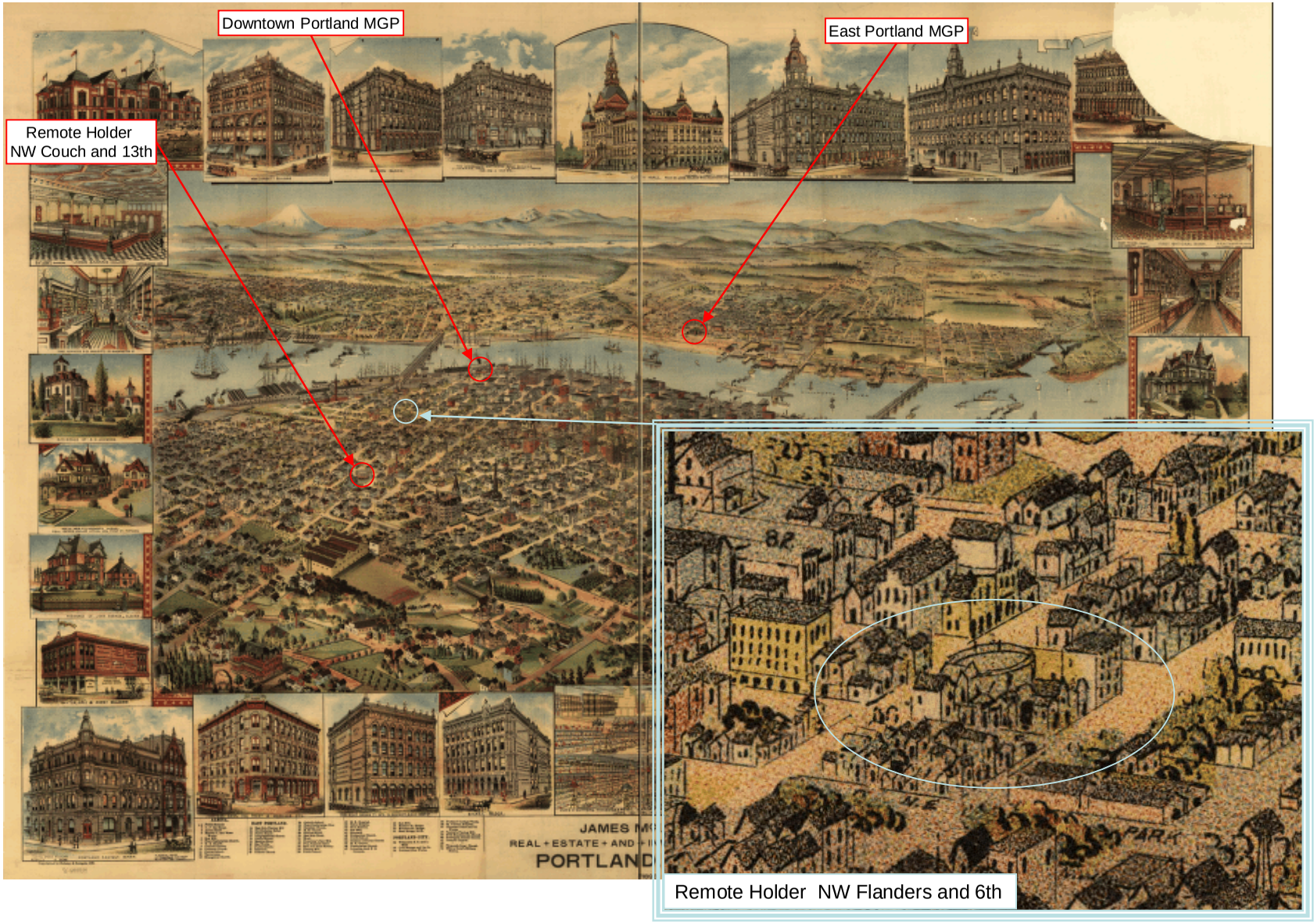
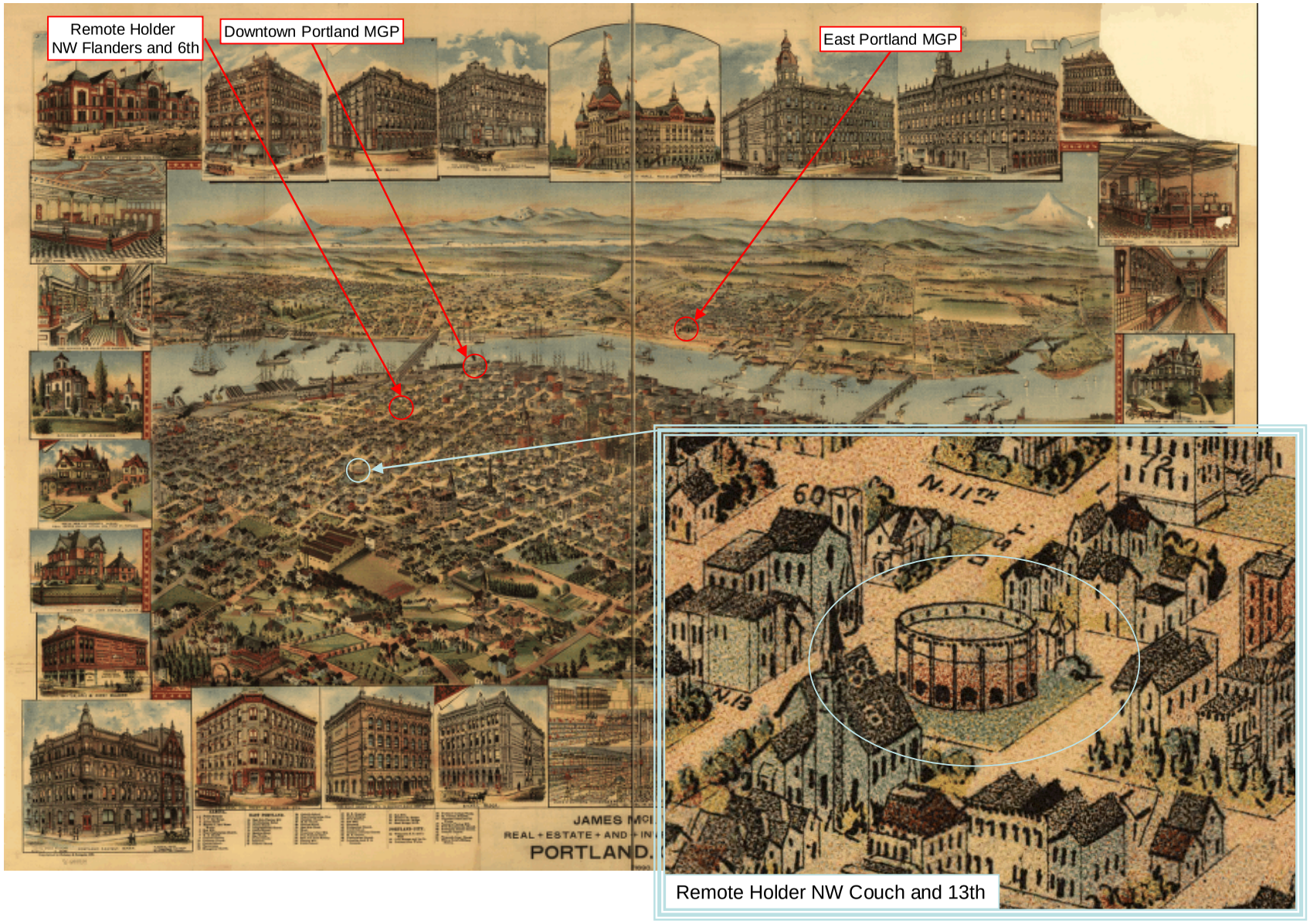
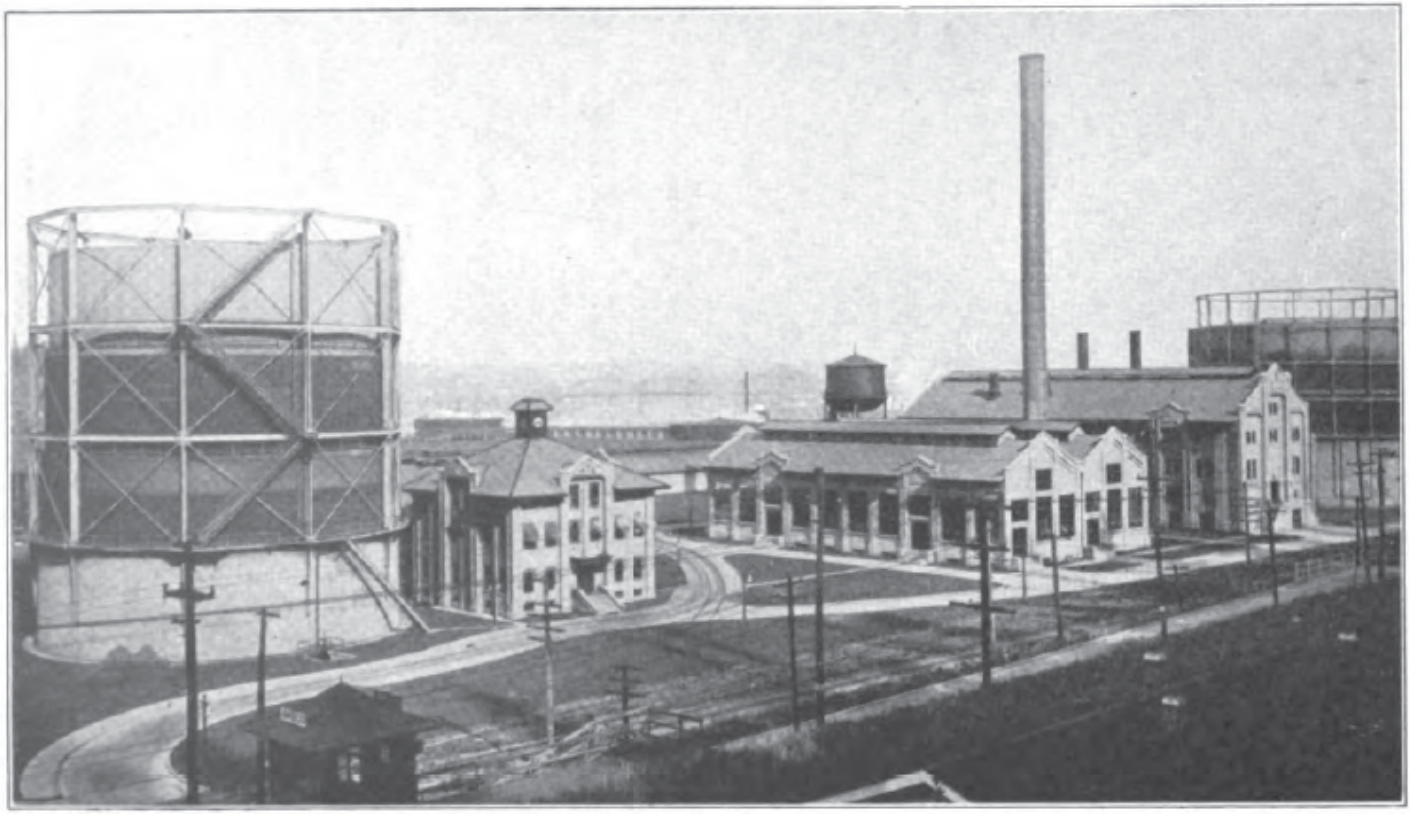


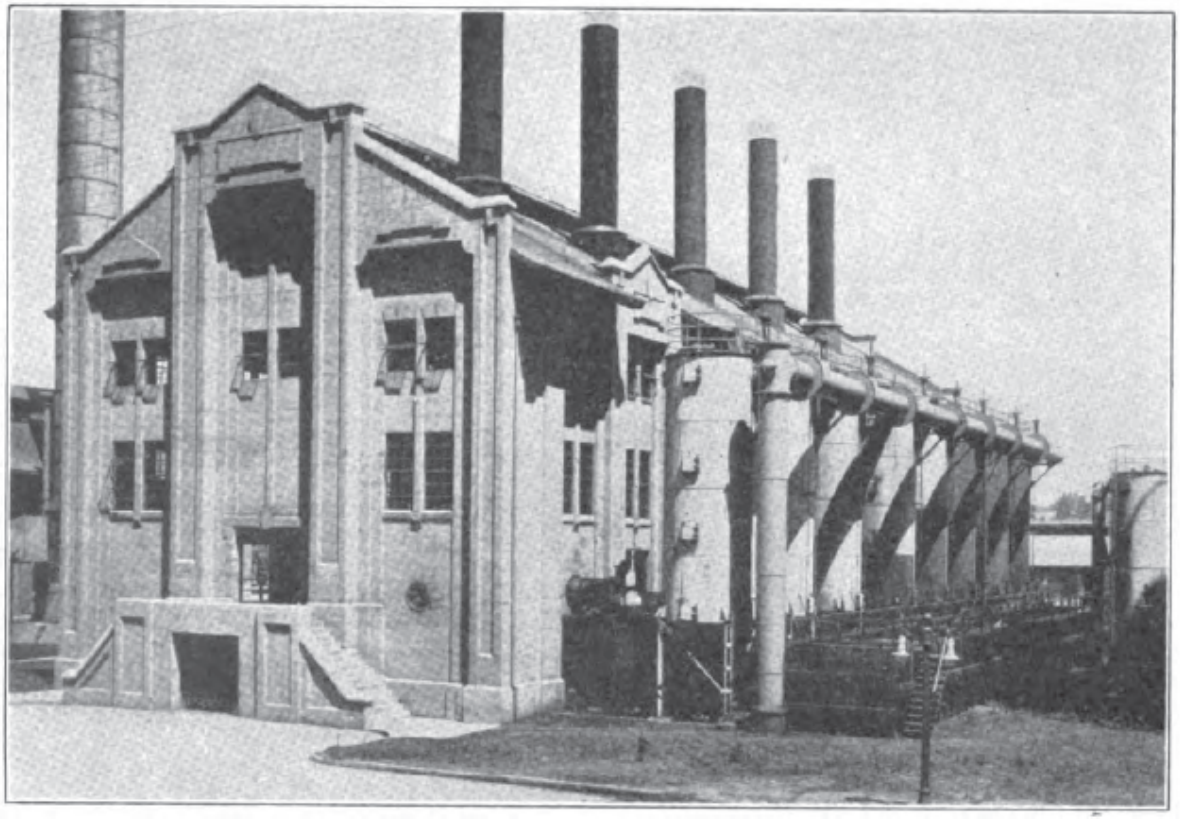
Exhibit 9: 1890 Panoramic Map Showing MGPs and Remote Holders with an Enlargement of the Remote Holder NW Couch and 13th





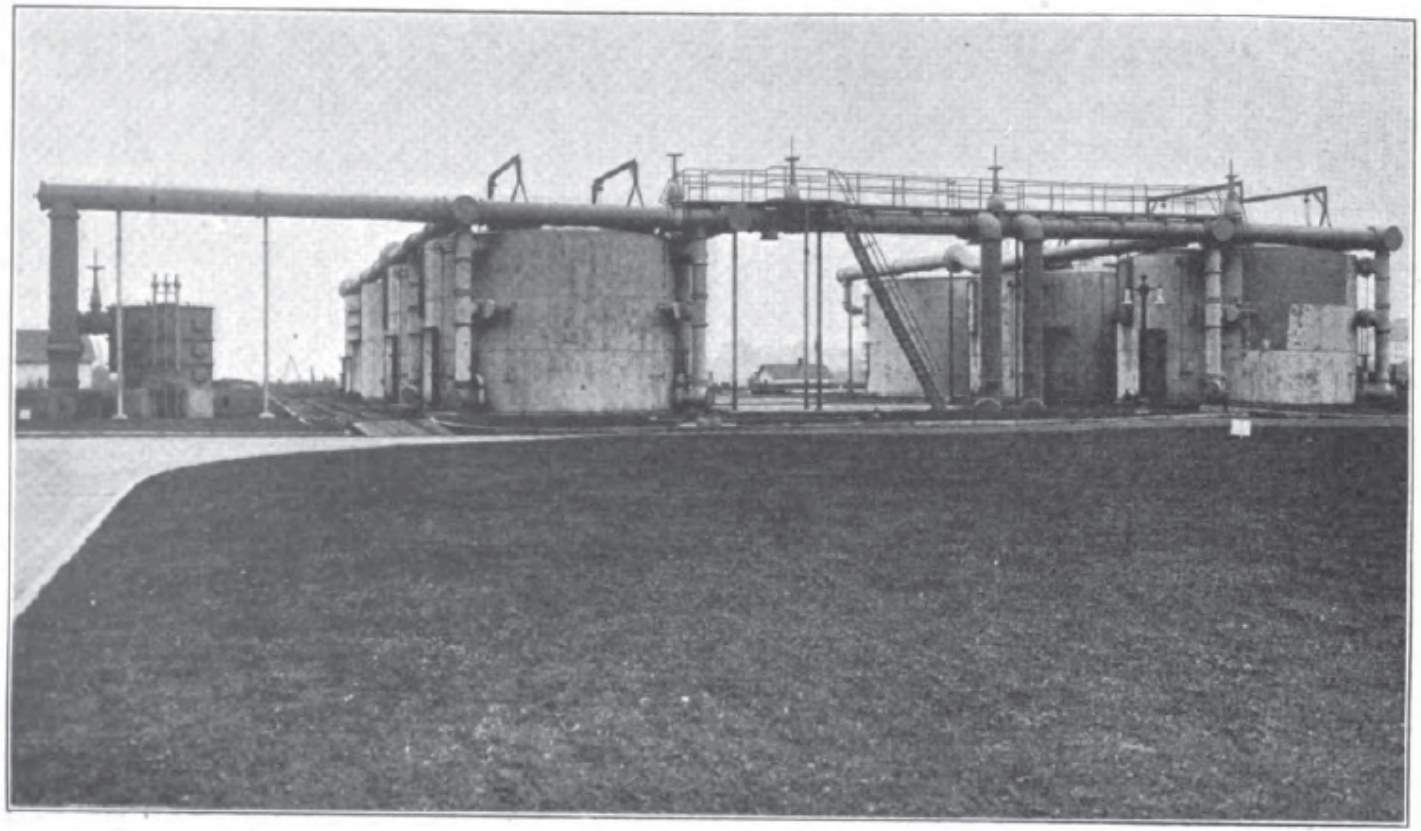
BUILDINGS AND GROUNDS.

Exhibit 10: Picture of Entrance to New Gas Plant at Linnton from 1916 Paper



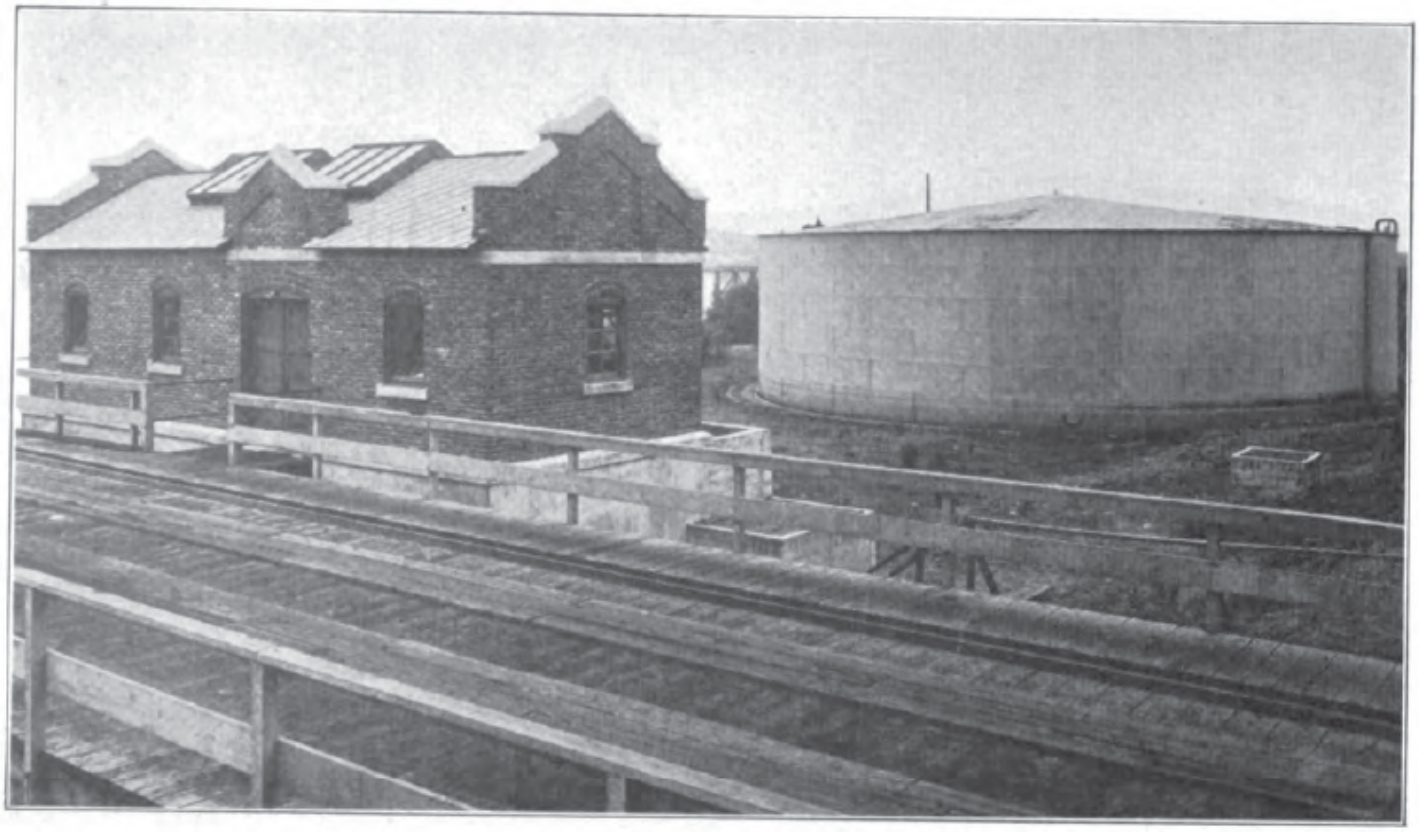
GENERATOR BUILDING.

Exhibit 11: Picture of Generator Building at New Gas Plant at Linnton from 1916 Paper



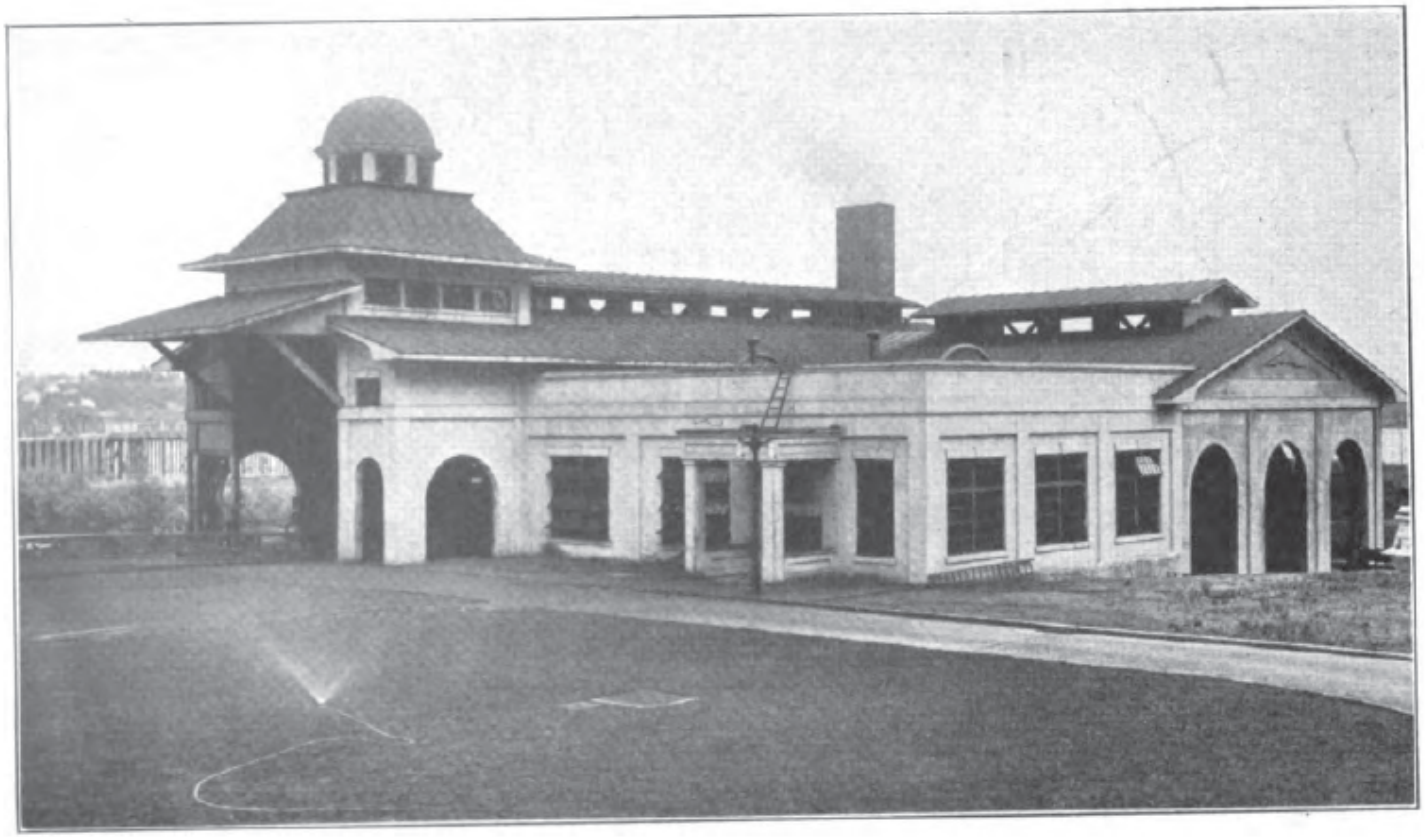
PURIFYING PLANT.

Exhibit 12: Picture of Purifiers at New Gas Plant at Linnton from 1916 Paper



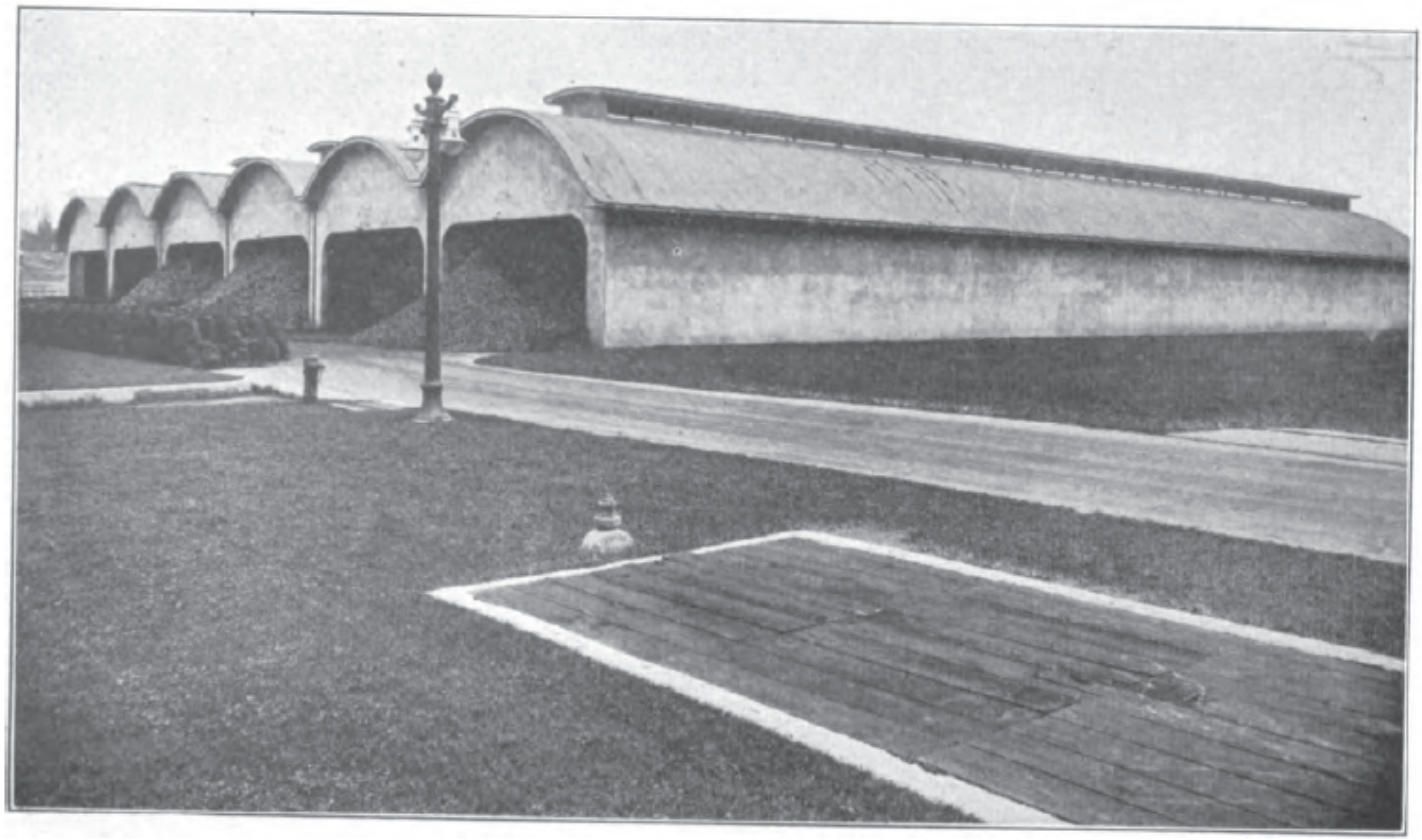
PUMPING STATION AND OIL TANK.

Exhibit 13: Picture of Oil Tank at New Gas Plant at Linnton from 1916 Paper



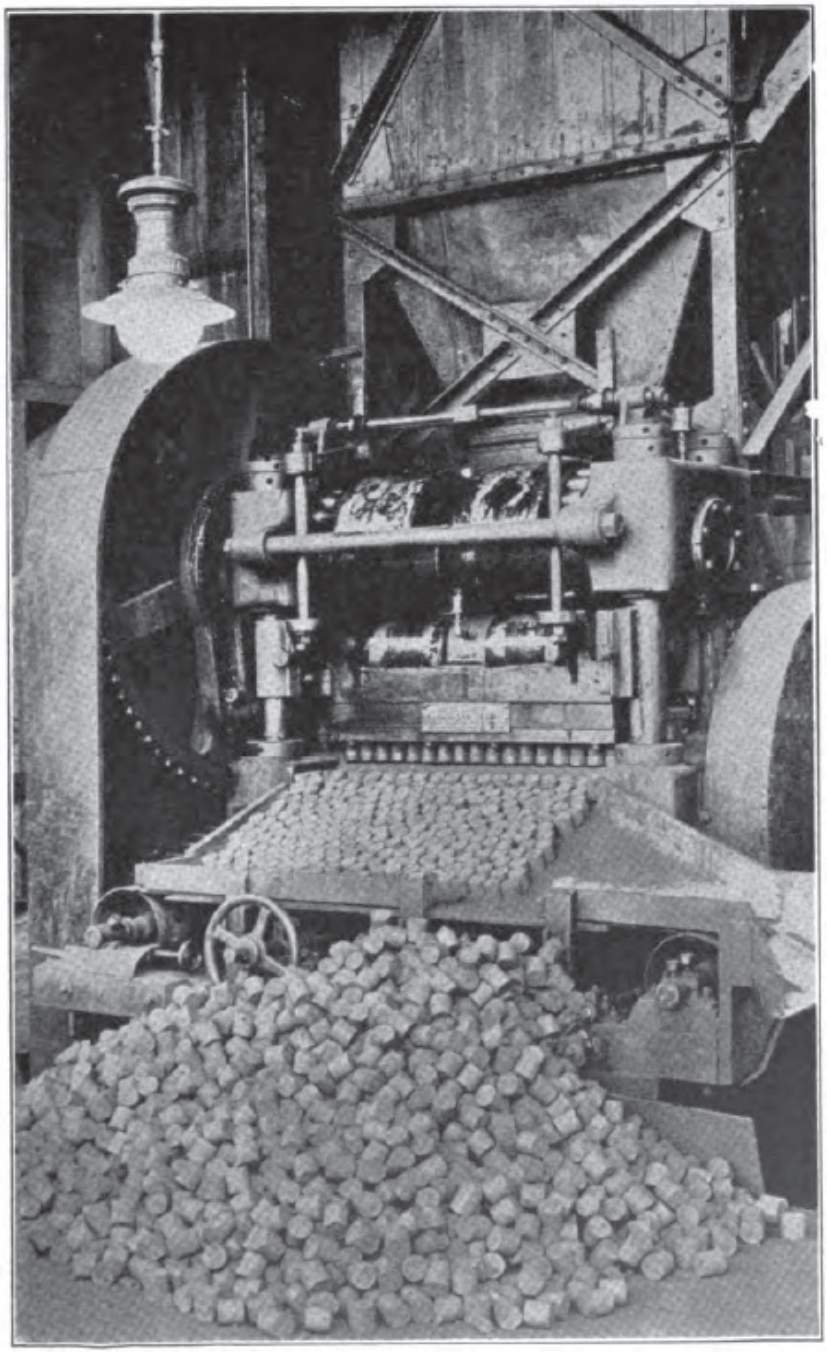
BRIQUETTE PLANT.

Exhibit 14: Picture of the Briquette Plant at New Gas Plant at Linnton from 1916 Paper



BRIQUETTE STORAGE SHEDS.

Exhibit 15: Picture of the Briquette Storage Sheds at New Gas Plant at Linnton from 1916 Paper



BRIQUETTE PRESS.

Exhibit 16: Picture of a Briquette Press at New Gas Plant at Linnton from 1916 Paper

NWN/403
Witness: Andrew Middleton

BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UM 1635

NW NATURAL

Exhibit Accompanying Direct Testimony of Andrew Middleton

Site Layout Plan, Schematic Diagrams, and Graphs

March 29, 2013

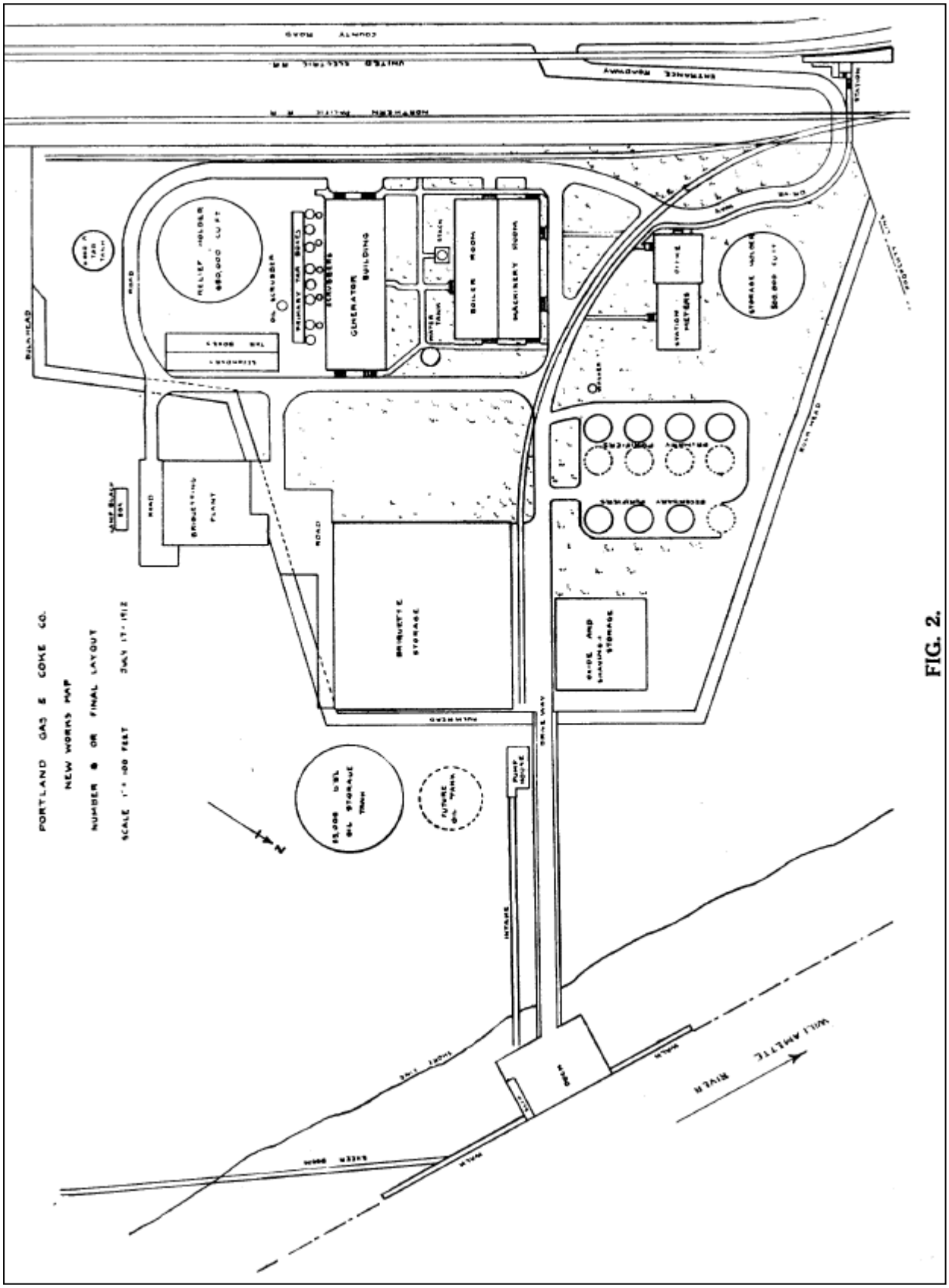


FIG. 2.

Exhibit 17: Site Layout Plan of the New Gas Plant at Linnton from 1916 Paper

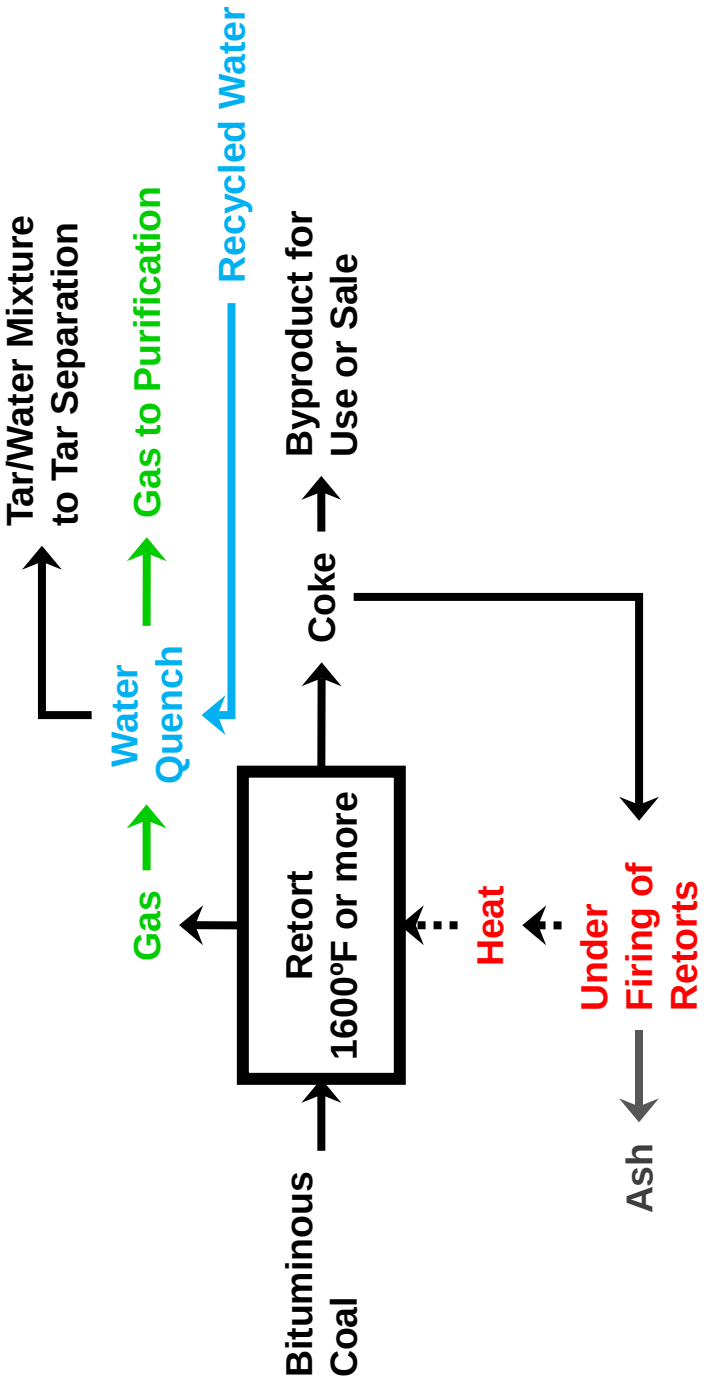


Exhibit 18: Schematic Diagram of Coal Gas Manufacture in Retorts

Exhibit 19: Schematic Diagram of Carburetted Water Gas ("Water Gas") Manufacture

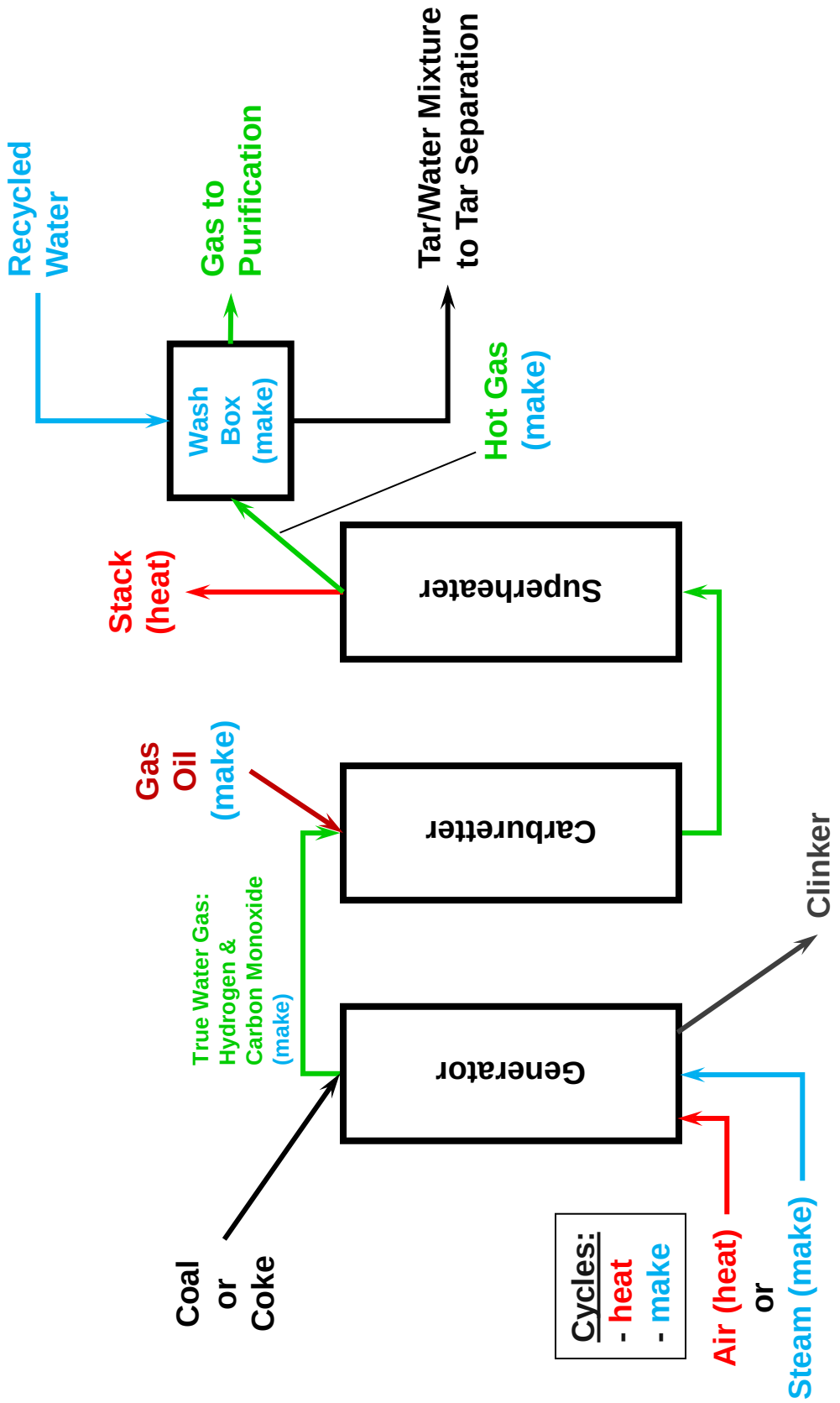
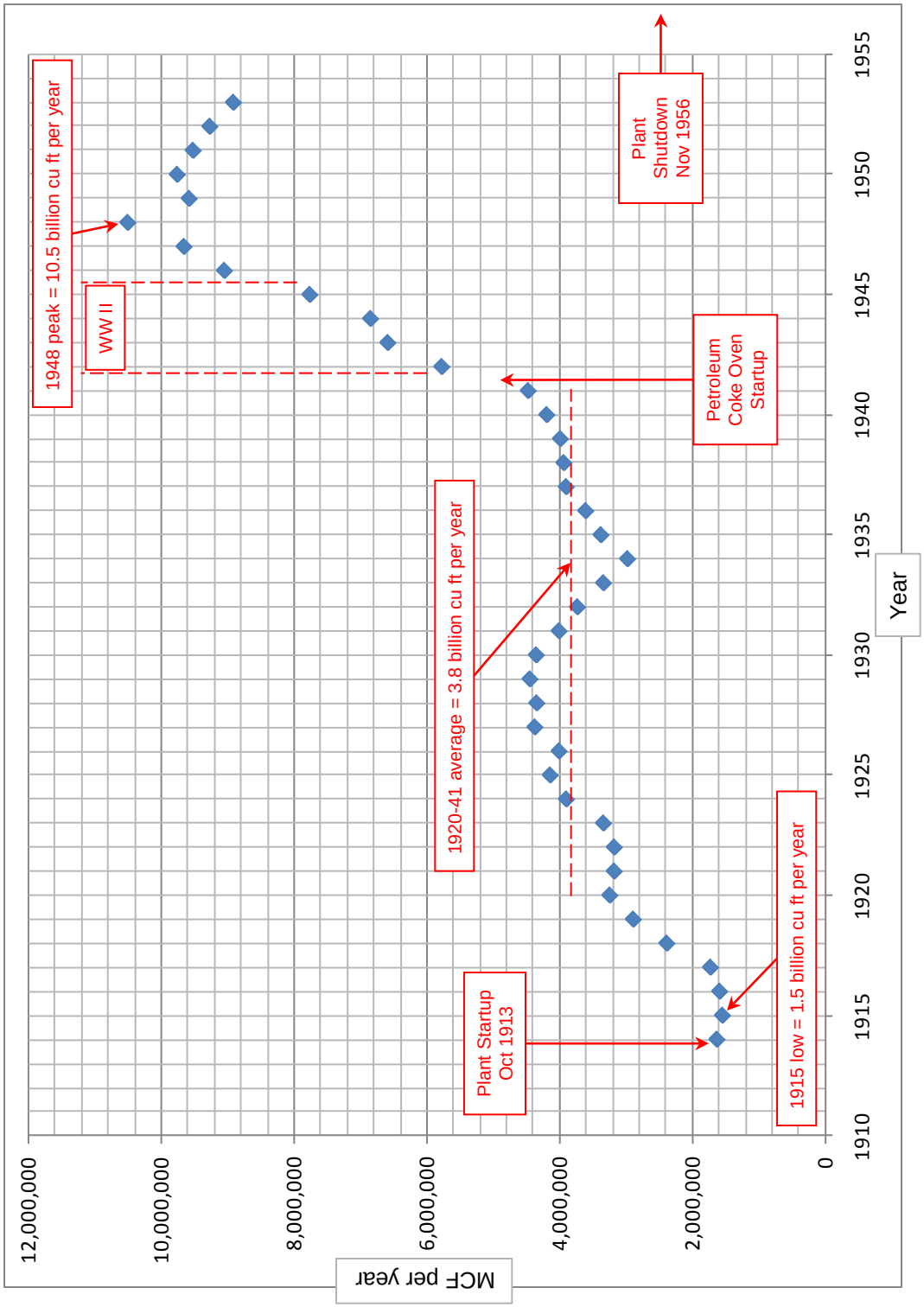


Exhibit 20: Graph of Annual Gas Production at the Linnton Plant 1914-53



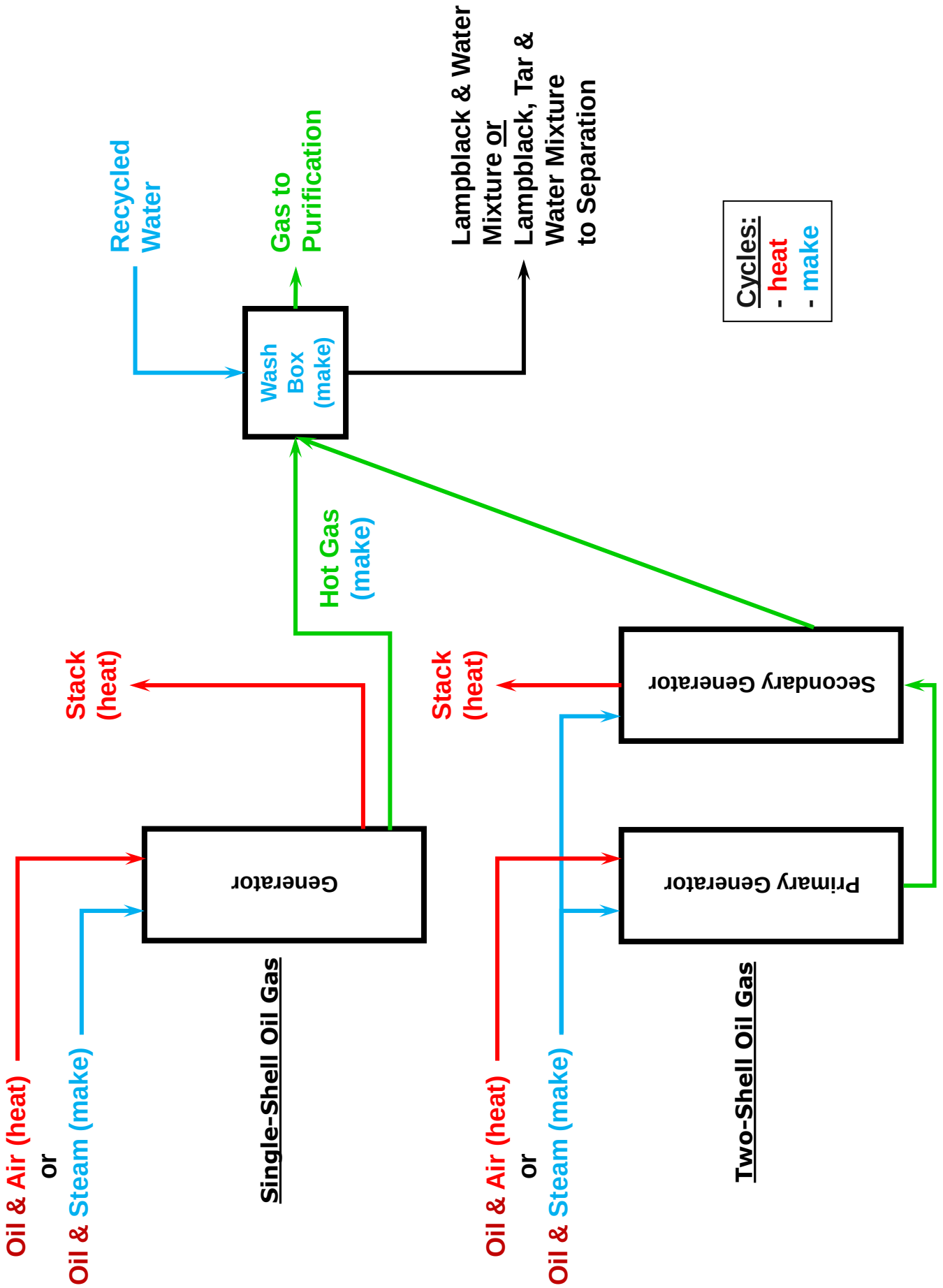


Exhibit 21: Schematic Diagram of Oil Gas Manufacture

NWN/404
Witness: Andrew Middleton

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1635

NW NATURAL

Exhibit Accompanying Direct Testimony of Andrew Middleton

Andrew Middleton Curriculum Vitae

March 29, 2013

CURRICULUM VITAE

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EDUCATION

Rockingham County Public School System, Rockingham County, Virginia, 1954-1966.
Virginia Polytechnic Institute & State University, Blacksburg, Virginia, 1966-1971.
Awarded B.S. with distinction in Civil Engineering with Cooperative Education Option (1971).
Awarded M.S. in Sanitary Engineering (1972).
Cornell University, Ithaca, New York, 1971-74
Awarded Ph.D. in Environmental Engineering (1975).

PROFESSIONAL REGISTRATION

Registered Professional Engineer of Province of Ontario (No. 31596018) since 1975.

PROFESSIONAL SOCIETIES

American Society of Civil Engineers
American Society for Testing and Materials
Water Environment Federation

BOARD CERTIFCATION

American Academy of Environmental Engineers (board certified by eminence in the specialty area of hazardous waste management), BCEE

AWARDS

Recipient of 1995 New York Water Environment Association Linn H. Enslow Memorial Award for outstanding paper, “Treatment of Organically Contaminated Groundwater in Municipal Activated Sludge System.”

Recipient of the 1999 PECO Energy (Philadelphia, PA) High Energy Excellence Award for work as a member of PECO’s Environmental Insurance Recovery Team.

MEMBERSHIP/COMMITTEE ACTIVITIES

November 1995 – Present: *National Trainer for ASTM* for its risk-based corrective action (RBCA) standard (E1739). In this capacity, Dr. Middleton instructs at the two-day ASTM RBCA course being held nationally. He has instructed hundreds of students in numerous of these courses across the U.S.

2000 – 2006: *Member of the External Advisory Panel, Environmental Engineering Department, SUNY/Buffalo, Buffalo, NY.* As a member he advised the Environmental Engineering Department on the educational needs of the environmental engineering practice on matters related to environmental remediation, waste treatment and management and management of environmental affairs. This panel periodically met with the faculty of the Department regarding the undergraduate environmental engineering program.

1999 – 2004: *Member of the Environmental Technical Advisory Board, Alcoa, Pittsburgh, PA.* As a member he advised the Alcoa Corporation on technical topics related to environmental remediation, waste treatment and management and management of environmental affairs, including topics for research and development. This board met several times annually with Alcoa's environmental management and remediation teams.

1999 – 2002: *Chair, Water Environment Research Foundation (WERF) Project Subcommittee on "Enhancing Biodegradability of Refractory Aromatics in Wastewater: Pretreatment with Elemental Iron, 99-CTS-3."* WERF awarded this grant to the University of Delaware for research on the capabilities of elemental iron to pretreat recalcitrant organic compounds in wastewater to improve their treatability in biological systems. The subcommittee then provided oversight on the progress of the research including review of the interim and final reports.

1998 – 2004: *Chair, Water Environment Research Foundation (WERF) Project Subcommittee on "Evaluating and Optimizing Source Treatment Technologies to Improve the Biodegradability of Organic Compounds, 99-WWF-5."* This subcommittee solicited and awarded a WERF grant to San Diego State University for research on the capabilities of advanced oxidative technologies to pretreat recalcitrant organic compounds in wastewater to improve their treatability in biological systems. The subcommittee then provided oversight on the progress of the research including review of the interim and final reports.

EMPLOYMENT RECORD

November 2001 – Present: *President, Corporate Environmental Solutions LLC.* Dr. Middleton founded this company in 2001 to provide environmental services. He is responsible for technical, operational and business affairs. He personally provides senior consulting services in the areas of corporate environmental management, environmental risk characterization and management, environmental dispute resolution, site assessment and remediation, and treatment of industrial wastewaters.

September 1981 – 2001: *Civil Engineering Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania*: Intermittent teaching of graduate courses in contaminated water treatment. He developed an innovative approach for the water and wastewater treatment course by unifying the subject matter into a course on "Treatment of Contaminated Water." This course focused on selection and design of a treatment system based on the nature and concentrations of contaminants and the intended means of disposition using a matrix of individual unit processes. The approach is applicable regardless of whether the contaminated water is municipal or industrial wastewater, groundwater or storm runoff. This approach contrasts to separate courses for water, wastewater or groundwater treatment.

January 2001 – November 2001: *Senior Vice President, The RETEC Group, Inc.* In this capacity he was responsible for executive oversight of engineering, science and technology efforts across the company as well as his technical consulting client program management practices. Additionally, he managed the O&M Group and provided consulting and engineering services, project and program management and business development in environmental management; contaminated water treatment; and, in site assessment and remediation.

April 1999 – December 2000: *General Manager of ThermoRetec's Site Management and Closure Division.* Responsible for the division technical and business affairs including division P&L. This division had a Construction Group and an Operations and Maintenance (O&M) Group. The construction group carried out large civil remediation construction projects (e.g., excavation, sheet piling, slurry walls, landfill covers, contaminated water treatment plant construction) for industrial and utility clients. The O&M Group operated remediation systems (e.g., groundwater extraction and treatment, land treatment units for bioremediation of soil, soil venting, NAPL recovery, landfill leachate treatment) across the U.S. also for industrial and utility clients. Additionally, he provided consulting and engineering services in environmental management, contaminated water treatment, laboratory and field treatability projects on site assessment and remediation.

January 1990 – April 1999: *Principal of ThermoRetec Consulting Corporation*. Responsible for technical and business affairs of company. ThermoRetec (formerly RETEC) is an engineering and remedial services company specializing in on-site treatment of organic wastes. Day-to-day duties included project management of RI/FS's on Superfund sites, site remediation, environmental audits of industrial facilities, design and operation of treatment facilities for contaminated groundwater, soils, industrial and municipal wastewaters, permitting of industrial facilities, and remedial technology development. He also was the principal investigator on field research studies for site remediation. He served as a member of ThermoRetec's Board of Directors from 1990 until 1995.

June 1991 – December 1996: *Member of the Board of Directors of EnSys Environmental Products, Inc.:* EnSys was a biotechnology start up company developing and selling immunoassay test kits for the analysis of soil and water. During his tenure on the Board, EnSys went public in an IPO in 1993 and merged with Strategic Diagnostics, Inc. (symbol: SDIX) in 1996. Dr. Middleton provided advice on commercialization opportunities for new test kits, served on the Audit Committee and chaired the Compensation Committee of this publicly traded company.

May 1990 – December 1995: *Member of the Board of Directors of Remediation Technologies, Inc (RETEC):* RETEC was a privately held company during his tenure on the Board. It tripled in size in this five-year period and became an acquisition of the publicly traded Thermo Remediation, Inc. (later renamed ThermoRetec) in December 1995. Dr. Middleton provided advice on strategic direction for the company as well as on technology commercialization.

July 1988 – December 1989: *President of Haniel Environmental Services, Inc. (HES).* Responsible for operations, technical matters and business affairs. HES was the U.S. branch of a German company specializing in site remediation. While in this position, his technical activities included managing soil gas surveys and *in situ* clean up of volatile organic compounds with soil venting and groundwater aeration systems, as well as general site decommissioning and remediation, project management of RI/FS's, and technical support of litigation. He served on the boards of directors of HES and its subsidiary companies during this his tenure as President.

June 1986 – June 1988: *President of Keystone Environmental Resources, Inc.* (also founder of Keystone). Responsible for management and leadership that grew the company from 90 employees to

over 250 with ten offices in the United States and Canada offering environmental consulting, analytical, and remediation services. Keystone was a wholly owned subsidiary of Koppers. Keystone specialized in the investigation and remediation of wood treating, tar-contaminated and chemical sites and in the design and operation of wastewater and groundwater treatment systems. He was also the principal investigator for Keystone's research project funded by the Gas Research Institute on assessment and remediation of manufactured gas plant sites and the director of the company's research and development efforts on new environmental technologies. He served on the board of directors of Keystone and continued as Vice President of Koppers Environmental Resources.

August 1984 – June 1986: *Vice President and General Manager of Pioneering Technologies (in addition to Environmental Resources):* Overall responsibilities for a program made up of a Materials Science Department, a Manufacturing Technologies Department, a Technical Information Department, and a Project Management Group; activities included research on polymer science and wood treating chemicals, computer-assisted drafting; instrumentation and control, systems design and installation, and computer and library facility management. Project management activities included facilitating use of a computer-based project management system throughout Koppers Science and Technology activities, especially on interdisciplinary teams. Additionally, Dr. Middleton directed this department's interactions with Koppers' venture investments in biotechnology and materials science.

June 1981 – June 1988: *Vice President and General Manager of Environmental Resources Department, Koppers Company, Inc., Monroeville, Pennsylvania*: Overall responsibility for management of Koppers environmental affairs. Included in Koppers operations were over 50 Chemical & Allied Products plants including 17 wood preserving plants, as well as other facilities producing metal products and road materials. In addition to the operating facilities, his overall responsibility included management of over 50 previously operated plants (wood treating and chemical plants) and disposal sites, a number of which are Superfund sites. His duties also included management of the environmental reserves for remediation of previously operated properties as well as developing an annual budget for activities on these sites. He built a multi-disciplinary staff of environmental engineers and scientists from 1981-1986, which was of such quality and capability that it was converted to a P&L subsidiary in 1986 (Keystone Environmental Resources, Inc.) to provide services outside of Koppers on a commercial basis.

February 1979 – May 1981: *Manager of Water Quality Engineering Section of Environmental Resources and Occupational Health Department, Koppers Company, Inc., Monroeville, Pennsylvania*: The objective of this section was to provide in-house water quality engineering services to Koppers Company. Projects included activated sludge treatability studies (bench-scale and pilot plant) at tar distillation plants; wastewater characterization studies at tar distillation and chemical plants; treatability studies for oil removal (bench-scale and pilot plant) at tar distillation and chemical plants; activated sludge plant startup at coke plants; preparation of activated sludge control programs at coke, chemical, and tar distillation plants; hydrogeologic surveys at tar distillation, wood preserving, and coke plants; fish toxicity studies on chemical and tar distillation plant wastewaters; priority pollutant surveys at chemical, coke, and tar distillation plants; development of wastewater treatment processes to achieve BAT for coke, tar distillation, and synthetic fuels plants. In this position, he also established a treatability laboratory program for wastewater, groundwater, sludge and soil.

June 1978 – January 1979: *Senior Research Engineer, Research Department, Koppers Company, Inc., Monroeville, Pennsylvania*: Responsible for water pollution control projects with Koppers Company, Inc., including activated sludge pilot plant study with continuous fish bioassays of effluent at a chemical plant; preparation of operational control programs at chemical sludge plants for coke and tar distillation plants.

July 1976 – May 1978: *Assistant Professor of Civil Engineering, SUNY at Buffalo, Buffalo, New York:* Teaching graduate and undergraduate courses in water and wastewater treatment and environmental engineering; acquiring and directing funded programs of research in water pollution control engineering, supervised graduate students and development of water pollution control laboratories; two students received Ph.D. degrees and nine received M.S. degrees in environmental engineering under his direction.

September 1974 – June 1976: *Assistant Professor of Civil Engineering, University of Ottawa, Ottawa, Ontario*: Teaching graduate and undergraduate course in water and wastewater treatment and environmental engineering; acquiring and directing funded programs of research in water pollution control engineering; supervising graduate students and development of water pollution control laboratories; seven students received M.S. degrees in environmental engineering under his direction.

September 1971 – August 1974: *EPA Post Masters Trainee, Cornell University, Ithaca, New York*: Study in the Environmental Engineering Ph.D. Program under Dr. A. W. Lawrence in Civil and Environmental Engineering School. In addition to his experimental research on the kinetics of microbial sulfate reduction, he also developed an approach for least cost design of wastewater treatment systems. He received a Ph.D. in environmental engineering.

September 1970 – August 1971: *Public Health Fellow, VPI&SU, Blacksburg, Virginia*: Study in Sanitary Engineering Program under Dr. E. M. Jennelle, Civil Engineering Department. He conducted experimental research on the water quality of a large, pumped storage reservoir near VPI for his Master's thesis. He received an MS in sanitary engineering.

March-June, September-December 1968; March-June, September-December, 1969: *Co-op student in Civil Engineering, Wiley & Wilson Consulting Engineers & Architects, Lynchburg, Virginia*: Worked as Engineering Design Assistant on municipal water and wastewater projects and as a land and route survey party member. The Co-op Program was part of his undergraduate work at Virginia Tech, from which he received a BS in civil engineering with distinction.

PUBLICATIONS (JOURNALS)

1. Middleton, A.C. and Lawrence, A.W., 1973. Discussion of "Optimal Design of Wastewater Treatment Systems by Enumeration," by G.F. Parkin and R.R. Dague, Journal Environmental Engineering Division, ASCE, 99, 960.

2. Middleton, A.C. and Lawrence, A.W., 1974. "Cost Optimization of Activated Sludge Systems," Biotechnology and Bioengineering, XVI, 807.

3. Middleton, A.C. and Lawrence, A.W., 1976. "Least Cost Design of Activated Sludge Systems," Journal Water Pollution Control Federation. 48, 395.

4. Middleton, A.C. and Lawrence, A.W., 1977. "Kinetics of Microbial Sulfate Reduction, "Journal Water Pollution Control Federation. 49,1659.

5. Middleton, A.C. and Rovers, F.A., 1976. "Average pH," Communications, Journal Water Pollution Control Federation, 48, 395.

6. Adamowski, K and Middleton, A.C., 1977. "Steady-State Dissolved Oxygen Model for the Rideau River," Canadian Journal of Civil Engineering. 4, 471.

7. Craig, E.W., Meredith, D.D., and Middleton, A.C., 1977. Discussion of "Simplified Optimization of Activated Sludge Process," by C.P.L. Grady, Jr., Journal Environmental Engineering Division, ASCE, 103, 1158.

8. MacInnes, C.D., Middleton, A.C., and Adamowski, K, 1978. "Stochastic Design of Flow Equalization Basins," Journal Environmental Engineering Division, ASCE, 104, 1277.

9. Craig, E.W., Meredith, D.D. and Middleton, A.C., 1978. "Cost Optimization of the Activated Sludge Process Using the Box-Complex Algorithm," Journal Environmental Engineering Division, ASCE. 104, 1101.

10. Westerndorf, J.R. and Middleton, A.C., 1979. "Chemical Aspects of the Relationship Between Drinking Water Quality and Long-Term Health Effects: An Overview," Journal American Water Works Association. 71, 417.

11. Fritz, J.J., Middleton, A.C., and Meredith, D.D., 1979. "Dynamic Process Modeling of Wastewater Stabilization Ponds," Journal Water Pollution Control Federation, 51, 2724.

12. Fritz, J.J., Meredith, D.D., and Middleton, A.C., 1980. "Non-Steady State Bulk Temperature Determination for Simple Aquatic Ecosystems: Stabilization Ponds," Water Research (U.K), 14, 413.

13. Habicht, M.H., Adamowski, K., and Middleton, A.C., 1981. "Potential Eutrophication of the Rideau River by an Urban Drainage Waterway," Canadian Journal of Civil Engineering, 8, 165.

14. Hughey, P.W., Meredith, D.D., and Middleton, A.C., 1982. "Optimal Operation of an Activated Sludge Plant," Journal Environmental Engineering Division, ASCE, 108, 349.

15. Smith, J.R., Luthy, R.G., and Middleton, A.C., 1988. "Microbial Ferrous Iron Oxidation in Acidic Solution," Journal Water Pollution Control Federation, 60, 518.

16. Meredith, D.D., Middleton, A.C., and Smith, J.R., 1990. "Design of Detention Basins for Industrial Sites," Journal Water Resources Planning and Management, ASCE, 116, 586.

17. Middleton, A.C., Nakles, D.V., and Linz, D.G., 1991. "The Influence of Soil Composition on Bioremediation of PAH-Contaminated Soils," Remediation, 1, 391.

18. Smith, J.R., Neuhauser, E.F., Middleton, A.C., Weightman, R.L, Linz, D.G., 1993. "Treatment of Organically Contaminated Groundwaters in Municipal Activated Sludge Systems," Water Environment Research, 65.

PUBLICATIONS (BOOKS)

1. Craun, J.C. and Middleton, A.C. (co-editors/authors), 1984. Handbook on Manufactured Gas Plant Sites, Washington, D.C.: Edison Electric Institute.

2. Unites, D., Nakles, D., Menzie, C., Middleton, A., and Helsel, R. (co-editors/authors), 1987. Management of Manufactured Gas Plant Sites, Vol. I-IV, Chicago, Illinois: Gas Research Institute.

PUBLICATIONS (CONFERENCE PROCEEDINGS)

1. Weyland, H.J. and Middleton, A.C., 1977. "Metals Recovery from Metallic Hydroxide Sludges Through Microbial Sulfate Reduction," Proceedings 9th Mid-Atlantic Industrial Waste Conference, Bucknell University, Lewisburg, Pennsylvania.

2. Lee, G.C., Meredith, D.D., and Middleton, A.C., Eds., 1979. "Proceedings of Hazardous Waste Management and Disposal Seminar," WREE Report No. 79-2, Civil Engineering SUNY/Buffalo, Buffalo, New York.

3. Bhattacharyya, A. and Middleton, A.C., 1979. "Development of Biological Treatment System Achieving BATEA for Coke Plant Wastewaters," Proceedings 11th Mid-Atlantic Industrial Waste Conference, Pennsylvania State University, State College, Pennsylvania.

4. Bhattacharyya, A. and Middleton, A.C., 1980. "Solids Retention Time: A Controlling Factor in the Successful Biological Nitrification of Coke Plant Wastes," Proceedings 12th Mid-Atlantic Industrial Waste Conference, Bucknell University, Lewisburg, Pennsylvania.

5. Bhattacharyya, A. and Middleton, A.C., 1980. "Enhanced Biological Treatment System for Coke Plant Wastewater Achieving Complete Nitrification," Proceedings 35th Industrial Waste Conference, Purdue University, Lafayette, Indiana.

6. Middleton, A.C., 1981. "Process Control for Activated Sludge Treatment of Coke Plant Wastewater," Proceedings: Symposium on Iron and Steel Pollution Abatement Technology for 1980, EPA-600/9-81-017, Philadelphia, Pennsylvania.

7. Middleton, A.C., Smith, J.R., Urbassik, M.R., Keffer, R.E., Sawchuck, P.W., and Edwards, G.E., 1984. "Industrial Wastewater Treatability Study Achieving BCT/BAT Treatment," Proceedings 16th Mid-Atlantic Industrial Waste Conference, Pennsylvania State University, State College, Pennsylvania.

8. Middleton, A.C., 1995. "Historical Overview of Manufactured Gas Processes Used in the United States," presented at International Symposium and Trade Fair on the Clean-up of Manufactured Gas Plants, Prague, Czech Republic; published in Land Contamination & Reclamation, Vol. 3, No. 4, pp.5-17 – 5-19.

PRESENTATIONS

1. Middleton, A.C. and Jenelle, E.M., "The Influence of an Impoundment on the Priority of Effluent Treatment in the Upstream Watershed," presented at 26th Annual Meeting, Virginia Water Poll. Control Assn., Roanoke, Virginia, April 30, 1970.

2. Middleton, A.C. and Jenelle, E.M., "Processes Influencing Water Quality in a Pumped Storage Reservoir," presented at 8th Annual Meeting, Am. Water Resources Assn., St. Louis, Missouri, October 31, 1972.

3. Middleton, A.C. and Lawrence, A.W., "Cost Optimization of Activated Sludge Wastewater Treatment Systems," presented at 166th National Meeting, Am. Chem. Soc., Chicago, Illinois, August 30, 1973.

4. Middleton, A.C. and Lawrence, A.W., "Least Cost Design of Activated Sludge Systems," presented at 46th Annual Meeting, Water Pollution Control Federation, Cleveland, Ohio, October 22, 1973.

5. Adamowski, K and Middleton, A.C., "Water Quality of the Rideau River," invited seminar at 2nd Annual Science Education Day Conf., Kanata, Ontario, April 12, 1975.

6. Middleton, A.C. and Lawrence, A.W., "Kinetics and Engineering Significant of Microbial Sulfate Reduction," presented at 47th Annual Meeting, Water Pollution Control Federation, Miami Beach, Florida, October 8, 1975.

7. Middleton, A.C., "The Science of Environmental Impact Statement," invited seminar for Buffalo Section of ASCE Workshop on "The Preparation of Environmental Impact Statements," Buffalo, New York, February 8, 1977.

8. Middleton, A.C., "Design of the Activated Sludge Process," invited seminar for Buffalo Section ASCE Workshop on "Design and Operation of the Activated Sludge Process," Buffalo, New York, March 14, 1978.

9. Middleton, A.C. and Lawrence, A.W., "The Effect of Recycle Sludge Pumping Rates on the Activated Sludge Process," invited seminar for Buffalo Section ASCE Workshop on "Design and Operation of the Activated Sludge Process," Buffalo, New York, March 14, 1978.

10. Westendorf, J.R., Middleton, A.C., and Kasprzak, P.J., "Co-Disposal of a Combined Municipal/Industrial Wastewater Treatment Plant Sludge with Municipal Refuse in a Sanitary Landfill," presented at 52nd Annual Conference Water Pollution Control Federation, Houston, Texas, October, May 14, 1980.

11. Middleton, A.C., "Wastewater Treatment for Coke and Coal-Tar Distillation Plants," presented at the Spring Meeting American Coke and Coal Chemicals Institute, Hilton Head, South Carolina, May 19, 1981.

12. Middleton, A.C., "Hazardous Wastes," presented at Disaster Emphasis Day, Annual Conference, Church of the Brethren, Indianapolis, Indiana, June 23, 1981.

13. Hughey, P.W., Meredith, D.D., and Middleton, A.C., "Optimal Operation of an Activated Sludge Wastewater Treatment Plant," presented at The International Symposium on Real Time Operation of Hydrosystems, Waterloo, Ontario, Canada, June 25, 1981.

14. Middleton, A.C., "Removal of Priority Pollutants From Coal-Tar Condensate Water," invited speaker at The Fate of Wastewater-Borne Priority Pollutants Subjected to Biological Treatment, U.S. EPA Seminar, Washington, D.C., May 4, 1982.

15. Malik, D.P., Middleton, A.C., Bryant, D.L., Sgro, G.A., Fillo, J.P., Charna, R.B., and Maruhnich, E.D., "Water Usage and Treatment, Tennessee Synfuels Project," presented at ASCE Conference on Water & Energy: Technical & Policy Issues, Pittsburgh, Pennsylvania, May 1982.

16. Middleton, A.C., "BAT Regulations for Coke Plants," invited speaker at Fall Meeting, Manufacturing and Environmental Committee, American Coke and Coal Chemicals Institute, Indianapolis, Indiana, September 14, 1982.

17. Middleton, A.C., "Priority Pollutant Removal From Coke and Coal-Tar Distillation Plant Wastewaters By Biological Treatment," invited speaker at Biological Treatment, Priority Pollutants and BATEA Seminar, Philadelphia, Pennsylvania, December 10, 1982.

18. Middleton, A.C., "Wastewater Treatment For Coke Plants: Regulations and Capabilities," invited speaker at Eastern States Coke Conference, Pittsburgh, Pennsylvania, February 1983.

19. Middleton, A.C., "Land Disposal and Spill Site Environments," invited speaker at Genetic Control of Environmental Pollutants, University of Washington, Seattle, August 1, 1983.

20. Middleton, A.C. and Oster, L.A., "Projected Environmental Costs to Permit and Operate the PMA Methanol Plant," presented at the AIChE 1984 Summer National Meeting, Philadelphia, Pennsylvania, August 19, 1984.

21. Spencer, J.D., Middleton, A.C., Smith, J.R., Campbell, J.R., and Zeff, J.D., "Evaluation of Treatment Technologies for Contaminated Groundwater," presented at the Water Pollution Control Federation 59th Annual Conference/Exposition, Los Angeles, California, October 6-9, 1986.

22. Middleton, A.C., "Opportunities for Chemical Engineers in Hazardous Waste Management," presented to the Pittsburgh Section of AIChE, Pittsburgh, Pennsylvania, January 13, 1987.

23. Middleton, A.C., "Environmental Management," invited speaker at the annual meeting of the National Wood Window and Door Association, Maui, Hawaii, February 1987.

24. Hegnauer, A. and Middleton, A.C., "Environmental Considerations at Manufactured Gas Plant Sites," presented at the American Gas Association Distribution/Transmission Conference, Las Vegas, Nevada, May 1987.

25. McShea, L.J., Smith, J.R., Middleton, A.C., and Zeff, J.D., "Chemical Oxidation of Aqueous Pentachlorophenol and Phenolics by UV-Ozonation," presented at the American Institute of Chemical Engineers 1986 Summer National Meeting, Boston, Massachusetts, August 24-27, 1986.

26. Middleton, A.C., Presentation on bioremediation of wood treating wastes to Committee on Small Business, Subcommittee on Energy and Agriculture, U.S. House of Representatives, Washington, D.C., September 1987.

27. Hiller, D.H. and Middleton, A.C., "Die Abwicklung von Schadensfallen in den USA," presented at Harress Geotechnik-Umweltseminar, Kloster Banz, Germany, October, 21-22, 1988.

28. Smith, J.R., Fu, J.K, and Middleton, A.C., "Field Work Evaluating Engineered Biodegradation System Treatment of Soil Contaminated with Wood Preserving Chemicals," presented at Conference on Genetically Engineered or Adapted Microorganisms in Hazardous Waste Treatment, Washington, D.C., December 1988.

29. Middleton, A.C., "Co-Treatment of Groundwater in POTWs," presented at Management of Manufactured Gas Plant Sites Technology Transfer Seminar sponsored by EEI, EPRI, and GRI, Pittsburgh, Pennsylvania, April 19-20, 1989.

30. Middleton, A.C. and Hiller, D.H., *"In Situ* Aeration of Groundwater, a Technology Overview," presented at Conference on Prevention and Treatment of Soil and Groundwater Contamination in the Petroleum Refining and Distribution Industry, Montreal, Quebec, October 16-17, 1990.

31. Linz, D.G., Neuhauser, E.F. and Middleton, A.C., "Perspectives on Bioremediation in Gas Industry," presented at Environmental Biotechnology Symposium, Knoxville, TN, October 17-19, 1990.

32. Middleton, A.C., "A Historical Perspective of Manufactured Gas Plant Operations," presented at 1990 Manufactured Gas Plant Site Workshop sponsored by AGA, Boston, MA, October 31-November 1, 1990.

33. Middleton, A.C., "Past Operations and Present-Day Site Management," presented at MGP Technology Transfer Seminar sponsored by EPRI and GRI, Atlanta, GA, April 2-3, 1991.

34. Middleton, A.C., "Remediation Options and Technologies," presented at Manufactured Gas Plant Site Workshop sponsored by NEGA, Sutton, MA, October 9, 1991.

35. Saber, D.L., Smith, J.R., Lawrence, A.W. and Middleton, A.C., "Optimization of an Oil Recovery/Groundwater Treatment System Based upon Treatability Study/Engineering Evaluations of Superfund Site Clean-Up," presented at the AIChE 1992 Summer National Meeting, August 9-12, 1992.

36. Smith, J.R., Lawrence, A.W. and Middleton, A.C., "Sequencing Batch Reactor Treatment of Superfund Site Groundwater," presented at the 65th Annual Water Environment Federation Conference, New Orleans, LA, September 20-24, 1992.

37. Middleton, A.C., Lawrence, A.W., Morgan, D.J., Lees, M.G. and Hayes, T.D., Biosparging Strategies for Containment and Remediation of Organic Contaminant Groundwater Plumes at E&P Sites Using Either Vertical or Horizontal Sparge Wells," presented at The Eighth International IGT Symposium on Gas, Oil and Environmental Biotechnology, Colorado Springs, Colorado, December 11-13, 1995.

38. Middleton, A.C., Draybuck, B.M., Grizzle, P.L. and Hayes, T.D., "Pilot Test of Biosparging at a Natural Gas Plant and Pipeline Facility," presented at the Ninth International IGT Symposium on Gas, Oil, and Environmental Biotechnology, Colorado Springs, Colorado, December 9-11, 1996

39. Middleton, A.C., Lawrence, A.W., Draybuck, B.M., Grizzle, P.L. and Hayes, T.D., "The Role of Preliminary Testing in the Design of a Biosparge System at a Natural Gas Plant and Pipeline Facility," presented at the 1997 SPE/EPA Exploration & Production Environmental Conference, Dallas, Texas, March 3-5, 1997.

40. Middleton, A.C., "Historical Operations at MGP Sites," presented at the Illinois Manufactured Gas Plant (MGP) Forum, Bloomington, Illinois, May 20, 1999 and at the Midwest Energy Association Meeting, Colorado Springs, CO, October 15, 1999.

41. Middleton, A.C., "Future Needs to be Addressed by Environmental Engineers and Scientists," presented at the University at Buffalo, Buffalo, NY, October 22, 1999.

42. Middleton, A.C., “Future Corporate Needs to be addressed by Environmental Engineers and Scientists,” presented at Carnegie Mellon University, Pittsburgh, PA, February 18, 2000, and the University of Texas Austin, Austin, TX, February 23, 2000.

43. Middleton, A.C., “Future Trends in Corporate Environmental Management,” presented at the University of Pittsburgh, Pittsburgh, PA, March 22, 2000.

44. Hasel, M.J., Shamory, C. and Middleton, A.C., “Thermal Desorption of Heavily Impacted MGP Soils under New TCLP Exemption,” presented at the GTI 14th International Conference on Site Remediation Technologies, Orlando, FL, December 2-6, 2001.

45. Middleton, A.C., “The Effect of Historical Issues on Risk,” presented at the AGA MGP Workshop, Washington, DC, August 6, 2004.

46. Morgan, D., Mahfood, J., Malle, J., Middleton, A. and McGraw, D., “The Effect of Site Remediation Risk Level on Potential Incidence of Cancer within the United States,” poster displayed at the Midwestern Risk Assessment Meeting, Indianapolis, IN, August 26, 2004.

47. Middleton, A.C. and Flaherty, J.M., “PAH Sources: Sources and Their Identification,” presented at the MEA Environmental Management Conference, Chicago, IL, September 23, 2004.

48. Bhattacharyya, A., Blayden, J.M., and Middleton, A.C. “Estimating Historic Tar Production at Manufactured Gas Plants,” presented at the poster session of National Gas Technologies 2005 Conference, Orlando Fl, January 30-February 2, 2005.

49. Blayden, J.M., Gould, J.E., Middleton, A.C., Morgan, D.J., Sladky, B.R. and McCauley, P.B., “Integration of State Risk-Based Closure Endpoints into Probabilistic Remediation Cost Estimates for MGP Sites,” presented at the National Gas Technologies 2005 Conference, Orlando Fl, January 30-February 2, 2005.

50. Sladky, B.R., Fernandes, A.C., Middleton and Morgan, D.J. “Long-Term Management Issues Resulting from Risk-Based Closure of MGP Sites,” presented at the National Gas Technologies 2005 Conference, Orlando FL, January 30-February 2, 2005.

51. Middleton, A. C. **“**Financial Strategies for Environmental Projects,” presented at the MEA Environmental Management Conference, Colorado Springs, CO, September 28, 2005.

52. Middleton, A. C. and Gould, J. E. **“**Data Management,” presented at the MEA Environmental Management Conference, Colorado Springs, CO, September 28, 2005.

53. Fernandes, A. F. and Middleton, A.C., "A Unified Multi-State Utility MGP Management Program," presented at MGP 2006 Conference, Reading, UK, April 4-6, 2006.

54. Middleton, A.C., Weightman, R.L. and Blayden, J.M. "Forensic Observation during MGP Site Remediation," poster displayed at MGP 2006 Conference, Reading, UK, April 4-6, 2006.

55. Lynch, M.J., Sylvester, J.M., Hart-Lovelace, J., Jones, D.R., and Middleton, A.C. “Insurance Recovery for MGP Site Clean-Up Costs," presented at MGP 2006 Conference, Reading, UK, April 4-6, 2006.

56. Morgan, D.J., Middleton, A.C. and Blayden, J.M. "Business Management Considerations in the Selection of Institutional and Engineering Controls for MGP Site Remediation," presented at MGP 2006 Conference, Reading, UK, April 4-6, 2006.

57. Middleton, A.C. "Influence of History of MGPs – Lecture 1," presented at EPRI MGP 101 Course, Philadelphia, PA, June 18, 2008.

TECHNICAL AND RESEARCH REPORTS

1. Middleton, A.C. and Lawrence, A.W., 1973. “Cost Optimization of Activated Sludge Wastewater Treatment Systems,” EPM Technical Report No. 73-1, Department of Environmental Engineering, Cornell University, Ithaca, New York.

2. Middleton, A.C. and Lawrence, A.W., 1974. “Least Cost Design of Activated Sludge Wastewater Treatment Systems,” EPM Technical Report 74-1, Department of Environmental Engineering, Cornell University, Ithaca, New York.

3. Adamowski, K and Middleton, A.C., 1976. “Comprehensive Water Quality Study of the Rideau River from Long Island to Hog’s Back Falls, June-July, 1975,” Final Report to the Ontario Ministry of Environment, Kingston, Ontario.

4. Middleton, A.C. and McDougall, W.J., 1977. “Technological Alternatives for Industrial Wastewater Treatment,” Seminar Notes, Civil Engineering, SUNY/Buffalo, Buffalo, New York.

5. Uchida, A. and Middleton, A.C., 1978. “Water Quality Modeling of Mine Acid Drainage II: Laboratory Evaluation of Preliminary Model,” WREE Report No. 78-3, Civil Engineering, SUNY/Buffalo, Buffalo, New York.

6. Fritz, J.J., Meredith, D.D., and Middleton, A.C., 1978. “Modeling and Design of Wastewater Stabilization Ponds,” WREE Report No. 78-4, Civil Engineering, SUNY/Buffalo, Buffalo, New York.

7. Middleton, A.C., Narbaitz, R.M., and Uchida, A., 1980. “Phosphorus Solubilization during Anaerobic Decomposition of Algae,” WREE Report No. 80-1, Civil Engineering, SUNY, Buffalo, Buffalo, New York.

8. Fritz, J.J., Middleton, A.C., and Meredith, D.D., 1981. “Application of a Rational Process Model in Design of Waste Stabilization Ponds,” WREE Report, Civil Engineering, SUNY/Buffalo, Buffalo, New York.

9. Kasprzak, P.J., Meredith, D.D., and Middleton, A.C., 1982. “Effect of Primary Settling Tank Efficiency on Cost Optimization of the Activated Sludge Process,” WREE Report, Civil Engineering, SUNY/Buffalo, Buffalo, New York.

10. Numerous other technical, research and expert reports have been prepared during employment outside universities.

FUNDED RESEARCH PROJECTS

1. "Design of Aerated Lagoons for Low Temperature Operation," funded by Research Office, School of Graduate Studies, University of Ottawa, for the amount of $4,500, during the period March 20,1975 to December 31,1975 (Principal Investigator).

2. "Assessment and Control of Storm Water Pollution," funded by National Research Council of Canada, for the amount of $16,500 during the period of April 1, 1975 to March 31, 1978 (Principal Investigator).

3. "Development of a Water Quality Model for the Rideau River," funded by Ontario Ministry of the Environment for the amount of $12,065 during the period of May 20, 1975 to August 8, 1975 (Co-Principal Investigator).

4. "Microbial Production of Limestone from Gypsum," funded by the SUNY Research Foundation for the amount of $2,100 during the period of January 1, 1977-December 31, 1980 (Principal Investigator).

5. "Phosphorus Solubilization during Anaerobic Decomposition of Algae," funded by National Science Foundation for the amount of $52,887 during the period of October 15, 1977-March 31, 1980 (Principal Investigator).

6. "Co-Disposal of Wastewater Treatment Sludge and Municipal Refuse – City of Niagara Falls, New York," funded by City of Niagara Falls, New York for the amount of $1,500 during the period of June 1,1978 to September 30,1978 (Co-Principal Investigator).

7. "Metals Recovery from Waste Metallic Hydroxide Sludges through Microbial Sulfate Reduction," funded by Environment Canada for the amount of $30,000 during the period of January 1980 to May 1980 (Co-Principal Investigator).

8. "Development of MGP Site Remediation Methodologies," funded by Gas Research Institute for the amount of $250,000 during the period of June 1986-June 1988 (Principal Investigator).

9. "Co-Treatment of MGP Groundwater in a POTW," funded by Gas Research Institute for the amount of $250,000 during the period of June 1987-June 1988 (Principal Investigator).

10. "Pilot Scale Biosparging Project," funded by Gas Research Institute for the amount of $226,000 during the period January 1994-April 1995.

PAST PROFESSIONAL ACTIVITIES

1. Lecturer, Short Course on Engineering Control of Industrial Wastewaters, Cornell University, June 1975.

2. Technical Advisor, Environmental Conservation Task Force, Greater Buffalo Development Foundation, December 1976-May 1978.

3. Organizer and Chairperson, Hazardous Waste Management and Disposal Seminar, SUNY/Buffalo, February 1979.

4. Associate Engineer, Conestoga-Rovers, Ltd., Waterloo, Ontario, 1976-78. Consultant to government and industry on water and wastewater treatment and waste disposal on land.

5. Member, Chemical Manufacturers Association (CMA) Five-Plant Study Work Group on Priority Pollutant Removal by Biological Treatment Plants.

6. Member, U.S. EPA TSCA Panel on Genetic Engineering of Microorganisms for Bioremediation, Washington, D.C., 1987.

7. Member, Environmental Advisory Committee, Fox Chapel Borough, PA, 1988-91.

8. Member, Industrial Advisory Committee, Gulf States Hazardous Research Center, Lamar University, Beaumont, TX, 1990-91.

9. Member, Technical Advisory Committee, New York State Hazardous Waste Management Center, SUNY/Buffalo, Buffalo, NY, 1988-95.

10. Organizer of Gas Research Institute Seminar on Risk-Based Corrective Action for Gas Industry Applications, Chicago, IL, 1996-97.

11. Developer and Lecturer in Courses on Operation of a Refinery Activated Sludge Wastewater Treatment Plant, Ergon Refining, Newell, WV, 1997-99.

HEALTH AND SAFETY

Current on 8-hour OSHA Hazardous Waste Operations Refresher
40-hour OSHA Hazardous Waste Operations Training, 1991
8-hour Hazardous Waste Supervisor Training, 1992
10-hour OSHA Construction Outreach Training, 2000
8-hour Competent Person Training (Trenching), 2000
Confined-Space Entry Training, 2005

TESTIMONY

YEAR	TESTIMONY	STATE	CASE
1988-89	Deposition and trial testimony (expert witness) in Broderick Investment Co. vs. Ponderosa Timber regarding wood treating plants (Broderick Investment Co.)	CO	---
1989	Deposition and trial testimony (expert witness) in USF&G Co. vs. Colorado National Bank, et al. regarding wood treating plants (Broderick Investment Co.)	CO	Civil Action No. 86-Z-1033
1989-90	Pre-filed direct and rebuttal and cross-examination testimony (expert witness) before Massachusetts Department of Public Utilities regarding manufactured gas plants (Bay State Gas, et. al.).	MA	DPU 89-161

1991	Deposition testimony (expert witness) in Burlington Northern vs. Washington Natural Gas, et. al. regarding manufactured gas plants (Electric Utilities Group)	WA	No. C89-155TB
1991	Pre-filed direct and cross-examination testimony (expert witness) before Illinois Commerce Commission regarding manufactured gas plants (Peoples Gas Light & Coke, et al.)	IL	ICC: Docket Nos. 91-0080 through 91-0095
1991	Trial testimony (expert witness) in Escambia vs. Soule regarding wood treating plants (Escambia)	FL	---
1992	Rebuttal and cross-examination testimony (expert witness) before the New Jersey Bureau of Regulatory Commissioners regarding manufactured gas plants (South Jersey Gas)	NJ	BRC Docket No. GR91071243J
1992	Direct and cross examination testimony (expert witness) before the New Jersey Bureau of Regulated Utilities regarding manufactured gas plants (New Jersey Natural Gas)	NJ	BRC Docket No. GR91081393J
1992	Deposition testimony (expert witness) in Chemical Lehman Tank Lines vs. Aetna regarding wastewater management (Chemical Lehman)	NJ	Case No. 89-1543
1993	Pre-filed direct and cross-examination testimony (expert witness) before Indiana Utilities Regulatory Commission regarding manufactured gas plants (Indiana Gas)	IN	Cause No. 39353 Phase II
1993	Deposition and trial testimony (expert witness) in Broderick vs. Hartford regarding wood treating plants (Broderick Investment Co.)	CO	Civil Action No. 86-Z-1033 CA No. 90-1112
1993	Deposition and trial testimony (expert witness) in Washington Natural Gas vs. Aetna regarding manufactured gas plants (Washington Natural Gas)	WA	Civil Action No. 91-2-13506-1
1994	Deposition testimony (fact witness) in Koppers Company vs. Aetna regarding the Koppers Company, Inc. (1978-1988)	PA	Civil Action No. 85-2136
1994-95	Pre-filed direct and cross-examination testimony (expert witness) before the Michigan Public Service Commission regarding manufactured gas plants (Consumers Power Company)	MI	Case No. 4-10755
1995	Testimony (expert witness) before the Oklahoma Corporation Commission regarding groundwater remediation (Oryx, ANR and Conoco, Inc.)	OK	Cause PD No. 920024760
1996	Deposition testimony in Indiana Gas vs. Aetna regarding manufactured gas plants (Indiana Gas)	IN	Civil Action 1:95CV101
1996	Deposition testimony (expert witness) in Hickmon vs. Oryx Energy Co. regarding groundwater remediation (Oryx, ANR and Conoco, Inc.)	OK	Case No. CIV94-1524-T
1997	Deposition testimony (expert witness) in EnergyNorth Natural Gas vs. UGI Utilities, Inc. regarding manufactured gas plants (EnergyNorth Natural Gas)	NH	C-95-438-B
1997	Deposition testimony (fact witness) in Penn Fuel Gas vs. Pennsylvania Electric Co. regarding manufactured gas plant site investigations and remediation (1996-1997)	PA	---

1999	Deposition testimony (fact witness) in Penn Fuel Gas vs. Aetna, et al. regarding manufactured gas plant site investigations and remediation (1996-1999)	PA	Chester Co., PA, Court of Common Pleas Civil Division No. 94-07744
2001	Deposition testimony (fact witness) in PSI Energy, Inc vs. Aetna, et al. regarding manufactured gas plant site investigations and remediation (1996-1999)	IN	Hendricks Co., IN, Hendricks Superior Court Cause No. 32DO1 9807 CP 230
2002-03	Deposition testimony (expert witness) in PECO Energy vs. INA, et al. regarding manufactured gas plants (PECO Energy)	PA	Chester Co., PA, Court of Common Pleas Civil Division No. 99-07386
2004	Deposition testimony (expert witness) in Bangor vs. Citizens Communications vs. Barrett et al. regarding manufactured gas plants (Citizens Communications)	ME	USDC, Maine, Civil Docket No. 02-cv-183-B-S
2004	Deposition testimony (30(b)6 witness, rebuttal expert witness) in PECO Energy vs. INA, et al. regarding manufactured gas plants (PECO Energy)	PA	Chester Co., PA, Court of Common Pleas Civil Division No. 99-07386
2005	Deposition testimony (expert witness, rebuttal expert witness) in Puget Sound Energy v. Alba General Insurance Co. et al. regarding manufactured gas plants (Puget Sound Energy)	WA	Superior Court of State of Washington No. 97-2-29050-3 SEA
2005	Trial testimony (expert witness) in Bangor vs. Citizens Communications vs. Barrett et al. regarding manufactured gas plants (Citizens Communications)	ME	USDC, Maine, Civil Docket No. 02-cv-183-B-S
2006	Deposition testimony (30(b)6 witness) in CGCU vs. Aetna Casualty & Surety Co., et al. regarding manufactured gas plants (CGCU)	IN	Marion Co., IN, Superior Court Cause No. 49F12-0407-PL-01986
2007	Deposition testimony (expert witness, 30(b)6 witness) in CGCU vs. Aetna Casualty & Surety Co., et al. regarding manufactured gas plants (CGCU)	IN	Marion Co., IN, Superior Court Cause No. 49F12-0407-PL-01986
2010	Deposition testimony (expert witness) in SIGECO vs. Admiral Ins. Co., et al. regarding manufactured gas plants (SIGECO [Vectren])	IN	Marion Co., IN, Superior Court Cause No. 49D05-0411-PL-2265
2011	Deposition testimony (rebuttal expert witness) in SIGECO vs. Admiral Ins. Co., et al. regarding manufactured gas plants (SIGECO [Vectren])	IN	Marion Co., IN, Superior Court Cause No. 49D05-0411-PL-2265