commitment to a number of important initiatives. New leadership has shown attention to a broad series of changes. However, Liberty considers the future of current new management at Peoples Gas to be in doubt, given the pending acquisition.

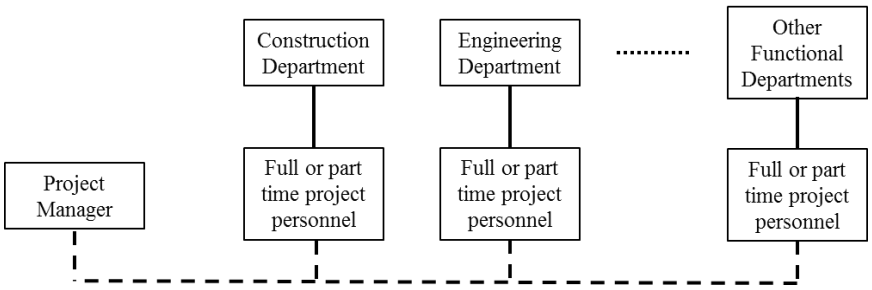
d. Program Management

i. Approach

The choice of how to structure and design a project organization has far-reaching implications. Two primary options have common industry application, with variations in between them.

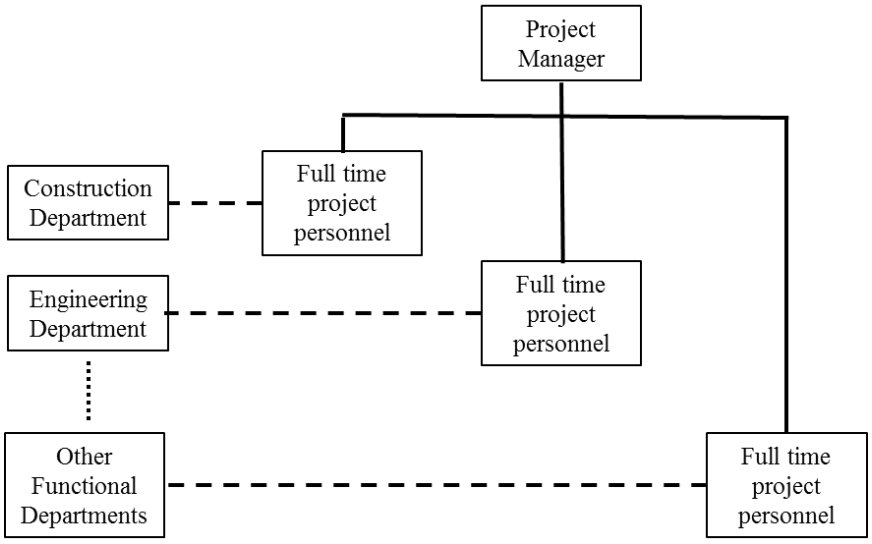
The first approach employs what the industry terms a "weak" project manager: While it may sound negative, a "weak" project structure often proves very effective. The next chart illustrates this approach. A weak approach uses a largely matrix-type organization. The functional groups (*e.g.*, engineering, construction, procurement, quality) take day-to-day technical direction from functional management and project direction from the project manager, usually via a dotted-line relationship. Decision-making occurs at the functional level and functional managers have limited accountability to the project manager.

Chart E.2: Typical "Weak" (Matrix) Project Structure



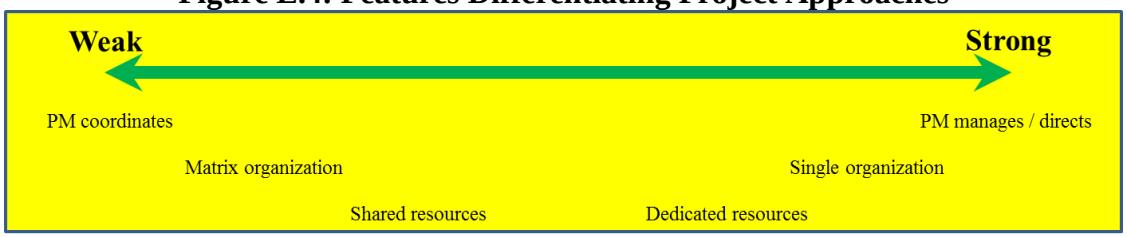
The second approach employs a so-called "strong" project manager. The term does not refer to the project manager's capabilities or style. Rather, it denotes the use of a dedicated project organization that employs full-time (not matrixed) functional groups reporting to the project manager. These groups may also have a dotted-line relationship for technical support and direction back to a functional leader. The project manager has full authority.

Chart E.3: Strong Project Manager Structure



A broad spectrum of choices exists between the two approaches pictured above. Organization designers have many workable options. The following illustration shows the differences and the range of options.

Figure E.4: Features Differentiating Project Approaches



There is no universal, correct choice. The weak project management approach often serves as the optimum approach. It actually requires a strong manager; *i.e.*, one who gets things done by consensus building or "jawboning," rather than by exercising direct authority. Approaches moving toward the "weak" end of the spectrum require increasing degrees of cooperation and teamwork.

The strong approach brings advantages in a number of circumstances. First, only the largest projects can afford large groups of dedicated resources. The smaller the project, the more likely the need for sharing resources. Second, technical expertise theoretically becomes weaker, because one no longer has call on the entire technical organization and leadership. Project success, under strong project management, becomes more dependent on the capabilities of dedicated resources.

Liberty does not consider the choice of a weak project management approach for the AMRP optimum. First, the relationship between Integrys and Peoples Gas did not commend an approach that relies more on cooperation among organizations with different priorities and approaches. Equally important, the size and duration of the AMRP make a dedicated organization with comparatively larger numbers of qualified people more affordable. Management can secure strong

contributors, assign them only to the AMRP, sustain a large and dedicated staff over the program's life, and offer career-length opportunities for many.

A program like the AMRP cannot function effectively as a "tack-on" to day-to-day responsibilities and activities of a company like Peoples Gas. Regular program functions, not to mention inevitable crises, require a dedicated structural approach to serve program needs fully, while allowing sufficient attention to other matters. The scope and importance of those matters will not generally diminish. Management of a mega-program will demand attention on a recurring, long-term, and sometimes unpredictable basis. Even the best organization simply cannot perform normal duties with an AMRP treated as an add-on. Problems that the AMRP experienced with respect to the back end AMRP work (meter installations, for example) performed by internal Peoples Gas resources exemplify this situation.

ii. AMRP Program Management

Successful performance of the AMRP depends on a strong emphasis on program management commitment and oversight. Early Liberty work raised concerns about that commitment, as evidenced by a number of indicators:

- The role of Peoples Gas or Integrys employees in the management of the program was limited and indirect
- The lack of a strong owner presence with a corresponding level of leadership weakened management, oversight, and control
- This approach to owner involvement resulted in a near total reliance on a contractor (Jacobs Engineering) for staffing program management functions
- The lack of a long-term plan and efforts to build internal skills and capabilities existed
- There was limited owner program management presence in Chicago
- That management did not bring sufficient coordination and control of engineering and construction resources in performing key AMRP work activities.

The Integrys Project Management Office had responsibility for managing the main and service installation portions of AMRP work. A senior Integrys person headed that organization, but operated from outside Chicago. Liberty learned that the plan had been to create a truly integrated contractor/employee Project Management Office. Early interviews indicated a plan to add Integrys personnel in leadership roles to the management organization largely staffed by an outside firm. Liberty observed, however, only limited numbers of Integrys personnel. Moreover, they filled roles more on the periphery of the organization than in leadership. The Project Management Office chart provided literally superimposed the few Integrys members on the organization chart populated by contractor personnel, placing internal employees along one of the chart's edges.

As a result, the AMRP's Project Management Office continues to rely on personnel from Jacobs Engineering to provide project management of the main and service installation portion of the AMRP. This is not to criticize the outside firm, but to observe insufficient owner management and direction.

There was thus no Chicago-based, dedicated, owner-centric management group responsible for main and service installations. Moreover, responsibility for critical, last-stage tie-in, meter setting,

and relighting work resided outside the Project Management Office. Each of the three, geographically-divided "Shops" of Peoples Gas performed such work using employee crews. Coordination of effort between the Integrys and Peoples Gas organizations was not strong. The lack of dedicated, common management of all AMRP activities contributed to the lack of coordination.

Liberty considers the following attributes, all of which were lacking in at least some form on the AMRP, to be those best suited to optimizing the performance of such a major program:

- High level, full time, on-site program management
- Long-term organizational vision for the life of the project
- Owner expertise to lead or guide, and at least actively participate in, all core functions
- Permanent, as opposed to transient, identity of an elite project team
- An integrated organization
- Clear executive commitment and support, actively and continually exercised and communicated
- Accountability for performance and the ability to enforce it at both the program manager and functional levels
- Sound philosophy on high level usage of contractors
- Strong technical and analytical skills in management controls in the Project Management Office
- Effective reports with strong analytical components that identify performance issues and their causes, together with potential corrective measures
- Ability to forecast on a real-time basis final program cost
- A comprehensive long-term resource planning processes for engineering and construction resources
- An up-to-date succession plan for key management and supervisory positions.

iii. Management of AMRP Projects

How Peoples Gas has managed the overall AMRP comprises a principal focus of this study. The requisite project management skills address the planning, flow, execution, and management of more than a thousand people. Personnel with senior-level skills need to direct and coordinate many organizations, and many stakeholders, in order to keep the program moving with efficiency, effectiveness, and transparency.

However, project management skills need to exist at another level as well; *i.e.*, the individual projects that collectively comprise the AMRP. Individual projects within the AMRP involve many organizations, complex coordination challenges, many millions of dollars, and skill requirements. Government coordination, contract management, safety, quality, cost, schedule, and labor management provide some examples of these needed skills. The skills required have similarity to those that program management requires, but have application at a different level. The program management function executes through a wide array of managers, mostly at high levels. In contrast, individual project managers interact with people much closer to the work. Both levels require substantial experience and the ability to bring people together. They form prerequisites of an effective program and project management organization.

An option for addressing project level challenges would assign a project manager to every project or neighborhood to assure effective management and coordination of all work elements involved. The AMRP did not operate under this approach. The Company assigned project managers only to "high risk" projects. That included four projects: (1) Calumet Transmission, (2) High Pressure Interconnect, (3) Public Improvement Projects, and (4) the Loop Project. The Company has stated that it is in the process of staffing up to enable it to assign a manager to each AMRP project.

The key roles of project managers associated with the four high risk projects include:

- Complete all project planning activities, thoroughly and completely.
  - Develop all components of the project plan as specified in the project management methods
  - Ensure joint ownership of the project plans by including participation of team leads, subject matter experts, and key stakeholders in development of the plans
  - Work closely with the project sponsor to ensure that clear deliverables, project measures, and critical success factors are documented
  - Facilitate development of time, cost, functionality and safety parameters for the project
  - Work with the Project Leadership Team to ensure project funding and a project team appropriately resourced with skilled personnel
  - Recommend timing of formal milestone reviews and participate in getting the project approved
  - Ensure the plans are communicated, understood, approved by management and bought-into by project team
- Set up project team and structure and ensure understanding of project team roles and accountabilities.
  - Negotiate with business and technical resource managers to gain commitment of skilled resources to the project
  - Ensure identification of key internal stakeholders, solicit their input, keep them up-to-date in project communications, and use them as a proponent for changes in their functional areas
  - Recommend appropriate incentives, as necessary
  - Ensure project team roles and accountabilities are clear and understood
  - Assign project activities to team members based on skills, desires and growth opportunities (identified by the resource manager)
- Execute the project against plan to assure functionality within cost, time, and safety parameters.
  - Work closely with the project team and with leadership to assure project progress as planned, project cost control, and realization of project benefits
  - Actively engage project team members, ensuring they understand weekly expectations
  - Reinforce cross-functional team and business unit cooperation
  - Maintain up-to-date project plans and cash flow projections
  - Review (at least weekly) progress against the project plans (tasks, milestones, deliverables, costs, resources, schedule)
  - Track and resolve issues; elevate issues that cannot be resolved by the team to prevent impacts to the project schedule
  - Track and resolve changes, balancing the needs of stakeholders and impacts to functionality, deliverables, cost, and schedule

  - Track project risks, implementing mitigation strategies
  - Coordinate project with other related projects (deliverables, timing, overlapping resources)
  - Ensure administrative task completion, including time recording and project documentation
  - Acquire final project sign-offs and acceptance
  - Ensure smooth implementation, focusing on communication and change management
  - Conduct review of performance and lessons learned; publish post-project report
- Communicate key project information with project leadership team, project steering committee, and project team.
  - Ensure a common understanding of strategic, business, and project vision; share how each team member contributes to project success
  - Conduct regularly scheduled project team meetings (progress, issues, upcoming activities, expectations for the week, scope changes)
  - Conduct regularly scheduled project leadership meetings; participate in in project steering committee meetings
  - Ask questions of team members to understand true project status
  - Publish complete and accurate status reports to team members, project leadership team, project steering committee, and project champion
  - Recommend to project leadership team timing and content of proactive project communications
  - Ensure active engagement of business unit leaders to assist with change management and implementation
- Effectively lead the project team through team development stages.
  - Advocate for the project and project team
  - Gain personal and team commitment to the project
  - Seek ways to recognize and reward project team members
  - Reinforce team collaboration
  - Resolve interpersonal conflict and team dynamics issues
  - Foster a solution-focused team attitude
  - Host the project celebration to recognize and reward project team.

The above description illustrates the demands that a weak project management imposes and the challenges of getting things done with limited authority.

3. Conclusions

E.1. A strong first effort at instituting a plan for the management of the AMRP occurred in 2011, but fell into disuse after failing to gain traction. *(Recommendations E.1 and E.2)*

A strong start in defining how to manage the AMRP came in 2011. Unfortunately, sound program ideas and some strong statements of objectives have not translated into a plan for management that effectively guides the AMRP today. Committing to such elements of the Project Execution Program's effectiveness and building upon the principles it established would have placed the program in a more desirable place than exists today. A number of possible inquiries may explain why the plan did not become a foundation element of AMRP management:

- Was the plan ahead of its time; *i.e.*, put in place before the organization had the skills and capability to implement it?
- Was it too detailed, too complex?
- Did it cover too much ground?
- Was its content suitable for day-to-day reference?
- Did management properly introduce it, set good expectations for its use, and communicate a commitment to following it to the organization?
- Did its external authorship (Jacobs Engineering) detract from internal acceptance?
- Were its details prepared too soon; *i.e.*, with insufficient time to build and develop the processes needed?
- Did management assign anyone the responsibility of maintaining and keeping it up to date?
- Did the commitments and instructions not fully align with management's intentions, thus potentially invalidating the plan? (*e.g.*, "Transformation of PGL from a reactive system maintenance organization to a state-of-the-art modern, progressive and proactive gas utility" does not appear to be a concept with which management agreed).

Answers to these questions would be speculative, but Liberty did find sufficient reason to conclude that a lack of management backing has played a major role. Words on paper alone do not produce results. A strong management commitment, regularly reinforced, must accompany them.

E.2 The early years of developing the AMRP management organization have not brought sufficient skills, capabilities, and systems to provide the world-class management that the AMRP warrants. *(Recommendation E.3)*

A program of the magnitude and duration of the AMRP deserves, and can afford, a sophisticated organization. It should be staffed by a team having first-rate qualifications and experience. It should operate with the use of leading edge tools and systems. The Project Management Office, however, lacks a breadth of experience in some skill categories. Efforts to build the needed organization appear to have had low priority across the program's early years.

Resource planning for the AMRP management organization must determine the quality of management the Company needs to employ across the program's life. The program's history indicates that senior management did not begin program work with the correct perception of what a program of this magnitude entails. On an absolute basis, the project's dimensions include, for example, 2,000 miles of pipe to replace, more than $5 billion in total expenditures in all probability (and maybe significantly more), and a need for a compelling level of management, executive, and board attention for two decades. It dwarfs by comparison any typical Peoples Gas program or initiative. It seems clear that the Company did not understand, and certainly did not respond fully to, the magnitude of the challenges involved in ramping up to very high levels of production and sustaining them across twenty years.

Liberty has not examined and therefore does not draw any negative conclusions about the attention that Peoples Gas has paid to building its internal capabilities through the years. They may have been sound for business as usual. They should not, however, have produced confidence that organizations built for traditional utility projects would sustain a burden vastly greater than that of traditional work. Liberty's work in the electric industry found a similar phenomenon with companies undertaking nuclear plant construction in the 1980s. Peoples Gas cannot go back four

or five years to change how it viewed the challenges of the AMRP. The Company can, however, change for the future. It is essential for Peoples Gas, Integrys, or whoever owns and operates the Chicago gas utility in the future to accept the need for a fundamental revision to thinking about meeting those challenges. The challenges will remain and they may grow bigger as the years pass.

Utilities (and Peoples Gas is no exception) tackling a super-project (which the AMRP certainly is) need to enhance their management capabilities extensively. By definition, internal organizations, designed and built for traditional work, cannot absorb a program far more challenging.

E.3 A series of staffing decisions (whether explicit or implicit) have constrained the ability to manage the AMRP and to build a reliable, long-term, qualified management team for the program's still long future. *(Recommendation E.3)*

Peoples Gas' staffing decisions made when moving into the AMRP and during its early years of operation worked against developing a strong management approach and team. A number of AMRP elements warrant substantial improvement in this regard:

- Lack of clear assessment and definition of the skills needed to manage the AMRP
- Lack of a plan to acquire and develop requisite skills
- Lack of a long-term organization philosophy and design
- Failure to recognize the need for very active owner participation in key management positions
- Over-reliance on contractors
- Failure to assign full-time, Chicago-based project management
- Lack of common, single leadership of the planning and execution of program activities that were distributed among the Integrys-led Project Management Office and the Peoples Gas North, Central, and South Shops
- Failure to develop or acquire strong internal program controls skills
- Failure to soundly integrate AMRP with non-AMRP planning, resourcing, and scheduling as they concern field work and supporting services performed by Peoples Gas
- A resulting inability to marshal adequate resources to meet AMRP priorities
- Lack of succession planning for key managers.

E.4 Peoples Gas lacks a credible plan for the acquisition and development of resources to manage and execute the AMRP. *(Recommendation E.3)*

Liberty found that program management lacked sound knowledge of the required program skills, numbers of people, and overall capabilities to form a sound program management resource plan. The Company cannot develop such a plan without first identifying needs through a structured review and analysis. The planning process therefore must get underway as soon as possible, with definition of needs being the first step. That process requires a long-term focus to complement short term efforts to fill the most critical positions. The AMRP's length gives it more the nature of permanent organization, which can attract dedicated, high-quality personnel. Identifying and filling personnel needs in a revised AMRP management organization lies among the initiatives that management states are now underway, following discussions that began with Liberty last September.

E.5 The use of a matrix-type approach to AMRP program management did not prove optimum. *(Recommendation E.4)*

A program of the size and duration of the AMRP can justify a dedicated set of resources. A matrix-type organization also requires a high level of teamwork and cooperation among participating organizations and a project management team skilled at facilitating and maintaining those attributes. For the AMRP, factors such as these favor a dedicated organization, and a strong project manager approach.

E.6 The current approach and organization for program management produces too little authority and engagement by internal management resources. *(Recommendation E.5)*

The AMRP applies substantial resources to project management and Jacobs Engineering has supplied many quality people at Peoples Gas' request. The overall organization and approach selected, however, have not been fully effective. The organization consists largely of Jacobs Engineering personnel, with limited leadership from Peoples Gas. The Integrys full-time program manager directing the work that Jacobs Engineering personnel largely perform was not located full-time in Chicago. This arrangement detracted from the ability to continuously follow and interact with project resources and engage on issues. Other Integrys members of the program management resided on the organization's periphery, not in key leadership roles.

Concern arises from the fact that Peoples Gas has managed the AMRP as a "project"; *i.e.*, treating the program as temporary and its people as engaged in transient assignments. A quality, dedicated workforce will become far easier to build, should Peoples Gas treat the program as it should; *i.e.*, as a massive, long term initiative.

E.7 Peoples Gas should not limit the use of project managers for AMRP projects to only high risk cases. *(Recommendation E.6)*

The nature of the AMRP projects makes them complex, expensive, a challenge to coordinate, and difficult to manage. The lack of a single, project management focal point for every substantive project has not served the program well.

4. Recommendations

E.1 Peoples Gas should complete a full replacement of the plan for management (the Project Execution Plan) addressing all key elements of AMRP management and control. *(Conclusion E.1)*

A strong basis for the new document exists in the original Project Execution Plan. Liberty believes, however, that adding a more summary-level document to the replacement of the Plan would best serve to gain support and traction. In addition, Liberty recommends that the plan discuss a number of specific processes at a summary level:

- A cost estimating process that establishes a valid cost monitoring base and forecasts with confidence final program costs
- Scheduling that develops realistic schedules at all levels with appropriate details to support engineering, procurement, work planning, construction, and contractor activities

- Resource planning that employs staffing strategies, crew allocation, contractor management, training requirements, and productivity measurements
- A work management process that supports the facilitation of work from design to construction to completion
- A cost management program that promotes a culture of program cost control
- Cost reporting designed to precipitate corrective and improvement actions
- Scope control that identifies potential scope growth to minimize cost and schedule impacts
- Procurement strategies that take advantage of large purchases to obtain favorable pricing and supportive deliveries
- Contracting management that takes advantage of the magnitude and long-term nature of a mega-program to develop beneficial and creative relationships with contractors.

E.2 Current developmental plans for a new Project Execution Plan should specifically address prior failures and how they will be avoided in the new plan. (*Conclusion E.1*)

In considering potential reasons for failure of the early plan, Liberty concluded that a lack of sufficient management commitment contributed significantly. The lack of credibility that seems inherent in the failure of the early plan naturally raises questions about management's current commitment to the new initiatives as well. Answering the question of "What is different this time?" thus becomes important in sustaining credibility in the change initiatives underway.

E.3 Peoples Gas should prepare a long-term AMRP management resource plan that specifically addresses: (a) requisite skills needed both on an immediate and on a longer term basis, (b) current gaps in internal capabilities, (c) the optimum balance of owner versus contractor personnel, (d) acquisition and development of resources, and (e) succession plans. (*Conclusions E.2, E.3, and E.4*)

This work should adhere to the guiding principle that the AMRP requires and can afford a top tier organization and staff. Liberty does not recommend a "money is no object" approach. Rather, so much money is involved, and the risks and opportunities for savings are so great, that acquiring the best people comprises the best approach for managing risks and pursuing opportunities and thus the most cost-effective option.

In defining skill requirements Peoples Gas should apply high standards. The Company should identify where gaps exist in those skills in the current organization. A simple, but highly effective approach would:

- Identify the standards and levels of capability appropriate for the AMRP
- Identify those areas worthy of analysis; *i.e.*, where a mismatch might exist
- Identify gaps between standards and current capabilities
- Prepare an implementation plan for improvement / upgrade of capabilities

In performing this review, the Company should not just look at specific skills, but instead view existing resources holistically by seeking answers to questions like:

- Do we have people with these skills?
- Are there enough of them?
- Are they in the right positions?

- Do they have the organizational standing to get their job done?
- Do they have the appropriate systems and processes at their disposal?
- Where they have weaknesses, do available and communicated developmental opportunities address them fully?

These questions presume that the existing workforce will continue to have a big role, despite the changes required. The goal is not to replace incumbents. The goal is to develop further the capabilities of existing resources, align them properly, and supplement them with new people where needed. The long-term nature of the AMRP particularly opens incumbent development avenues to a greater extent than programs of shorter duration typically would.

Planning also must recognize the impracticability of staffing certain, highly specialized positions internally, and of staffing less specialized ones internally in the full numbers required. Peoples Gas therefore will continue to face the challenge of optimizing the employee/contractor mix, but should act pursuant to the goal of using the program's length to secure in-house resources in areas where the Company has traditionally relied strongly on contractors.

E.4 Peoples Gas should move toward a project organization that makes significantly more use of dedicated resources under a strong project manager approach. (*Conclusion E.5*)

The nature of the AMRP and the internal relationships among Integrys and Peoples Gas argue against a matrix-type organization and a move toward a "strong" project manager approach. AMRP experience to date further compels a re-thinking of the organization approach. AMRP size, cost, and duration indicate that dedicated resources are appropriate for many functions. There is no reason the AMRP should have to compete for resources or go begging. Having qualified people on hand and focused on this singular priority for the next 15 years presents a superior option from performance, quality, cost, and effectiveness of management perspectives.

The AMRP internal issues also argue for a strong approach to project management and greater use of dedicated resources.

E.5 Peoples Gas should prepare a specification for a new program management function, correcting the weaknesses in the current process. (*Conclusion E.6*)

In designing a new program management organization and process, the following attributes should form a part of the specification:

- *High level, full time, on-site program management*: The large number of AMRP resources in Chicago demands that the program manager and the bulk of the Project Management Office be located there full time.
- *Unquestioned executive support*, whether a strong or weak approach applies: Whatever approach is adopted requires the unquestioned support of executive management.
- *Owner expertise*: To lead, at least guide, or at least actively participate in, all core functions. The level of owner participation can remain flexible, but what stands as critical is reinforcing the perception that the owner leads the effort, and has skills as strong as anyone else on the project. A mere figure-head or peripheral role will not work effectively.
- *Permanent, as opposed to transient, identity*: A project usually has a transient identity, reflecting its comparatively short life and the temporary nature of most positions. That

transient identity places limits on the kind of people willing to work on the project and the kind and number of people that management will hire. However, at a duration of twenty years, the AMRP can hardly be viewed as "temporary." Acting in accord with a belief that it is, produces a naturally weaker approach to staffing.

- *An integrated organization or not – no halfway*: Peoples Gas has taken a split approach to its role in the program management. Liberty recommends active participation and a strong leadership role for the owner. An integrated organization can accomplish this result. However, doing it halfway, with limited positions, limited owner skills, or limited owner authority, can prove worse than using an organization and a management role completely provided by a contractor. At least in that case, accountability remains clear.
- *Accountability for performance*: Accountability and the ability to enforce it at both the program management and functional levels is important. Accountability for performance will not alone prove sufficient for strong performance but it certainly is necessary.
- *Strong technical and analytical skills in management controls in the Project Management Office*: Strong technical and analytical skills on the part of controls personnel often comprise the greatest asset an executive oversight and program manager can have.

Peoples Gas should test its AMRP organization development plans and activities by providing candid and full answers to questions like:

- To what extent must AMRP compete or beg for resources?
- To what extent does the AMRP have to rely on part-time or non-dedicated resources?
- Are lines of accountability and authority clear?
- Is the owner clearly in charge?
- Is the owner fully involved?

E.6 Peoples Gas should assign a project manager to most, if not all, AMRP neighborhood projects. (*Conclusion E.7*)

Even at the individual level, these non-high-risk projects still tend to have very large scope and size. Liberty's experience produces the expectation that each would have its own project manager. Compared to typical electric or gas utility projects, they are more complex, expensive, customer-sensitive, and carry local regulatory challenges.

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Chapter F: Risk Assessment and Replacement Prioritization

1. Background

This chapter addresses Liberty's review of the related topics of Risk Assessment and Replacement Prioritization. Chapter C: The Peoples Gas Distribution System focuses on overall design of the AMRP, including its use of a neighborhood approach. The specific areas that Liberty's review addressed in this chapter include:

1. Systems, tools, and resources for generating and integrating data required for risk assessment
2. The quality of resulting data
3. How Peoples Gas addresses gaps in that data
4. Accuracy, vintage, and use of key data types (*e.g.*, leaks and soils)
5. Risk models, methods, and factor weighting
6. External factors (*e.g.*, repaving programs, other Company programs, such as meter replacements, meter movement outside) and inspections
7. Methods for identifying and prioritizing infrastructure replacement candidates
8. Consideration of alternatives to replacement
9. Quality of replacement decisions
10. Effectiveness of replacements in reducing leak rates
11. Model updating and consistency with industry practice
12. Short-term optimization of risk reduction versus cost
13. Evaluating upcoming projects to test application of risk assessment and prioritization goals, approaches and methods
14. Judgmental factors affecting/overriding risk model output.

a. Replacement Prioritization

The work required to address aging gas infrastructure subject to failure requires a sophisticated approach to the assessment of safety risk. It also requires a structured and comprehensive set of methods for prioritizing repair and replacement efforts. The risk that each component in question presents for public and employee safety must drive prioritization. Chapter C: The Peoples Gas Distribution System addresses the basis for planning AMRP work in a manner (the "neighborhood" or "zonal" approach) that supports efficient replacement of high-risk pipe in conjunction with other operating improvements. Chapter C also addresses the Main Ranking Index, which Peoples Gas uses to address immediately that highest-risk pipe which may not be addressed immediately under the neighborhood approach. This chapter focuses on how determinations of risk occur and what role those determinations play in work prioritization.

The measurement assigned to particular risks should correlate: (a) the likelihood that failure events will occur, and (b) the likely consequences should such failures occur. Regarding the latter consideration, gas transmission mains fall into four classifications, driven by the nature of the areas (generally reflecting the number of people at risk) that might be affected by their failure:

- Class 1: Forest and farm areas, where failures have comparatively much lower likelihood of significant safety consequence
- Class 2: Relatively lower densities of homes
- Class 3: Higher home densities or places of public assembly

- Class 4: Significant numbers of buildings four stories or higher.

Location largely drives potential consequence. A main down even a large city street surrounded by parkland presents different consequences from one running past high-use structures. Likely consequences increase even further if those structures pose barriers to swift evacuation (*e.g.*, an elementary school or a hospital). Equipment configurations also drive consequence. For example, the existence of operable excess flow valves can significantly affect the consequences of pipe failures. They can limit the amount of gas that can escape via a major failure (such as break in the service pipe). It is generally difficult to control the locational determinants of risk, apart from relocation options that may exist from time to time.

The likelihood of failure comprises the other main factor in the calculation of risk determination. The likelihood of failure generally lends itself to greater control. For example, the clearly marked and maintained rights-of-way that often typify transmission corridors reduce the likelihood of hits during third-party excavations. Third-party education and communication programs, facility surveys, proper mark outs, and posting inspectors at work sites also can mitigate this component of risk. More pertinent to the review here, different pipe materials, ages, diameters, and other conditions combine to produce different likelihoods, even within a particular type (*e.g.*, cast or ductile iron) of material. Moreover, the degree of mitigation resulting from various activities (*e.g.*, leak monitoring, repair, and replacement) differs as well.

Companies like Peoples Gas therefore need to conduct periodic risk assessments that measure and combine likelihood and consequence to identify highest-risk facilities and the effects that various forms of mitigation can have on measured risk. Those assessments need to drive prioritization of mitigation efforts and produce the investment (in capital or O&M programs and initiatives) necessary to keep risk at acceptable levels.

Liberty's focus in examining prioritization (and the risk measurement that must underlie it to make it effective) concentrated particularly on overlaying Main Ranking Index-driven replacements on top of the neighborhoods approach addressed in Chapter C. Liberty examined the resulting performance in addressing pipe exhibiting the highest levels of risk. This chapter also addresses details underlying the risk assessment and prioritization processes used to plan work under the neighborhood approach.

b. O&M Savings

The neighborhood approaches' combination of main replacements with other work (increasing pressures from low to medium levels and the relocation of meters from inside to outside customer structures) will produce future operations and customer benefits. Peoples Gas addressed changes in operations and maintenance costs that it estimated would flow from AMRP work. It did so last in 2009 testimony before the Illinois Commerce Commission. Liberty did not seek to validate or critique that testimony or its supporting modeling and analysis. It was outside of the scope of this engagement.

Liberty did examine the ability on a present and going-forward basis to consider changes in O&M costs as a function of investment in pipe replacement. The examination also included a review of the ability to perform analyses of changes in O&M costs resulting from work undertaken in the

context of the neighborhood approach. This approach combines pipe replacement with other work. This broader examination becomes material, as promoting work efficiency through the neighborhood construct has the potential for affecting the pace at which Peoples Gas eliminates high-risk pipe from its system. Knowing the full "value" (which includes offsets to operations and maintenance costs) achieved through completion of neighborhood work (both pipe replacement and other) might, under certain circumstances, influence the pace of pipe replacement.

Another portion of this chapter also addresses questions of potential balance (particularly over time) between replacements driven by the Main Ranking Index and by the neighborhood construct. Optimizing that balance takes full knowledge and robust consideration of all the advantages produced by alternate approaches, including their operations and maintenance cost effects.

2. Findings

a. The Main Ranking Index

Peoples Gas has employed its Main Ranking Index to prioritize replacements for many years. The Index employs a variety of data to generate replacement rankings. At AMRP inception in 2011, the Index operated as the only prioritization driver of AMRP work. Since the beginning of 2013, it has operated in parallel with the zonal, "neighborhood" approach to planning and scheduling replacement work under the AMRP.

Peoples Gas uses the Main Ranking Index to give each distribution and transmission system segment a numbered risk ranking. Higher numbers reflect higher risk. Annual application means that a segment's rankings can, and some do, change each year.

Rank calculations use an equivalent likelihood of a main break. Breaks create the principal safety risk of low-pressure, cast iron mains. Ductile iron mains suffer from a similar failure event. The likelihood of main breaks increases as main diameters decrease; *i.e.*, smaller-diameter pipe is more likely to break. Soil type and construction in proximity to pipe can also affect the likelihood of breaks. The Main Ranking Index accounts for a range of break-risk factors, including numbers of breaks, cracks at taps, visual observations of cracks, pipe coupon equivalent breaks, and main repairs adjusted to breaks. Peoples Gas has gathered data about its gas system for use in the Main Replacement Index since the Company began using it about 20 years ago.

Each break-risk factor has an equivalence rating, used to determine the likelihood it will break. The relevant factors undergo correction for environmental conditions. The amount of paving and location in a business district with building-to-building paving are among these corrections. Peoples Gas standardizes index results to city-block lengths of 660 feet. This standardization accounts for the fact that discretely-captured pipe segments can range from a foot to a mile in length.

The Company replaces segments ranked six or higher within a year, irrespective of whether such replacement would coincide with the schedules developed under the AMRP's neighborhood construct. Peoples Gas also replaces some segments ranked at level five within a year. They include the segments in proximity to buildings of public assembly ("BPAs") whose conditions or occupants limit quick evacuation (*e.g.*, schools, churches, day- and elder-care facilities, prisons).

Peoples Gas does attempt where practicable to schedule "neighborhood" work (upgrades to medium pressure and relocating indoor meters to outside locations) to coincide with the segments requiring replacement within a year. The presence of medium-pressure mains in the neighborhood involved serves as a major determinant of the ability to do so. In any event, where combining priority replacements with other work is not practicable, Peoples Gas makes the replacements with substitute materials "like-for-like," based on physical size and pressure.

Use of the Main Ranking Index model requires up-to-date information about preceding-year retirements and main replacements. Peoples Gas adds this new data in re-computing segment Main Ranking Index scorings every year. The Company also runs the calculations that prioritize work on a neighborhood basis each year. After starting work in a neighborhood, however, it continues until completion regardless of whether the succeeding year's calculations change its relative ranking. A significant movement of other neighborhoods up in the list, could, however, cause adjustment of the schedule for a neighborhood requiring multi-year phasing.

The numbers of main segments replaced because they ranked six (or five in specified cases) has remained stable. About 10 segments come onto the list each year, as ten ranked from last year get removed by virtue of being replaced. The Main Ranking Index underwent an Illinois Commerce Commission-mandated review by an independent consultant in the mid-2000s. This review found Index-driven replacements appropriate, given declining rates of cast iron main breaks.

b. The "Neighborhood" Approach to Prioritization

The second, neighborhood (or zonal) method of replacement-work prioritization came into existence in 2012 for work performed during the 2013 construction season. Its introduction sought to increase the efficiency of capital work by combining high-risk pipe replacement with: (a) upgrades to medium pressure, and (b) relocating customer meters from inside buildings to outside. By 2014, the neighborhood approach had come to drive most of the main and service replacements. Main Ranking Index level six and partial level five replacements still operate as an override to work scheduled under the neighborhood approach.

Peoples Gas uses a 228-neighborhood Chicago division to prioritize and plan work. The neighborhood construct also uses risk ranking to prioritize neighborhoods. The large size of many of the more than 200 neighborhoods has led Peoples Gas to break work in them into phases. It takes more than one construction season to complete work in these neighborhoods. A ranking structure for the phases considers a number of attributes that can cause failures. The driving factors that Peoples Gas considers material include:

- A belief, based on past experience, that mains installed prior to 1920 (the oldest system components) have the highest likelihood of failure
- Services installed or renewed prior to the advent of mandated cathodic protection also have high failure risk
- Areas that have already experienced high failures are prone to do so in the future
- High- or medium-pressure cast iron or ductile iron feeder mains have a higher consequence of failure

- Small-diameter cast iron mains fail at a higher rate than do large-diameter mains. (Other operators share this observation.) Their thinner walls provide less protection from cracking when undermined or graphitized.

Peoples Gas therefore applies to each neighborhood a ranking determined by a set of specific factors. Each neighborhood's ranking predominantly drives its priority ranking under the neighborhood construct. Unlike the segment-specific Main Ranking Index approach, an entire neighborhood gets a single rating. This rating reflects the collective condition of its infrastructure. Subject to the Main Ranking Index overlay, this neighborhood ranking also predominantly drives its priority for main and service replacement.

External factors can provide a source of moderate adjustments to the scheduling of work in the highest-ranked neighborhoods. The same applies to some extent to Main Ranking Index-driven work as well. Peoples Gas takes into account city, state, and other utility infrastructure improvement plans when scheduling its infrastructure work. Street repaving schedules also have an impact. Peoples Gas cannot obtain permits to work in a newly-paved street unless it will repave the entire street. Short-term rearrangements among the highest-priority neighborhoods or replacements occur as required to account for such external factors.

c. Data Gathering Systems, Tools, and Resources

i. Leak Tracking

Peoples Gas has employed a leak-tracking system since the mid-1970s. The Company also employs long-standing systems to manage property records that address main and service locations, replacements, construction materials, size, and other parameters. Peoples Gas integrated data from these systems into the Main Ranking Index in the 1990s. Additional refinements to include mapping leaks on geographic-information-system-type models, which makes tracking and inquiries less labor-intensive. The knowledge of leak experts in each of the three Shops into which Peoples Gas divides its field operations supplements property records and leak histories.

ii. Capturing Leak Data

Companies must provide leak data to the U.S. Department of Transportation's Pipeline and Hazardous Materials Administration ("PHMSA"). Peoples Gas has been using computer and automated programs to capture leak data for many years. These programs assign a leak identification number, and then schedule follow up measurements based on Company procedures and regulatory requirements. Leak tickets track repair activities. Work orders track costs and associated work. Minor gaps due to issues such as the time between leak discovery and repair always exist. Prior audits, however, demonstrate that Peoples Gas tracks leaks with sufficient accuracy. Grade/Type 1 leaks require immediate repair, for example, while Grade/Type 2 leaks may be held for future repair, and Grade 3 leaks must be surveyed with no requirement for repair. The next two graphs show the number of leaks discovered and repaired in recent years.

Figure F.1: Main Leaks Received

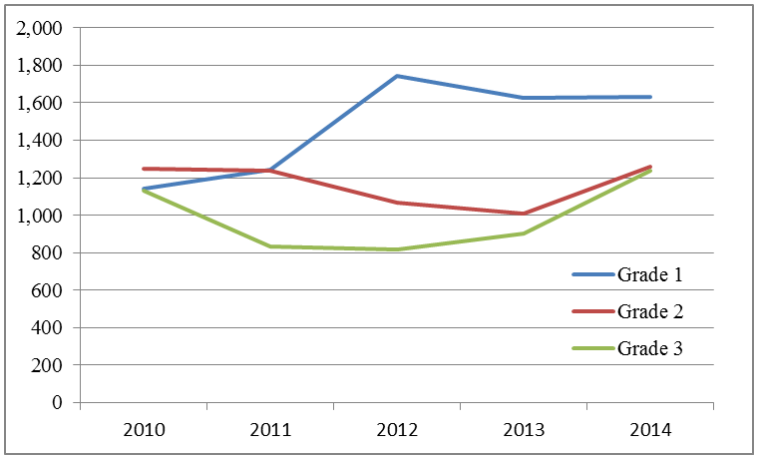
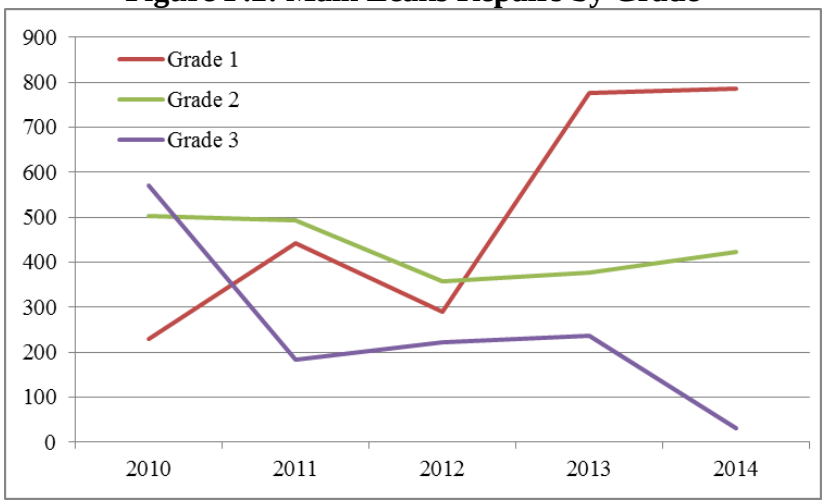


Figure F.2: Main Leaks Repairs by Grade



Liberty examined several different leak data tracking sources. This review disclosed significant differences in the number of Type (or grade) 1, 2 and 3 leak totals. Liberty could not reconcile differences in various reports about leaks. Re-grading of leaks often produces mismatches, but these differences could not be explained away completely by concluding that Peoples Gas changed some leaks to a lesser grade or type. The differences appear too substantial to be explained by re-grading leaks to non-hazardous classifications.

iii. Planned Infrastructure Work by Others

Peoples Gas compares Main Ranking Index and neighborhood modeling outputs against planned work by other government and utility entities. This comparison permits adjustment of program work schedules as needed. City of Chicago requirements have caused Peoples Gas to choose to place new mains on both sides of the street. This requirement generally necessitates the use of the "parkway" or sidewalk corridors. Thus, city-street construction *per se* does not present an overriding factor. However, intersections, where gas mains may require relocation because of conflicts with new water or sewer lines, become a more important factor.

iv. Soils Data

Soils can play an important role in determining comparative rates of cast iron pipe degradation. Soils should factor into risk modeling. We found no indication that Peoples Gas information directly or judgmentally considers soil condition as part of the Main Ranking Index or neighborhood rankings.

The lack of soils data has more consequence for the Main Ranking Index than for neighborhood rankings. Liberty considers soil type a break-risk factor. One can expect the Company's highly localized, individual pipe segments that comprise fundamental units of the Main Ranking Index to lie in relatively uniform soil types. The presence of unstable soils could and should be considered a risk factor for each segment is evaluated under the Main Ranking Index. The wide areas encompassed by neighborhoods likely produce less homogeneous soil conditions. This factor makes soil condition a less pertinent factor in ranking them.

v. Addressing Erroneous and Missing Data

Peoples Gas sometimes lacks material data, such as the exact location of a service line to its customer or the facilities of another utility. It requires contractors in such cases to locate underground facilities by digging test holes. This practice sometimes proves inefficient. Peoples Gas has found it more effective, however, than placing special crews on standby to perform custom locating, or using high-tech locating devices.

For directional drilling, Peoples Gas requires contractors to locate sewer mains and laterals via video-camera examination. Following drilling, but before new main activation, another video examination must take place. This video verification supplements test holes and other locating efforts (*e.g.*, marking services and mains on the surface).

Contractors have found main and service location errors on some Peoples Gas maps that show locations by using property lines. Peoples Gas has adopted a program to address such errors. It consists of locating all new and newly-retired mains and services on updated maps. Liberty's inquiries did not disclose the existence of a structured, controlled method for ensuring timely correction.

Liberty examined the Company's use of assumptions to account for missing data. Particularly for older, large urban systems, missing data presents an unavoidable problem. Liberty did not find broad needs to make assumptions to account for missing data. The use of neighborhood-wide rankings tends to marginalize the impact of data errors on individual segments. The primary need that Liberty observed occurs in determining the ages of particular segments, and particularly for use in ranking under the Main Ranking Index. Peoples Gas makes an appropriately conservative assumption of pre-1920 installation when it cannot verify an actual date.

Errors with respect to leak and break locations could have a material impact on Main Ranking Index rankings. Liberty knows no practical way to address old, untraceable data, however. The existence of multiple leaks would diminish concern about a missing record of a single leak, or about recording visible cracks during an inspection. With respect to missing environmental factor data, Google Maps offers a means for checking. Except for failing to consider soils data in the

Main Ranking Index, Liberty found no substantial concern about the ability to use existing data and to apply reasonable assumptions to feed models driving replacement prioritization.

Peoples Gas rounds Main Ranking Index scores to the nearest 1/4 point. This feature has significance in connection with the "must repair" status of all segments that achieve a ranking of at least six and a defined portion of those that achieve a ranking of 5. Rounding up, for example, to make a score of 4.88 become 5.0 and a score of 5.88 become 6.0 would include a level of conservatism into the rankings.

vi. Locating Services

The Company uses property line measurements to locate new services. It plots them in the geographic information system. The principal difficulty in using this approach arises when property line data associated with old services proves inaccurate. One of the three Peoples Gas Shops addresses this issue by requiring meter markers (when they locate the installation point for new meters) to locate on a drawing and sometimes on the property where the old service penetrates the foundation. This practice should increase success in finding the location of the old services. The lack of accurate locations for some existing service lines has caused some contractors to make large excavations in the parkway and sidewalks. That response increases the costs of main and service installations and restoration over the long term. The marking practice of the one Shop should be communicated to the other two as a best practice.

d. Risk Ranking Model Operation

i. The Main Ranking Index

The Main Ranking Index's algorithm uses a number of factors to calculate an Index score ("MRI"). Several factors determine an equivalent crack number, which then undergoes adjustment to a standard segment size equivalent to one typical city block (660 feet or so). The depiction below sets forth the equation used to calculate an MRI, which then gets rounded to the nearest 0.25 to determine the Main Ranking Index.

Figure F.3: Main Ranking Index Algorithm

MRI = B + C + VPE+ KU + RE

Where:
B = Break equivalent based on breaks.
C = Break equivalent based on cracks at taps.
VPE = Break equivalent based on visual observations of the main.
KU = Break equivalent based on pipe coupon analysis on the segment.
RE = Break equivalent based on repairs done on the main
Each of the above components is then broken down with various attributes.

B = K1 * B1 * MR20

(Analysis includes number of breaks, operating pressure, street classification (business versus residential), and pavement coverage multiplied by a Break Equivalent Factor).

C – Break Equivalent Based on Cracks at Taps:

(Analysis includes number of cracks at taps, operating pressure, street classification (business versus residential), and pavement coverage multiplied by a Break Equivalent Factor.)

VPE – Break Equivalent Based on Visual Observations of the Main:

(Analysis is based on a visual inspection ((Poors versus Goods) (or coupon analysis if available)) and also takes into account material, operating pressure, main size, street classification (business versus residential), pavement coverage multiplied by a Break Equivalent Factor.)

KU – Break Equivalent Based on Pipe Segment Coupon Analysis:

(Analysis includes physical evaluation of material condition, operating pressure, street classification (business versus residential), and pavement coverage multiplied by a Break Equivalent Factor.)

RE – Break Equivalent Based on Repairs Performed on the Main Segment:

(Analysis is based on a visual inspection (Poors versus Goods) and also takes into account material, operating pressure, main size, street classification (business versus residential), pavement coverage and (or coupon analysis if available) multiplied by a Break Equivalent Factor.)

Other factors applied address operating pressure, whether a coupon has been taken, and whether inspections have been performed. Numerical values for all factors get added together. The next figure shows a recent (August 2014) run of the Main Ranking Index model. The figure presents all of segments having a ranking of 6 or more. This run produced some interesting features (note the shading):

- It tends to confirm the small-diameter cast iron factor (11 of 12 entries)
- It tends to diminish the significance of pre-1920 construction (6 of 12 entries).

Table F.4: August 2014 MRI Model Result, Segments with Ranking >6

ID	SIZE	MATERIAL	PRESSURE	CORROSION FAMILY	YEAR	LENGTH	MRI
16845	6	CI	MEDIUM	0000000000	1956	25	12
1016898	6	CI	LOW	0000000000	1913	7	10.71
1000171	6	CI	LOW	0000000000	1924	2	7
87446	6	CI	LOW	0000000000	1902	607	7
42552	6	CI	LOW	0000000000	1910	569	6.78
25732	6	CI	LOW	0000000000	1937	763	6.64
79084	6	CI	LOW		1938	577	6.23
5653	6	CI	LOW		1924	626	6.15
6711	6	CI	LOW	0000000000	1917	210	6.05
43811	6	CI	LOW	0000000000	1913	595	6
1003792	12	CI	MEDIUM	0000000000	1953	434	6
1032641	6	CI	LOW	0000000000	1902	496	6

At present, the Main Ranking Index cannot and does not operate on a probabilistic basis. Probabilistic models use long-term histories of all main-failure events, and total understanding of the environment of mains and services, in order to develop probabilities of particular failures. Probabilistic models may prove more efficient in programming high-risk main replacements, but the amount of data they require entails significant time and cost. Moreover, some of the data may not be available. Thus, such models, to Liberty's knowledge, have not yet been used for main-replacement risk assessment and prioritization.

ii. Neighborhood Modeling

The next table shows the criteria weightings for rankings under the construct used to prioritize combined high-risk pipe replacement, medium pressure upgrading, and meter moving work in the designated 228 neighborhoods.

Table F.5: Neighborhood Criteria Weights

Criterion	Weight
MP Ductile iron Main	25%
8-Inch or Smaller CI Main	25%
CI Main Older than 1920	15%
Unrepaired Leaks	20%
Inside Meter	15%

The algorithm directly applies these criteria to determine neighborhood rankings, as the next depiction shows.

Table F.6: Neighborhood Ranking Algorithm

Ranking = [(MP DI Main Rank)*0.25] + [(8" or smaller CI Rank)*0.25] + (CI Older than 1920 Rank)*0.15] + [(Unrepaired Leaks Rank)*.020] + [(Inside Meters Rank)*0.15]

The Company also tracks "at risk" services (unprotected steel, clear plastic, copper) to determine how many to replace. Peoples Gas seeks to reduce the number of problematic low pressure regulators by eliminating them when a neighborhood transitions to medium pressure.

Work planning divides each neighborhood into a number of more manageable phases where required by dimensions and work requirements. The construction order of these phases considers:

- Availability of medium pressure
- Whether other contemporaneous infrastructure work necessitates moving the gas main
- Whether there is a planned repaving project.

The ability to combine AMRP work with other planned construction may accelerate work compared with what its risk ranking would otherwise indicate. Planning also seeks a degree of work levelization among the three Shops. Levelization seeks representative levels of work progress across the City, and avoidance of work overloads in a particular Shop. Preliminary work plans under the neighborhood approach to planning use five-year windows. Adjustments, mindful of minimizing out-of-priority-order work, then occur based on cross-checks against third-party plans.

The numbers of leak-prone services do not affect a neighborhood's ranking. Peoples Gas does, however, track and replace such services as part of the work under the neighborhood's plan and schedule. The transition to medium pressure and the relocation of meters outside as part of neighborhood work supports efficient replacement of leak-prone services (bare or unprotected steel, clear plastic, and copper).

The following table shows the results for the initial five-year replacement plan.

Table F.7: Five-Year Replacement Plan Results

2014 - 2018 Summary				
Shop	**Neighborhood**	**Main Retired** (feet)	**Number of Services**	**Vulnerable Services**
North	6	1,213,766	34,488	5,726
Central	5	793,954	21,674	1,600
South	6	908,904	23,407	2,055
Total	**17**	**2,916,624**	**79,569**	**9,381**
2014 - 2018 Breakdown				
2014*				
North				
	Portage Park (10 phases)	180,365	2,783	1,664
Central				
	South Austin (14 phases)	127,776	3,378	601
South				
	South Shore	203,280	4,273	344
Total		**511,421**	**10,434**	**2,609**
2015*				
North				
	Portage Park (7 phases)	178,464	6,388	1,690
Central				
	South Austin (14 phases)	168,725	3,647	
	Brighton Park	121,440	3,988	
South				
	Beverly	169,597	3,821	316
Total		**638,226**	**17,844**	**2,006**
2016				
North				
	Jefferson Park (Part 1)	158,815	4,801	728
	Albany Park	134,924	3,825	516
Central				
	West Englewood	167,975	4,924	
South				
	South Chicago	171,962	4,965	486
Total		**633,676**	**18,515**	**1,730**
2017				
North				
	Belmont Central	143,964	5,186	1,128
	Jefferson Park (Part 2)	158,815	4,801	

Central				
	West Town	121,289	2,693	211
South				
	Englewood	171,962	4,965	575
Total		**596,030**	**17,645**	**1,914**
2018				
North				
	Logan Square	199,666	5,505	
	Old Irving Park	58,753	1,199	675
Central				
	Gage Park	86,750	3,044	788
South				
	Back of the Yards	50,913	1,536	334
	Morgan Park	141,190	3,847	
Total		**537,272**	**15,131**	**1,797**

*Based on 100% design

e. O&M Savings

Peoples Gas has confirmed that it does not have current data or analysis addressing how operations and maintenance costs have recently changed or would change as a function of investment in pipe replacement. The Company confirmed that it incorporated the most recent such data and analysis in its 2009 testimony before the Illinois Commerce Commission.

That testimony came in support of a then-proposed acceleration of the replacement of leak-prone pipe. The analysis presented at that time addressed two scenarios (Scenarios 2 and 3). Scenario 3 reflected a 20-year AMRP; Scenario 2 reflected a "business as usual" pace that would complete the replacement of leak-prone pipe much later. Any flaws that analysis may have had have been rendered moot by changing conditions. Peoples Gas has agreed to the development of a cost model for analyzing the costs associated with the AMRP program. The Company intends that this model include the capacity to address not only investment costs, but also those associated with operations and maintenance.

3. Conclusions

F.1 Peoples Gas has substantially changed the nature of pipe replacement activities over what is now a long period of addressing the need.

Over the last 20 years Peoples Gas has used several methods to determine how to replace mains in the most cost effective manner. Early methods relied solely on highest Main Ranking Index scores, in an effort to address the highest risk mains each year. The Index yielded a comparatively small amount of mains to be replaced in 2004, as the next chart demonstrates.

Table F.8: Evaluation of Main Segments Based on Main Ranking Index

MRI Interval	Number of Miles									
	Jun-95	Oct-96	Oct-97	Oct-98	Oct-99	Oct-00	Oct-01	Oct-02	Oct-03	Oct-04
20 & Above	0.2	0	0	0	0	0	0	0	0	0
10 to 19.75	2.3	0.9	0.1	0.1	0	0	0	0.1	0.2	0.1
6 to 9.75	10.0	4.2	3.1	1.3	0.9	0.6	1.1	0.8	0.9	0.4
5 to 5.75	9.1	6.9	5.7	5.5	4.4	4.4	5.0	3.9	4.9	4.9
4 to 4.75	20.5	16.4	16.8	15.9	15.5	17.0	14.9	14.3	15.3	15.1
3 to 3.75	45.5	34.9	38.3	39.0	42.7	41.8	42.6	41.2	41.5	43.0
.25 to 2.75	995.1	1,044.5	1,082.8	1,092.6	1,097.1	1,102.0	1,083.5	1,064.9	1,055.8	1,047.2
0	2,948.5	2,907.3	2,855.2	2,848.0	2,842.2	2,835.7	2,875.2	2,915.6	2,910.9	2,936.5
Total	**4,031.2**	**4,015.1**	**4,002.0**	**4,002.4**	**4,002.8**	**4,001.5**	**4,022.3**	**4,040.8**	**4,029.5**	**4,047.2**

Starting in 2004 additional considerations led to the replacement of about 44 miles, excluding system expansions. It foreshadowed the neighborhood method insofar as it targeted areas for replacement while attempting also to upgrade pressure. In 2010, an expanded Capital Optimization Program, or COP, began. This program added consideration of nearby public improvements and risk-prone services, and calculated the resulting savings from existing and future leaks and work. It considered small-diameter, old cast iron installed prior to 1920.

Peoples Gas decided to implement the parallel operation of the neighborhood and Main Ranking Index rankings and drivers of replacement projects in 2012/13. Enlargement of the neighborhood model and breaking neighborhoods into phases sought to obtain economies of scale and promote more effective work planning. Those changes have improved the efficiency of performing replacements, and have well served conversion to medium pressure.

F.2 The neighborhood approach offers a sound construct for efficiently replacing high-risk pipe, while contemporaneously increasing the delivery pressure and moving meters outside.

The neighborhood construct permits main installation and conversion to medium pressure without having lengthy interruptions in service. It allows build-out of medium-pressure infrastructure, while low-pressure mains remain in service until the Company can switch all customers served from a main to medium pressure. This approach may defer retirement of some old, low-pressure system components, but it ensures that all customers have gas service almost continuously. Short-duration outages may occur while Peoples Gas ties in a new outside meter, but these outages should be minimal in duration.

Before moving to the neighborhood construct, Peoples Gas would find itself, when undertaking replacement of high-risk pipe, possibly extending medium-pressure feeds deep into areas without the ability to tie customers into them. Deferring the work necessary to make those connections not only forced customers to wait for medium-pressure service, it also substantially increased costs by requiring eventual tie-ins to occur under an entirely separate installation process.

Past reliance solely on the Main Ranking Index to drive replacements also tended to produce widely scattered and more isolated work. That also increased costs, when compared with a program encouraging work that the Company could more economically perform through commonly marshalling resources and equipment to work more pipe in the concentrated area achievable under the neighborhood approach.

F.3 There is no clear indication that data inadequacies threaten proper prioritization, but Peoples Gas lacks a data quality control function that exposes its risk modeling to potential sources of error. *(Recommendation F.1)*

Peoples Gas does not appear to have a data quality control program in place to evaluate current or past data. Such a program makes sense under normal circumstances, and has greater importance given the importance and magnitude of the work that will engage Peoples Gas for many years to come. The three Shops were addressing data issues, but did not seem to share best practices.

Reports showing differing leak totals provide one example of data inconsistency that Liberty's examination uncovered. Liberty could not reconcile leak totals to determine a single, reliable number of leaks and leak rates of Grade/Type 1 and 2. This difficulty raises the question of how Peoples Gas determines them. The large differences appear to negate the otherwise likely conclusion that differences result from timing or leak re-grading issues. The material variances in data provided to Liberty addressing similar measures do not have clear and logical explanations.

Liberty found no clear indications that quality and completeness of data used for risk modeling and replacement prioritization are fundamentally unsound. A structured assessment of gaps and potential consequences is nevertheless warranted to assure that risk models continue to operate effectively. However, Peoples Gas does not operate a structured program for validating data after its entry into the systems that feed the prioritizing models.

Each of the relative risk models uses historic records and property records to determine the most at risk segments or neighborhoods, based on the each model's requirements. Many, particularly older, records are likely to be missing, as is the case generally for utilities serving large cities with extremely old infrastructure. The breadth of the ranking models and the wealth of data available to populate them moderates the risks of inaccuracy. Peoples Gas has been populating data for use in replacement prioritization for decades.

Another factor that mitigates concern about data completeness and accuracy is the rounding feature of the Main Ranking Index. This feature serves to heighten the priority (six and above and some five ranked segments) of the facilities requiring immediate replacement whatever their ranking might be under the neighborhood construct.

F.4 Not including soils data in risk modeling fails to address a factor material to failure risk. (*Recommendation F.2)*

Peoples Gas does not appear to be using soils data in either risk model. Such data should be considered in differentiating the risk of corrosion and breaks, even within particular classes of high-risk pipe. Soils data is important for locating potential areas of high corrosion, and thus wall thinning of mains. Currently neither risk model used by Peoples Gas appears to use soils data in developing risk rankings. This data may not be as useful in the neighborhood model, which

identifies replacements on a large-area basis. The data has more applicability for "hot spots," where corrosion proceeds at accelerated levels.

F.5 Despite the improvements that replacement has brought, the failure to achieve a decrease in leaks raises questions about effectiveness in identifying the highest-risk pipe and slating it for replacement. (*Recommendations F.3 and F.4*)

The failure of leaks to trend significantly downward for a number of years calls into question the process used to select highest-risk mains. After so many miles of main replacement, one would anticipate a large reduction in leaks. The data simply do not show such reductions. Even after considering Company adjustments for third-party damage leaks and normalizing for degree days, Peoples Gas has experienced only a nominal reduction in hazardous or potentially hazardous leaks (Grade/Type 1 & 2) over the last several years. Several outside consultants have concluded that the Company measures the correct parameters. That conclusion points to the weightings being used in the models that drive replacement as a subject for evaluation. The Main Ranking Index model weightings have not changed over a number of years.

The neighborhood ranking calculation significantly weights the amount of small diameter and pre-1920 pipe in each neighborhood. It thus tends to favor larger over smaller neighborhoods, with all else being equal. The combined amount of small diameter and pre-1920 pipe comprises a full 40 percent of the neighborhood risk ranking. This emphasis causes the initial selections for work in each shop area (in the first five-year program increment) to consist primarily of the largest neighborhoods in each shop area. The selected areas also include those neighborhoods that have not had many replacements, because the miles of pre-1920 small diameter main remaining is the largest driver on the ranking scheme. Medium pressure ductile iron mains get the next-largest weighting. Meanwhile, unrepaired leaks and inside meters contribute the least to neighborhood risk rankings. Neighborhoods with the highest leak rates may fail selection for the first five-year window simply because they are physically small, do not contain a large percentage of pre- 1920 cast iron mains, or do not have much small diameter main.

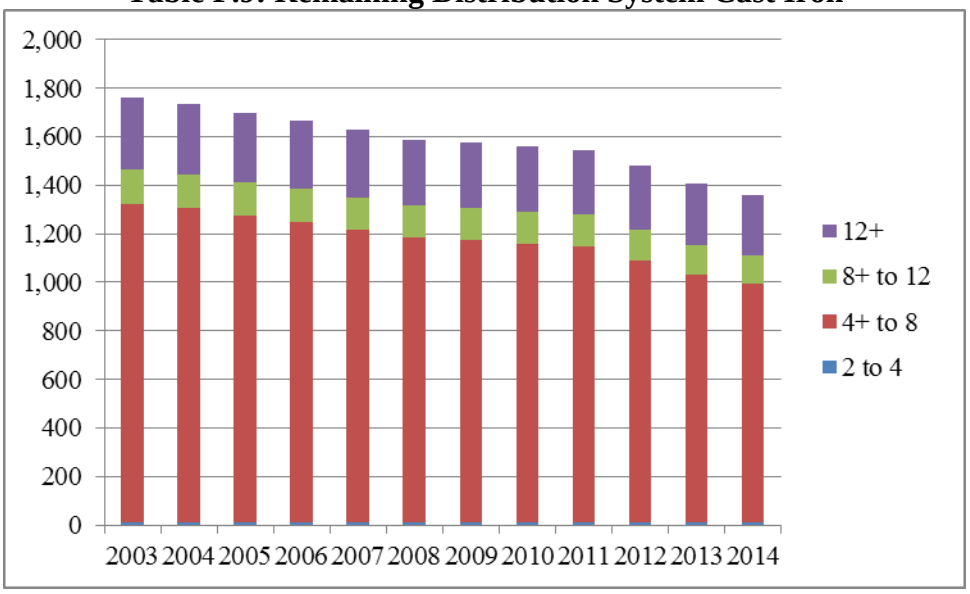
Leak rates fell in the early years of cast and ductile iron replacement. The pace of reductions were consistent with a conclusion that considerable reduction in risk was occurring. A downward trend continued following the introduction of the Main Ranking Index in the mid-1990s. The risk reduction line has now flattened (or slightly increased), even as more leak prone and higher risk segments undergo replacement.

The current risk models continue to target what certainly used to comprise the highest risk segments; *i.e.*, small diameter pre-1920 cast iron segments (due to their highest break potential). The once considerable amounts of such pipe, especially the smallest diameters, however, have fallen considerably, as replacement programs have continued to target them. A going-forward replacement rate of over 100 miles per year will continue their rapid elimination. However, the reduction in risk that each mile replaced from here forward will produce will continue to diminish, if one makes the logical assumption that the remaining segments pose less failure risk than those already replaced.

Cast and ductile iron remain at far greater risk of failure than do modern materials, such as plastic and cathodically-protected steel. At the same time, elimination of the most risky cast iron and

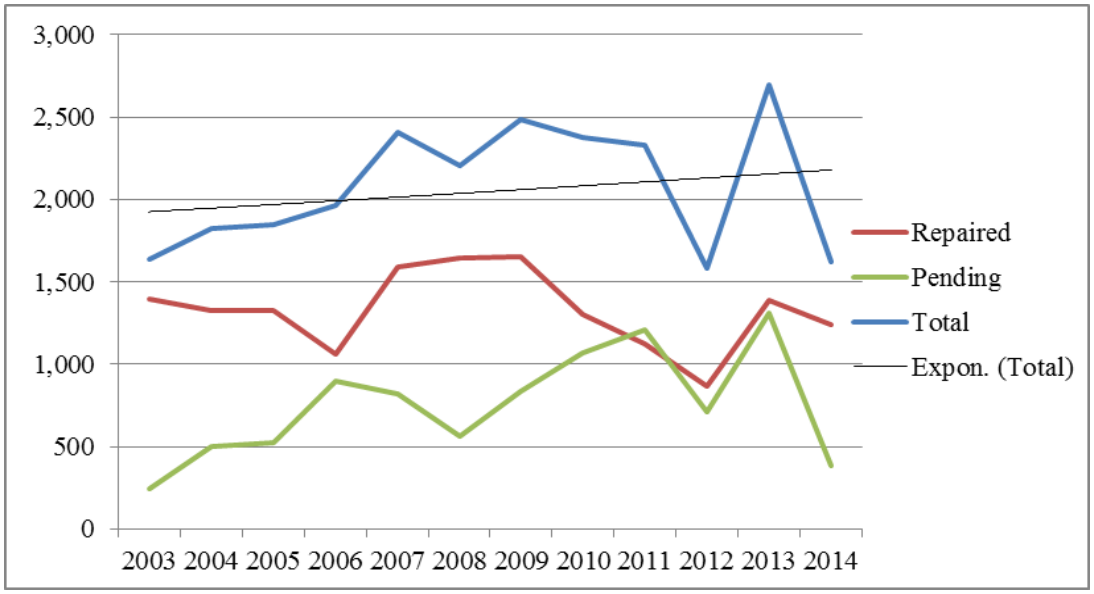
ductile iron segments reduces their risk relative to other system components. Note that the number of mains scoring near 6 under the Main Ranking Index continues to decrease. That number currently consists of less than 20 segments and less than 1 mile of mains. Between 2003 and 2013, the number of miles of small-diameter (8" and less) cast iron main decreased from 1,323 miles to 1,032 miles (22 percent in 11 years). The next table (from PHMSA yearly reports) shows the miles of cast iron remaining in the distribution system at year-end.

Table F.9: Remaining Distribution System Cast Iron



The same source, adding both repaired main leaks and leaks pending/scheduled for repair, shows that the overall leak count has not decreased significantly over the same 11 years.

Table F.10: Leak Count



The numbers of repaired and pending-repair leaks in the annual reports show that the number of repaired leaks either has remained constant or slightly decreased. Nevertheless, the number of leaks pending repair has increased. Several possible explanations for decreases in repaired leaks exist (*e.g.*, avoiding repairs mains scheduled for replacement, deferral of repairs to reduce O&M costs). It could also be that the overall leak rate has increased to the point of overwhelming the resources that do the repair work, in which case the backlog is growing. Liberty believes that finding the appropriate explanations for the failure of leak rates to decline should be a priority for AMRP management. Given the level of replacement activity, an increase in explosion or fire incidents caused by leaks would be unacceptable.

An examination of Peoples Gas monthly Type 1 and 2 leak reports for the last several years shows that leaks rates have not decreased as anticipated.

Table F.11: Annual Number of Hazardous or Potentially-Hazardous Leaks
(2014 extrapolated based on 10-months data)

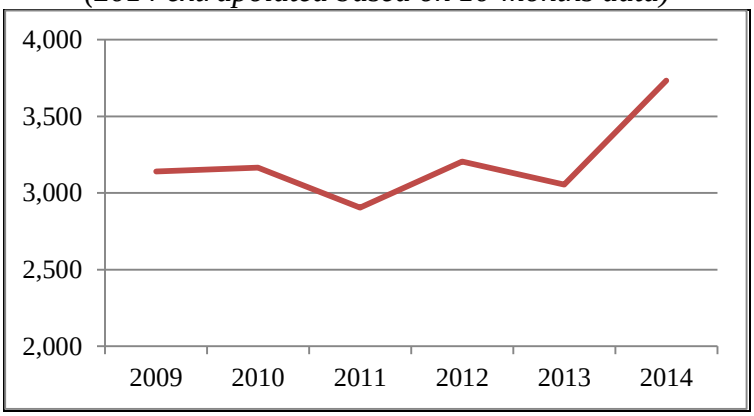
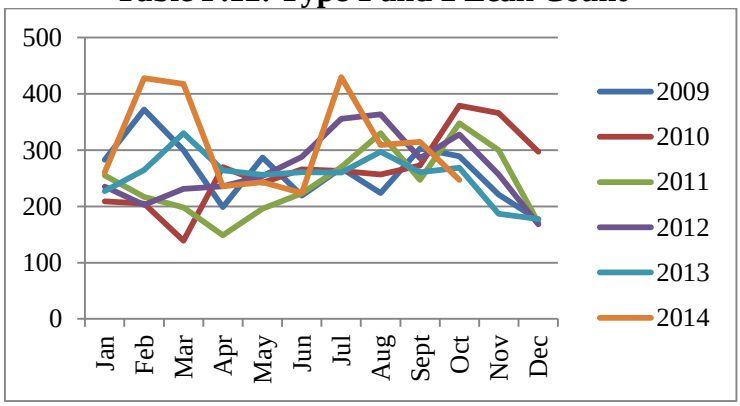


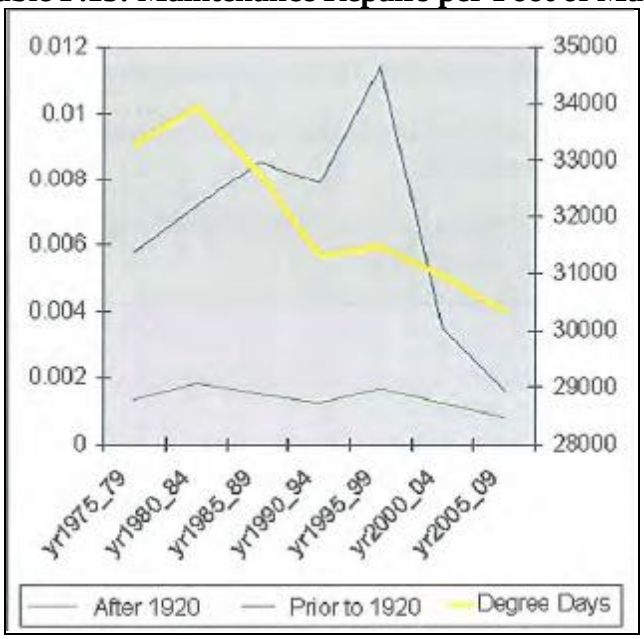
Table F.12: Type 1 and 2 Leak Count



Based on data that the Company has supplied, leak costs per mile of cast iron/ductile iron main have been trending downward for several years. The chart below shows that trend by plotting maintenance repairs per foot of main, separated into pre- and post-1920 vintages. During this same period, Peoples Gas relied only on the Main Ranking Index to determine replacement priorities. The neighborhood models targeting pre-1920 main should cause this trend to continue.

Showing degree days demonstrates that weather may account for part of the trend. Warmer winters tend to reduce leak numbers, and therefore repairs. Colder winters with deeper frost penetration may, on the other hand, accelerate leaks due to breaks. The 2013/2014 winter was one of the coldest in recent times, which may account at least in part for an uptick in leak rates then.

Table F.13: Maintenance Repairs per Foot of Main



F.6 The weight given to pre-1920 main may no longer support greatest risk reduction per mile replaced. (*Recommendations F.3 and F.4*)

Leak rates for pre-1920 cast iron mains decreased steadily and substantially from 1995 through 1999. By contrast, those rates have remained essentially flat during from 2010 through 2013. Hazardous leaks (Type 1) have increased, but declines in non-hazardous leaks (Type 3) have essentially offset the increase.

A number of factors complicate reaching definite conclusions about causes of leak-rate changes in the past ten years or so. The number of miles replaced in more recent years decreased, with uncertainty about rate recovery. Most recently, the extreme cold of the 2013/2014 winter brought increased frost-cracking potential for brittle cast iron mains. Peoples Gas still replaces segments having a Main Ranking Index ranking of 6 or greater (and 5 for certain conditions). The rankings that drive neighborhood work tend to emphasize small mains installed prior to 1920, because they are the most leak-prone.

Peoples Gas last commissioned a focused review of its risk-ranking effectiveness in 2007. The outside firm conducting the review observed continuing leak reductions, and discussed the merits of examining a date of 2038 or later for replacement completion. A fundamental premise of the finding of effectiveness at that time has no longer applied for a number of years. Liberty believes it is time to re-examine the weightings used to rank risk. In particular, the Company should consider the weight that small-diameter, pre-1920 cast iron mains should receive.

Pre-1920 and post-1920 main repair rates are approaching each other. Targeting pre-1920 cast iron main for replacement may not be yielding the largest reduction in leak rates. Rather, leak history in a neighborhood may offer a prioritization criterion for main replacement neighborhoods. Normalizing leaks, both repaired and open, per the number of feet or miles of main to be replaced in each neighborhood would also tend to produce the greatest reduction in risk per foot replaced.

F.7 Peoples Gas does not employ a meaningful metric that can directly relate costs expended to risk mitigation accomplished; Liberty continues to work with the Company to determine one. (*Recommendation F.5*)

Liberty examined the potential for identifying a metric that could directly and simply address effectiveness in identifying: (a) the right mains and services to replace, and (b) cost-effectiveness of replacements in relation to that identification. Such a metric would measure cost-effectiveness in terms of success in risk mitigation produced. Peoples Gas does not use such a metric. The recommendation implementation monitoring process that will follow this report should include efforts to develop such a metric.

A primary difficulty in defining a meaningful metric arises from the time lag between installation of new mains and retirement of the mains being replaced. Lags approaching one year can occur. For example, before retiring the old main, Peoples Gas must move all customers to a new, higher-pressure main. Thus, delays in locating and installing a few - perhaps even one - new meters delays retirement. The accounting process also delays recording retirements already physically accomplished. Updating property and tax records produces discontinuity in measuring the effects of replacement work.

F.8 A review of upcoming projects confirms that Peoples Gas does use the results of its two ranking systems to prioritize work on what those systems identify as highest-risk.

Liberty examined 2015 planned replacement projects to test their conformity with the neighborhood ranking process that Peoples Gas uses to select them. The next table lists 2015's major neighborhood replacement projects. Many carried over from 2014. Vulnerable services include bare steel, early clear plastic, copper, and any ductile iron services.

Table F.14: 2015 Major Neighborhood Replacement Projects

Shop	Neighborhood	Total Main Retirement (ft)	Total Number of Services	Vulnerable Services
North				
	Portage Park (7 phases)	178,464	6,388	1,690
Central				
	South Austin (14 phases)	168,725	3,647	
	Brighton Park	121,440	3,988	
South				
	Beverly	169,597	3,821	316
Total		**638,226**	**17,844**	**2,006**

The August 2014 run of the Main Ranking Index model identifies only about one mile (slightly less than 5,000 feet) of main segments having a score of 6 or more. The characteristics of these 12 (all cast iron) segments are:

- Lengths between 2 and 763 feet
- Both medium and low pressure
- Installation dates between 1902 and 1956
- 6" (11 segments) and 12" (1 segment) diameters.

These results illustrate that small diameter (6") cast iron now dominates pipe ranked as highest risk.

Both neighborhood and Main Ranking Index-driven 2014 work correspond to the results of the modeling that Peoples Gas uses to prioritize work. Planned 2015 work will eliminate the mains that reflect highest risk as scored by Peoples Gas. The low amount of highest-ranked main under the Main Ranking Index, however, indicates that it is timely to evaluate whether more immediate-term, index-driven work would produce greater risk reduction in a cost-effective manner. This improvement could occur by lowering the Index score that qualifies segments for immediate replacement, even where they do not lie in top-ranked neighborhoods.

Cases have occurred in which Peoples Gas has altered work schedules driven by the neighborhood and Main Index Ranking prioritizations. The Company checks its plans and schedules against planned work by the City of Chicago and by others. Other underground utility infrastructure improvements and repaving plans can make those changes appropriate, or even required. For the upcoming year's work, Peoples Gas sought to complete the design and engineering work required to have construction contracts in December or early January.

This work proceeds with knowledge of existing plans, but changes, particularly by the City, require continuing attention to schedule. In 2014, schedules for some of the North Shop area's Portage Park replacement work moved forward from 2015. Those not affected by changes in City plans moved back to 2015.

On occasions where City infrastructure work is being performed in a lower-risk neighborhood, moving the priority up on a neighborhood basis may prove particularly problematic. Changing pressure may require some additional infrastructure work by Peoples Gas, such as running medium-pressure feeder lines, supply sources, and detailed engineering analysis. These situations undergo evaluation on a case-by-case basis.

Changes to adapt to schedules for City improvements sometimes take a partial form. For example, where planned City work precedes the schedule for main replacement by a short time, the Company may perform installations at street crossings contemporaneously with City work, but save the balance of the work for later. This partial-replacement work avoids the need for later disruption, because intersections require open-trench construction. Irrespective of whether the City shares in paving and restoration, Peoples Gas saves money (as well as minimizing the public inconvenience during street openings) by coordinating work with the City. When Peoples Gas works in streets recently improved by the City (a so-called "moratorium street"), it must re-open the street, and then re-pave the entire area. (The City requires curb-to-curb repaving.)

F.9 Peoples Gas does not have a reliable method for identifying the operating and maintenance costs associated with AMRP, pressure increase, or meter relocation work. (*Conclusion F.6)*

Peoples Gas has confirmed that it does not have current data or analysis addressing operations and maintenance cost changes as a function of investment in work covered by the Qualifying Infrastructure Plant Surcharge. Peoples Gas has agreed to the development of a cost model that will incorporate this capability.

4. Recommendations

F.1 Peoples Gas should develop, staff, and implement a data quality control program. *(Conclusion F.3)*

The Company should develop and implement a data quality control program, in order to verify that its risk-prioritization models and processes continue to provide accurate results. The AMRP has produced a significant body of work under both models currently used. The data should support sampling of the documentary foundations for segments and neighborhoods completed in order to determine what kinds of information were missing, and what errors available data may have contained. Particularly for work driven by application of the Main Ranking Index, the Company should validate that assumptions and allowances made for missing or erroneous data. The validation should test the sufficiency of conservatism used to give confidence that the Index continues to identify what truly represent the highest-risk segments appropriate for immediate replacement.

Peoples Gas needs to develop a structured program for sharing experiences and problem solutions among the three Shops, as Chapter Q: Field Work Performance reports. Addressing issues of data accuracy should comprise one of a broad range of subjects for such sharing.

Peoples Gas needs to develop a single database combining all leak data. The Company should ensure that all data in various forms, such as PHMSA reports and monthly leak discovery and repaired data, is checked for accuracy and that totals are corrected for errors. Large differences exist between data that Peoples Gas provided to Liberty in several different data requests. The differences show that when leak data is checked against other lists, there are significant variations that cannot be explained by re-grades or timing issues.

F.2 Peoples Gas should develop a database of soils data already collected, and populate it further with soils data taken at new excavations. (*Conclusions F.4*)

The development of a soil database should serve, when reasonably populated, as a factor in determining replacement priorities, particularly for highest-priority segments identified through the Main Ranking Index. When data population reaches a level supporting defensible correlations between soil conditions and risk, Peoples Gas should determine whether and how to turn the data into a quantifiable ranking factor, or alternatively, how to apply it judgmentally in driving replacement priorities.

F.3 Peoples Gas should conduct a structured study of alternative criteria and weightings for the Main Ranking Index and for the neighborhood approach. (*Conclusions F.5 and F.6*)

It is time for Peoples Gas to engage in a structured, comprehensive, and analytically-driven review of other weighting, parameters, and additional inputs to its Main Ranking Index and its neighborhood rankings. For example, the repair rates for pre- and post-1920 cast iron are equalizing. Eliminating that distinction and giving greater emphasis to small-diameter cast iron mains may prove warranted. The Company also needs to address the bias that its zonal approach creates in favor of larger neighborhoods. Normalizing the lengths of small-diameter cast iron may prove beneficial. Another element of the review should be to consider leak history, as opposed to open leaks alone.

F.4 Should Peoples Gas not change the current criteria and weightings, the Company should develop additional measures to reduce leak rates further. (*Conclusions F.5 and F.6*)

Clearly, leaks have not decreased at rates one should expect this far into an accelerated main replacement program. Liberty's review of Type 1 and 2 leaks found that the opposite has occurred. Leak rates at Peoples Gas have increased. Data from 2009 through the third quarter of 2014 show leaks increasing by over 10 percent (from slightly under 3,000 per year to around 3,400). Peoples Gas offered adjustments to account for third-party damage leaks and to normalize for colder winter weather. Even after accounting for them, the rate of decline for the most recent years of the AMRP, 2012 through 2014, remains only nominal. Reports to federal authorities on repaired and pending repair leaks show a much larger increase (1,800 to 2,400) in the decade ending in 2013. Peoples Gas may attribute some of the difference to Type 2 leaks (considered to be potentially hazardous and thus requiring eventual repair) being downgraded to Type 3 (which never need to be repaired because they are not considered hazardous). However, such downgraded leaks are not sufficient in number to account for the difference.

Liberty expected the amount of main-replacement activity in recent years to show a correlation with decreasing numbers of Type 1 and Type 2 leaks. That correlation is not evident. The lack of correlation raises questions like: (a) whether the "right" mains are being replaced, (b) whether the leak rates for remaining mains have grown dramatically, or (c) whether the last, severe winter triggered large numbers of additional failures. Peoples Gas needs to examine these events to determine the causes of the anomalous leak/replacement relationship. Another factor that Peoples Gas needs to consider is the number of third-party damages each year and how infrastructure replacements of all underground utilities affect that rate.

F.5 Peoples Gas should determine on system, segment, and neighborhood bases the level of acceptable risk and metrics that will support appropriate adjustments in replacement rates. (*Conclusion F.7*)

Peoples Gas needs to develop a set of forward-looking metrics that will predict changes in risk level with replacement. Doing so will allow it to adjust replacement rates to meet future increases and decreases in the risk level. Peoples Gas should determine an acceptable risk level for each segment and neighborhood, and use that level to design a plan and schedule of main replacements to reach it.

Peoples Gas has not determined an acceptable level of risk for the general public, its customers and individuals working on the gas system. This tolerable level of risk needs to be determined so that both main-replacement risk models can be operated to reach the desired level. The acceptable level will not be static, but will change year to year, based on the mains already replaced, the activity of the prior year, and the continuing aging of mains not yet replaced.

We have discussed with Peoples Gas the identification of metrics that would relate costs incurred and replacements made to risk mitigation produced. Such metrics would provide benchmarks for assessing the amount of risk reduction achieved for the money spent. Liberty will continue to work with Peoples Gas to determine how to construct such a metric in a fashion that available data can support meaningfully.

Using average numbers of leaks and average main replacement rates (or average numbers of leaks over several years and main replacements over prior years) presents a possibility of developing an appropriate metric to measure risk reduction. Defining such a metric would need to take into account the fact that unusually cold weather can cause leak-rate spikes that can produce anomalous results. Using leak rates averaged over a number of years can help address this impact. Averaging replacement rates over multiple years may also help to correct for lags in physical completion and accounting recognition of retirements. Liberty anticipates that the search for applicable metrics will require an exploratory process, accompanied by deeper review of data issues. Thus identifying whether such metrics exist, and defining them properly if they do, will require an iterative approach.

F.6 Peoples Gas should develop a cost model that addresses O&M costs associated with AMRP and related work. (*Conclusion F.7*)

This model needs to permit detailed forecasting, estimating, and analysis of operations and maintenance cost changes occurring as a function of investments made to replace main under the Main Ranking Index, and of investments made to serve the purposes of the neighborhood approach.

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Chapter G: Cost Planning

1. Background

This report chapter:

- Discusses the nature of cost planning for the overall duration of the AMRP
- Addresses the sufficiency of the overall AMRP cost estimate
- Evaluates the use of contingency or reserve to address the uncertainties that the AMRP presents long term
- Assesses the quality of management's grasp on the drivers of long-term AMRP costs.

A program such as the AMRP requires a comprehensive approach to planning and managing costs. Its duration calls for a long-term cost plan, which this chapter addresses. Other chapters (K: Cost Estimating and L: Cost Management) address cost estimating and the management of costs in accord with the long-term cost plan and with shorter-term project cost estimates.

In 2009, Peoples Gas presented testimony before the Illinois Commerce Commission in support of its request to accelerate replacement of cast and ductile iron pipe. The Company also sought to upgrade low-pressure systems (normal operating pressure of about 0.25 psig) with a medium pressure system (normal operating pressure of about 23 psig). The Company estimated that accomplishing these two objectives would involve completion of the units of physical work summarized in the following table.

Table G.1: Proposed Main Replacement and Pressure Increase Quantities

Major Commodity	Quantities	Measure
Neighborhood	196	Each
Interstation High Pressure	63	Miles
Mains	3,056	Miles
Retirement	2,028	Miles
Services	296,391	Each
Meters	406,927	Each
Pressure Regulator Stations - Abandoned	325	Each
Pressure Regulator Stations - New	51	Each
City Gate Station Additions	2	Each

Both the 2009 "Original" and the 2012 "Current" AMRP cost projections use these units of installed (as opposed to retired) quantities.

2. Findings

The AMRP should be managed in a manner consistent with the requirements of a multi-billion dollar "mega-project." Peoples Gas should have a forecasting capability that supports continuing projections of final AMRP costs with a high degree of confidence, addressing the material levels of uncertainty necessarily associated with such a program.

a. The Cost Plan

i. Total AMRP Cost Estimate Background

Peoples Gas prepared the AMRP's Original Estimate of $2.63 billion to support the cost recovery mechanism (Infrastructure Cost Recovery) proposed in the Company's 2009 rate case. This early 2009 estimate used 2008 information, and presented costs in 2010 dollars. The current estimate, prepared in early 2013, used information available in 2012, and presented costs in 2012 dollars. This estimate revised total AMRP total cost significantly upward, to $4.45 billion. This revision came in the context of the latest update in Illinois Commerce Commission Docket No. 14-0496. This estimate used actual costs for the first two years of AMRP work, a current estimate of 2013 costs, the budget for 2014, and a projection of costs for the program's remaining 16 years. This chapter reconciles the original and this current estimate below.

ii. Assessment of Total Cost Estimate Methods

Preparing a total cost estimate for a project of the size of AMRP comprises a major endeavor. Significant effort and thought went into developing the Original Estimate, which considered the collective experiences and relevant information available at the time. The next table summarizes Liberty's observations about its methods.

Table G.2: Original Estimate Methods

Cost Driver	Liberty Observations
Underlying assumptions	Comprehensive – appropriate for the time
Estimating techniques	Sound – in line with industry practices
Scope definitions	Adequate – scope of mains defined by size
Quantities assumed	Reasonable – calculated and weighted based on known configuration and data
Final costs basis	Flawed – expressed in 2012 dollars, with no escalation considered
Engineering costs	Low – at 5 percent of construction costs
Material costs	Fair – based on research of actual and available vendor information
Meter installation rates	Probably low – used data from different environments
Labor rates for internal resources	Fair – based on actual costs
Contractor unit costs	Probably low – based on bid analysis
Annual production	Reasonable – retiring 100 miles per year is achievable
Schedule assumptions	Limited – assuming 20 year duration
Resource ramp-up	Inconsistent with estimate assumption of ramping up for five years and ramping down the last two years – Only one year ramp up and no ramp down
Demobilization	Not considered – an area of cost exposure
Major cost risks	Not considered – changes in regulations, technologies present cost exposure
Major schedule risks	Not considered – 20 years believed long enough to make up for schedule slippages
Contingency	None – failure to account for cost exposures within the known scope
Cost target	No industry data available for reference

iii. Company Reconciliation of Original and Current Estimates

A first 2012 cost estimate produced a cost of $4.86 billion, which management followed shortly with a downward revision to $4.56 billion. Following the availability of more actual (versus estimated) costs, a further reduction occurred, producing 2012's official Total Cost Estimate of $4.45 billion. The next table shows the Company's reconciliation of the cost estimate growth from

the estimate proposed in the 2009 rate case and the 2012 estimate. This 2012 estimate was the last one issued to address program-length costs, making it the most recent announced estimate.

Table G.3: Reconciliation of 2009 and Current (2012) AMRP Estimates

Description	All Costs in $ million			Remarks
	Original Estimate	Current Estimate	Change	
Intra-Station High Pressure	354	359	5	
Mains	1,343	2,097	754	Installation method changes from horizontal directional drilling to trenchless technologies, also new city regulations
Services	519	1,013	494	Based on actual bidding rates
Meters	151	277	126	Based on actual installation rates
Pressure Regulator Station - Abandoned	9	13	4	
Pressure Regulator Station - New	7	9	2	
House Regulator	76	-	(76)	
City Gate Station	8	10	2	
Total Construction Costs	**2,467**	**3,778**	**1,311**	
Program Management	160	673	513	Design, project Management, contractor inspection services, line locating costs
Total AMRP Costs	**2,627**	**4,451**	**1,824**	

Several observations arise with respect to this cost growth of 69 percent, just two years into the AMRP.

First, program management costs increased by three times, due to changes in assumptions and management strategy shifts. The original estimate, while unrealistically low, reflected only incremental AMRP costs. It did not include several elements initially thought to be covered in-house. Second, the bulk of construction costs lie within the main replacement and the services and meter installation categories. These areas experienced a collective cost increase of almost 68 percent in two years, much of which included revising the primary installation method from direct bore to open cut. Optimizing performance requires close monitoring and management of construction performance, using estimated unit rates as a measurement basis. The next table shows the very large changes in unit rates that one can determine from the two estimates. There has yet been no stable, accurate basis for measuring AMRP performance. The unit rate changes shown in the next table demonstrate the instability. A failure to monitor and manage unit rates carefully tends to cause construction performance to drift unfavorably.

Table G.4: Unit Rate Changes from Original to Current Estimate

Unit Cost of Commodity	Unit of Measure	Original Estimate	Current Estimate	Change	Percent Increase
Intra-Station High Pressure	$/station	5,607,748	5,558,432	(49,316)	-1%
Mains	$/mile	439,511	691,431	251,920	57%
Services	$/service	1,750	3,365	1,615	92%
Meters	$/meter	559	728	169	30%
Pressure Regulator Station - Abandoned	$/station	28,795	40,246	11,451	40%
Pressure Regulator Station - New	$/station	143,975	177,782	33,807	23%
City Gate Station	$/station	3,947,839	4,895,630	947,791	24%

iv. Program Contingency

Liberty found it surprising that the revised, 2012 estimate contained no contingency. A program cost growth of 69 percent in two years indicates that project cost and schedule risks have not been carefully addressed. That rate of growth should also signal to management that uncertainties in a major program of this magnitude and duration require recognition and treatment in the long-term cost plan. Even without the warning signals presented by the first two years of experience, a program of the AMRP's size, complexity, and duration calls for a clear and direct treatment of contingency.

The term "contingency" has different connotations to different people in the industry. A general perception is that it is meant to provide reserve for use whenever extra funds prove needed. Further, some operate with the view that explicitly recognizing the potential need for added funds makes them inevitable and implicitly acceptable. This view causes some to avoid the use of contingencies in estimating. The best practice view, however, recognizes that good estimating requires the use of contingency, for both small and large projects and programs. Determining the proper amount requires careful judgment, but ignoring contingency does not offer a sound alternative.

Peoples Gas does not use contingency in its long-term program cost plan (*i.e.*, across the full AMRP 20-year duration). The Company, however, does include contingency in its annual budgets. The primary use of contingency in these budgets is to address growth in contractor costs. Annual budgets use two categories of contingency: allocated and unallocated. Allocated contingency includes the costs required to manage known events or issues. Allocated contingency includes requests (Field Order Authorizations and Change Orders) in progress but not yet approved. Allocated contingency also includes the effects of emerging trends that management can attribute to a specific cost account or project. An example of such a trend might be a change in City of Chicago Department of Transportation requirements. Unallocated contingency consists of the cost required to manage unknown events or issues. The program manages unallocated contingency through a line item in the budget. Management transfers unallocated contingency amounts to more specific accounts as circumstances dictate. The AMRP Senior Project Manager must approve any transfers from the unallocated contingency account.

b. Maintenance of the Cost Plan

AMRP management established the current Cost Plan by laying out the annual gas main quantities it needed to replace. Design analyses supported this planning foundation. The gas main quantity

required to be replaced amounted to about 2,000 miles. Management identified the other categories of work involved (such as new gas main installation, services, meters, pressure regulator stations, and city gate stations), and established estimated quantities for those categories. Material cost calculations used available vendor information. Estimates of labor costs to move and install meters used historical data. Management approached the estimation of installation costs for gas mains and services by analyzing information from reasonably current bids. Support group costs (*e.g.*, design engineering and construction inspection) also required estimation and monitoring.

At a minimum, quantity, unit cost, and productivity require close monitoring and control. Peoples Gas, however, has only tracked the annual installation quantities of gas mains, services, and meters. The Monthly Status Report provides this tracking. Four years into the AMRP, one can find little focus on how the program has performed with respect to the original estimate assumptions, apart from current year production. The current AMRP cost management philosophy focuses on spending the annual budget and doing the best it can to reach 100 miles of main replacement. The failure carefully to track and focus on construction performance and project cost trends undermines attention on and eventually the capability for producing a credible estimate of final, total AMRP costs. Liberty also found no plan or set of structured processes defined and documented to monitor projected total program costs.

The Project Management Office ("PMO") displayed particular sensitivity to addressing the potential impacts of future uncertainties. Liberty acknowledges that a long-term, complex, multi-billion project spanning 20 years makes a deterministic, or single-point estimate of final costs unhelpful in managing the AMRP. That difficulty, however, does not justify avoiding treatment of such uncertainties. The AMRP requires a number of cost planning elements that it does not yet possess. These elements include a long-term estimate, the ability and commitment to track against it continually, and processes for assessing and trending scope additions and subtractions. Peoples Gas acknowledged during Liberty's field work the need for developing new tools essential for bringing these elements into existence.

Liberty learned from field work during mid-2014 that management had underway an update of the total program cost estimate. The Company led Liberty to believe that it would produce reviewable results imminently. Management agreed to provide a presentation of the new cost estimate on a preliminary basis. Canceled at the last minute, the presentation never happened, and AMRP management informed Liberty that Peoples Gas had abandoned efforts to produce a new estimate in the near term.

Instead, management hired a Planning & Forecast Manager, who has strong construction background. Management tasked this individual with developing an entirely new cost model, after taking a broad view of AMRP direction and consideration of the risks the program faces. That new model was to form the basis for a new total cost estimate. The Company has also advised that new modeling capability will incorporate the ability to address changes in operating and maintenance costs associated with capital investments in replacing high-risk pipe, moving meters to outside locations, and increasing pressures from low to medium levels.

Management estimated that it would take six months to complete work on a new cost model for use in generating a new estimate of total AMRP costs. Current initiatives continue to address these

objectives. Three months after the end of management's six-month time estimate, however, the AMRP continues to lack an announced new cost plan and a current estimate of total program costs at completion. Liberty has no reliable information on when Peoples Gas plans to issue a new estimate.

3. Conclusions

G.1 The AMRP does not have a long-term cost plan that provides a credible estimate of final program costs; management is only now creating the modeling capability to produce such an estimate. ***(Recommendation G.1)***

The original (2009) Cost Plan contained sufficient detail, and used appropriate assumptions to establish production quantities and unit costs. The 2012 estimate updated total program costs, but its $4.45 billion estimate used 2012 dollars. The use of 2012 dollars significantly understates expected final costs. The AMRP needs a new cost plan that will provide a current final cost estimate. An effort to provide such an estimate collapsed in mid-2014.

We found, as Peoples Gas has acknowledged, that it could not provide a meaningful total estimate of AMRP costs without first developing new cost modeling capability. Sound estimates comprise a critical element in effective management of AMRP costs. Peoples Gas has embarked on efforts to develop that model. It needs to complete model development, and estimate work expeditiously. Moreover, the results of the modeling effort need to address more than the direct costs of AMRP work. Peoples Gas also needs to develop the modeling capability to address the ongoing O&M costs and savings over the long term. The Planning and Forecasting Manager has responsibility for cost model development.

G.2 AMRP estimates break program costs down into suitable major categories by year, but management does not use that breakdown to inform cost tracking at either the program-wide or project-specific levels. ***(Recommendation G.1)***

Managers cannot manage what they do not monitor, and cannot monitor what they do not measure. Cost tracking needs to provide information at a significantly enhanced level of detail.

G.3 The AMRP program's lack of reserve to cover cost growth fails to reflect potential cost exposure. ***(Recommendation G.1 and G.2)***

Best cost estimating practice regards contingency or reserve as a necessary part of a total cost estimate. Cost estimates need to recognize uncertainties that make full cost driver definition imprecise. A specific portion of funding should be earmarked to account for unforeseeable elements of cost. Hence, owners often add contingency or reserve to an estimate to provide for uncertainties in defined scope and in internal and external cost drivers.

A traditionally derived contingency amount will likely prove inadequate in forecasting the costs of a major, long-term program. Liberty therefore favors the term "reserve" or "management reserve" to account for the many uncertainties that exist within and outside program scope as currently defined. Scope changes will almost inevitably occur, and likely have substantial impacts. This broader definition allows a more robust portrayal of forecasted final costs.

G.4 Management does not compare AMRP costs and performance with what others in the industry have experienced. (*Recommendation G.1*)

Major main replacement work has become more common in the industry. It is useful to examine the performance of others, in order to provide a benchmark for gauging one's own approaches, methods, practices, and results. The AMRP appears to use no organized or documented approach to meeting this need. Instead, project management simply cites the experience of Jacobs Engineering, which leads and staffs most of the Project Management Office, as providing insight into other companies' efforts, making such comparisons unnecessary in its view.

In the development of the revised Total Cost Estimate, Peoples Gas did make use of some industry data; *i.e.*, a conversion factor published by the Handy Whitman Construction Trend of Utility Construction – North Central Region to price out most of the major commodities. The next table summarizes that information.

Table G.5: Handy Whitman Index Data

Handy-Whitman Cost Index	2010, Jan 1	2012, Jul 1	Factor
Mains, Steel	656	826	1.2591
Mains, PE (polyethylene)	482	521	1.0809
Services, PE	501	536	1.0699
Meter, Materials	257	271	1.0545
Meter, Installation	708	923	1.3037
Regulator Materials	406	438	1.0788
Regulator Installation	692	889	1.2847
Regulator Stations	567	700	1.2346
City Gate Stations	568	704	1.2394

G.5 Peoples Gas does not sufficiently understand and quantify major cost drivers. *(Recommendation G.1)*

A cost driver is an activity or component that adds significant cost to a project or program. Periodic cost analysis of actual data can yield relationships or linkages between events and contributions to cost increases. Examples of such contributors include contractor change orders, restoration contractor costs, material pricing, changes in City requirements, labor costs, and escalation. Cost professionals in the cost management organization should perform such analyses.

4. Recommendations

G.1 Peoples Gas should develop a new Cost Plan Model that includes comprehensive measurement bases and critical assumptions regarding scope, quantities, productivity, labor costs, unit costs, and regulatory requirements; a reserve should be included as part of the overall program costs. *(Conclusions G.1, G.2, G.3, G.4, and G.5)*

A first deliverable of this Model will be the new Total Cost Estimate. For Peoples Gas to be able to project final AMRP costs on a continuous basis, it has to establish a new capability to estimate on an almost real-time basis the total program costs. Liberty understands that a new AMRP cost

forecasting model will be developed by the Planning and Forecasting Manager. Features important to consider in development of that model include a number of elements that will assist in making the cost plan a sound, comprehensive baseline for continually measuring performance.

Key parameters to measure at the program level include:

- Cost Metrics (input related)
  - Program-to-date costs by year expended
  - Potential cost impacts from Cost Trend Program
- Production Metrics (output related)
  - Program-to-date miles of main installed
  - Program-to-date miles of main retired
  - Program-to-date services installed
  - Program-to-date meters moved/installed
  - Program-to-date pressure regulator stations installed
- Productivity Metrics (output versus input)
  - Average cost per mile installed
  - Average cost per mile retired
  - Average cost per service installed
  - Average cost per meter moved
  - Average cost per pressure regulator station installed.

A comprehensive cost plan should incorporate the following elements:

- Effective cost control tools
- Specifically defined tools for each key element of the AMRP project costs
- Ability to promptly identify and respond to cost issues during the course of each project, facilitating corrective action and providing meaningful and timely forecasts
- Agreement among the team on the structure and viability of the tools and resulting reports
- Understanding by the managers regarding the tools and commitment to their use
- Ability to document that AMRP project costs were prudently managed during the life of the program.

Such a plan should take the following approach:

- Senior Management communicates cost management expectations
- Responsible manager assists in developing the cost element plan
- The cost element plan is evaluated
- Performance is measured by compliance with the cost management plan.

The plan should seek to establish:

- Accountabilities for specific cost elements
- Tools to be utilized, including how and when
- The tasks required of the manager, cost analysts, and others
- Data and reports, including when prepared and to whom distributed
- Analytical expectations
- Corrective action responsibilities.

Other guidelines for developing the cost plan include:

- The plan should identify tasks that represent a disproportionate cost risk or otherwise require special treatment (this identification should include tasks that have a relatively high work-hour budget)
- An assigned cost analyst should prepare the cost element plan with input received from all involved managers
- The cost element plan should undergo review and approval by AMRP project manager before its inception
- The cost element structure should be simple, and consist of one to two pages.

Important features of the cost element structure include:

- Breaking the AMRP down into specifically identified cost elements
- Structuring the elements in accordance with their control characteristics
- Elements that might include engineering, planning and support functions, materials, mains, services, meters and regulators, other construction items, such as intra-stations, city gate stations, and pressure regulator stations, for example
- A total population of 8-12 elements, of various size and importance
- Element features that define the following:
    - A cost estimate, including its basis and assumptions
    - The manager responsible for the costs associated with the element
    - A cost engineer or cost analyst assigned to track and analyze its associated costs
    - Its control category based on its controllability and the sophistication of control demanded:
        - A = High importance – maximum control activities
        - B = Either less important or less controllable, but still significant and some degree of special attention is appropriate
        - C = Inconsequential – hence ignore.

The plan should also include a Cost Element Database having the following characteristics:

- The cost element database serves as the repository for all of cost element information
- The database structure supports collection of cost estimates and documentation of changes to them
- The sum of the cost elements at any point in time produces the "defined cost."

Each element falling into Category A or B elements (as described immediately above) requires a cost management plan with the following characteristics:

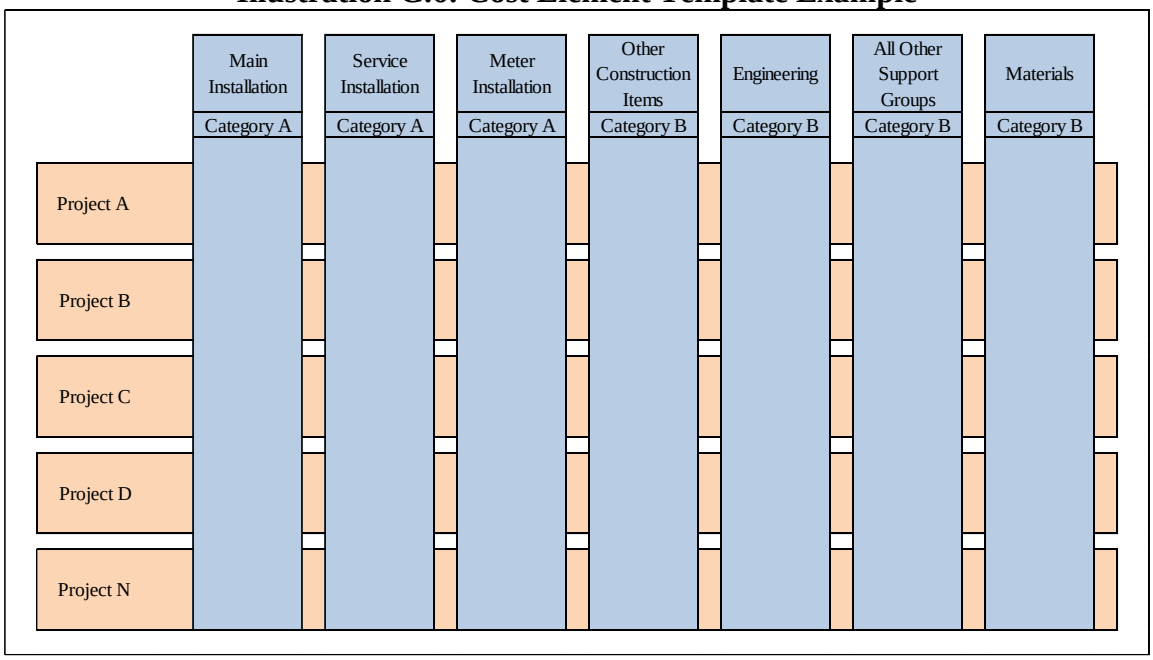
- The plan can be anywhere from one to a few pages, and may include supporting attachments.
- It defines the specific actions that will be taken to manage costs.
- It is both a tutorial and a procedure.
- It is likely to include key metrics and specifically what is to be done with them, required reports by contractors and others, a requirement for monthly analysis by the cost engineer, specific actions required of the manager, and update requirements for the model.
- Plans should be maintained and updated in a cost management manual.

One suggested approach for the AMRP would develop Individual Cost Management Plans to focus on the major cost elements:

- Main Installation
- Service Installation
- Meter Installation
- Other Construction Items
- Engineering
- All Other Support Groups
- Materials.

These major cost elements focus on cost issues common to all projects or phases of a project, producing a template like that shown in the next illustration.

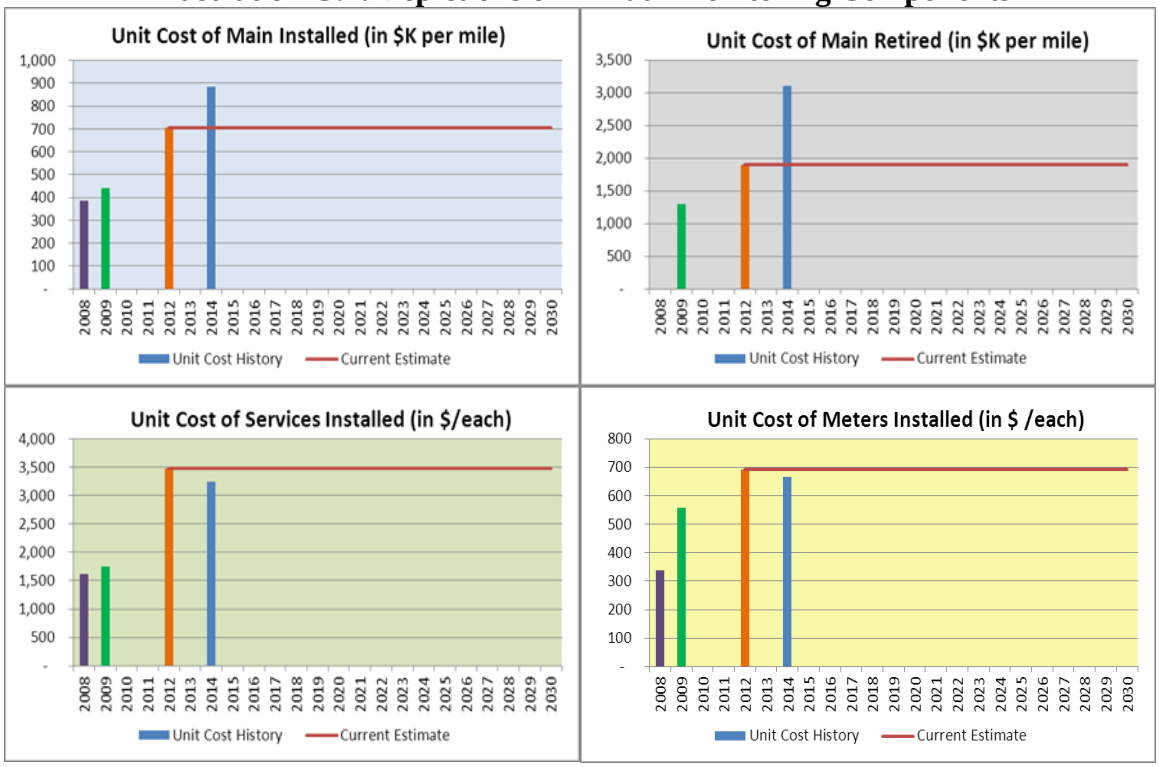
Illustration G.6: Cost Element Template Example



Management should prepare and continuously maintain a detailed cost management plan for each element.

Monitoring proves essential to making a cost plan function optimally. Given the AMRP's long duration, management should monitor annually the following areas: unit cost of main installed, unit cost of main retired, unit cost of services installed, and unit cost of meters installed. The following charts show examples of monitoring depictions.

Illustration G.7: Depictions of Annual Monitoring Components



Explanations of the source of data on the preceding charts include:

- 2008 – Historical data up to that year
- 2009 – Original AMRP Total Cost Estimate ($2.63 billion)
- 2012 – Current AMRP Total Cost Estimate ($4.45 billion)
- 2014 – Actual based on completed projects.

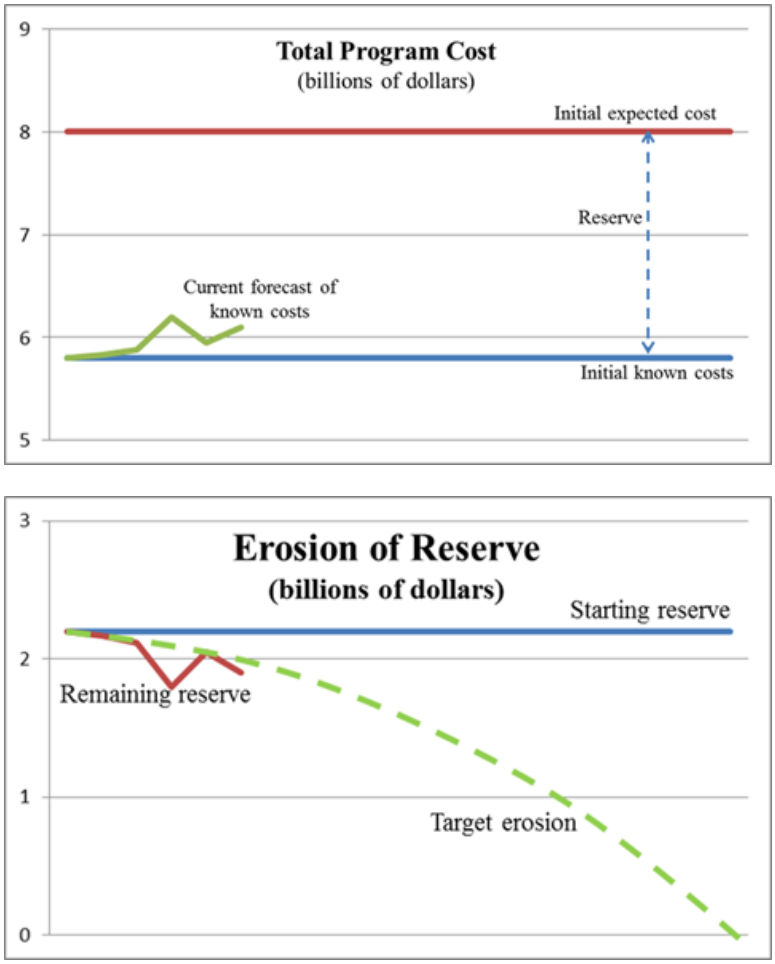
Note that unit costs in the 2012 Current Total Cost Estimate would provide the monitoring base until management completes a new Total Cost Estimate.

Other important elements in tracking total AMRP costs should include:

- The defined and expected costs become the standards for tracking program costs
- As the defined costs change, the amount of reserve remaining erodes, and the pace of such erosions becomes a key metric
- Expected costs may undergo periodic revision if and as the pace of erosion becomes too fast or too slow
- The key metrics can be displayed over the full 20 year period, but a shorter window can be selected to supplement the long-range view as warranted.

The next charts show simplified, hypothetical means for depicting erosion in the cost plan.

Illustration G.8: Depicting the Erosion of Program Reserve



Two important aspects should apply with respect to model updates:

- The model produces real-time cost forecasts; *i.e.*, changes in the defined program costs as they are revealed
- The assigned cost analysts or cost engineers initiate model changes, based on reconciled cost trends and monthly analysis of cost elements.

After completing the current work to establish a new final AMRP cost estimate, Peoples Gas needs to develop an effective cost forecasting capability, in concert with the cost management program.

G.2 Peoples Gas should establish a Cost Trend Program to monitor potential, major cost-affecting items. *(Conclusion G.3)*

Such a cost trend program serves as an early-warning system for potential cost deviations. Potential cost changes should get reported immediately, by an assigned cost analyst or cost engineer. Interventions can be initiated to mitigate correctible problems or minimize cost impacts. The cost trend program is a valuable tool that provides up-to-date information that enables Peoples Gas to forecast the final AMRP costs on an almost real-time basis.

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Chapter H: Schedule Planning

1. Background

This report chapter:

- Assesses long-term schedule planning and the schedules that drive replacement work in the immediate term
- Discusses the organization and resources that perform and support the scheduling function
- Examines the tools and processes that support scheduling functions and activities
- Reviews the use of production quantities and personnel resources in scheduling
- Evaluates the means used to monitor schedule performance and update schedules.

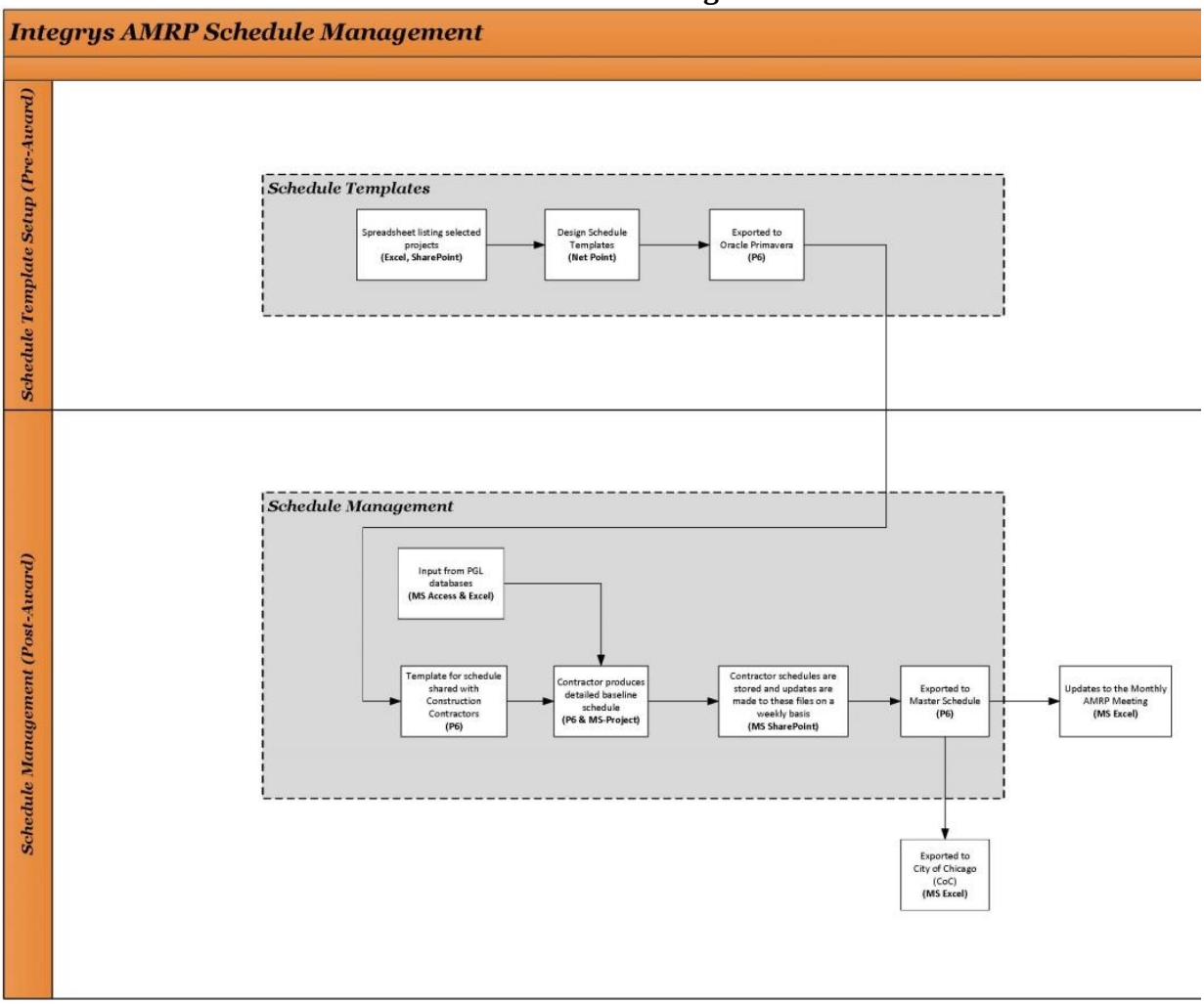
Good project scheduling provides real-time visibility on where a program or project is heading in comparison with clear milestones. Scheduling outputs should provide a common platform for the whole project team, focusing attention on important activities on critical paths. Good scheduling will ensure effective and efficient project and program execution.

Liberty evaluated the appropriateness and credibility of AMRP schedule planning. The examination addressed the AMRP's overall long-term schedule plan and the more detailed near-term schedules. The latter should form part of and be integrated with that long-term plan. Bulk quantities (feet or miles) of main to be replaced in each schedule time period comprise a paramount driver of program schedules. Overall, the AMRP's main replacement target, both peak and average over the 20 years, should drive overall planning. It defines the level that must be maintained to support the eventual replacement quantities in the field. Integrating engineering and procurement activities, considering the drivers of work planning, ensuring activity coordination, addressing permitting, and aligning contractor and employee resources form important elements in constructing achievable, but appropriately aggressive schedules.

2. Findings

Work by PwC, which has consulted for AMRP management for a number of years, has produced a good summary of the program's scheduling management process. The next chart depicts that process.

Illustration H.1: Schedule Management Process



a. Master Schedule Plan

No AMRP Master Schedule exists at the long-term, program-wide level. The approach to scheduling has been to use the annual budget to drive the schedule. This approach will support an overall 20-year duration, provided that annual cost limits can support the average target completion rate of 100 miles per year for 20 years. However, the first four years produced an average annual rate of only 70 miles. Liberty found no assessment on the impact of the current progress rate (70 percent of that required to meet 20 years) on total duration. Liberty also found no long-term schedule recovery plan or evidence of focused efforts to identify any. The lack of assessments and recovery planning evidence that annual spending limits prevail in the minds of management over completion within 20 years as the AMRP time driver.

Scheduling for 2015 (see the next table) addresses projects already active plus incomplete projects (or project phases) started in 2011 through 2014. The two active 2015 projects consist of Portage Park and South Austin.

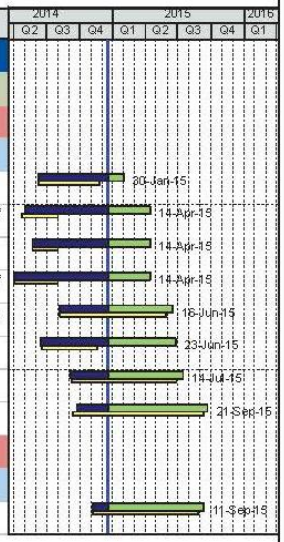
Figure H.2: 2015 Schedule of Active Projects

Peoples Gas AMRP Master Schedule - January 2015

2015 AMRP Projects Construction Summary

Data Date: 19-Dec-14
Run Date: 12-Jan-15 12:25

Activity ID	Activity Name	Orig Dur	Rem Dur	Dur % Compl	Start	Finish	Baseline Start	Baseline Finish	Variance (Finish)	Comments / Notes
Peoples Gas AMRP Master Schedule - January 2015		366d	192d	47.58%	02-Apr-14 A	21-Sep-15	02-Apr-14	11-Sep-15	-7d	
2015		366d	192d	47.58%	02-Apr-14 A	21-Sep-15	02-Apr-14	11-Sep-15	-7d	
North Shop		366d	192d	47.58%	02-Apr-14 A	21-Sep-15	02-Apr-14	11-Sep-15	-7d	
N-13-01 Portage Park		366d	192d	47.58%	02-Apr-14 A	21-Sep-15	02-Apr-14	11-Sep-15	-7d	
A1100	N-13-01 Portage Park PH 14 (KS)	119d	29d	75.67%	06-Jun-14 A	30-Jan-15	06-Jun-14	25-Nov-14	-45d	Main & Service Install, Gassing & Retirement Complete; RFI Pending for Additonal Service
A1060	N-13-01 Portage Park PH 10 (KS) - Conflict Areas	71d	81d	0%	30-Apr-14 A	14-Apr-15	22-Apr-14	31-Jul-14	-177d	Punchlist & PGL Verification in Progress; Total of 8 Punchlist Items Remain
A1070	N-13-01 Portage Park PH 11 (KS) - Conflict Areas	48d	81d	0%	22-May-14 A	14-Apr-15	23-May-14	31-Jul-14	-177d	Gassing to be Completed at a Later Date; Punchlist & Verification in Progress - 10 Items
A1090	N-13-01 Portage Park PH 13 (KS) - Conflict Areas	85d	81d	4.41%	02-Apr-14 A	14-Apr-15	02-Apr-14	31-Jul-14	-177d	Punchlist & PGL Verification in Progress; Total of 11 Punchlist Items Remain
A1110	N-13-01 Portage Park PH 15 (KS)	206d	125d	39.4%	05-Aug-14 A	16-Jun-15	05-Aug-14	29-May-15	-13d	Main Install Complete; Service Install & Gassing Pending Michels PH3 Work
A1080	N-13-01 Portage Park PH 13 (KS)	108d	130d	0%	16-Jun-14 A	23-Jun-15	16-Jun-14	18-Nov-14	-151d	Main & Service Install / Gassing Completion Pending RFI#0024; Restoration in 2015
A1120	N-13-01 Portage Park PH 16 (KS)	203d	144d	28.92%	08-Sep-14 A	14-Jul-15	08-Sep-14	26-Jun-15	-12d	Main Install/Gassing Complete; Service Install Complete Aside from Scattered Services
A1050	N-13-01 Portage Park PH 10 (KS)	252d	192d	23.95%	22-Sep-14 A	21-Sep-15	11-Sep-14	11-Sep-15	-7d	Main Installation in Progress
Central Shop		203d	186d	8.44%	05-Nov-14 A	11-Sep-15	05-Nov-14	25-Aug-15	-12d	
C-14-02 South Austin		203d	186d	8.44%	05-Nov-14 A	11-Sep-15	05-Nov-14	25-Aug-15	-12d	
A1010	C-14-02 South Austin PH 20 (Meade)	203d	186d	8.44%	05-Nov-14 A	11-Sep-15	05-Nov-14	25-Aug-15	-12d	Main Installation in Progress



Remaining Level of Effort
Actual Level of Effort
Baseline Level of Effort

TASK filter: PG - 2015 Construction Summary.

File Name: LOE Summary-5

PEOPLES GAS
NATURAL GAS DELIVERY

Page 1 of 1
NOTES: Actual dates are as reported by the contractor.

Date	Revision	Checked	Approved

b. The Scheduling Function

Program management develops an annual schedule with development of the annual budget. To date, program schedules only address construction, excluding, for example, design and permitting. AMRP management uses schedules provided by the contractors performing main and service installations to begin schedule development. Management adds to these contractor schedules required back end work, such as meter installations, performed by the internal Company workforce.

i. Construction Scheduling

The activities involved in assembling the annual construction schedule for input into the scheduling system follow this sequence:

- Engineering generally completes the design of projects or phases of a project by the end of the preceding summer
- Bid invitations issue at the beginning of November
- Contractor bid awards occur at the end of January
- Preliminary meetings with contractors (about 15 days later) discuss construction baseline schedules
- Contractors provide construction schedules for import into the scheduling system (P6) in mid-February
- The three Peoples Gas Shops provide scheduling information for the employee-performed AMRP in March, as the construction season approaches commencement.

ii. Contractor Scheduling Process

Management terms this overall contractor schedule the Construction Project Schedule. Each project passes through three schedule phases, developed for the stages through which each progresses.

Management terms the first schedule that each project uses the Preliminary Project Schedule ("PPS"). Bid packages to which contractors respond define work sequences for each project phase. Contractors must submit a Preliminary Project Schedule (using critical path method scheduling) when providing a price proposal as part of bidding for particular projects.

The Preliminary Project Schedule of the contractor selected covers first project activities, and eventually provides the foundation for the next, or Project Baseline Schedule. The Preliminary Project Schedule provides a preliminary logic plan for the project, divided (for multi-phased projects) at the phase level. Management depicts the Preliminary Project Schedule as a network diagram. The diagramming uses a "Sample Logic Model" provided by the Project Management Office's Senior Scheduler.

This summary-level diagram depicts a work breakdown structure, at the level required eventually to produce a fully developed baseline schedule. A Preconstruction Conference, scheduled within fifteen calendar days after bid award, uses this basic logic to support a discussion of more detailed requirements, reporting, logic, and expectations.

A project's second schedule, the Project Baseline Schedule, comes from the contractor. It becomes due within fourteen calendar days following the Preconstruction Conference. Contractors submit these fully developed baseline schedules for review and acceptance by the Project Management Office. The Project Baseline Schedule submittal presents the contractor's complete plan for executing work in accordance with bid and contract documents. Contractors work with the three Peoples Gas Shops, in order to allow sufficient time for the Shops to identify their work activities. Submission to the Project Management Office occurs after this coordination between contractors and the Shops. The Project Management Office's Senior Scheduler reviews these schedules, and must accept them.

A project's third schedule stage, the Project Schedule Update, involves weekly contractor reviews and schedule updates that seek to incorporate all current information. The data considered includes progress, identifies approved adjustments of logic and duration, and proposes any changes required.

At the time of Project Baseline Schedule development, contractors produce schedule narratives for each project. These narratives overview each project as a whole. The narratives discuss details of contractor execution plans, the sequencing plans that the Shops provide for their work, contractor crew loadings, the sequencing plan, explanations of lags and constraints applied when scheduling activities, and contract milestones tied to the applicable dates from the Project Baseline Schedule.

Contractors prepare and maintain these three types of Construction Project Schedules. Their contracts define start and completion dates. Contractors must establish progress rates required to meet the finish dates defined in purchase orders. Contractors use these Construction Project Schedules to plan, organize, and execute work. These schedules also provide reference points for recording and reporting performance and physical progress. They show how the contractor plans to complete all remaining work as of each progress report.

Project Baseline Schedules provide the basis against which management monitors and measures project production and progress. These schedules use project scope dimensions, specified milestones, and completion dates from the applicable contract. These schedules use critical path method ("CPM") scheduling. The construction industry very commonly uses this, so-called CPM method and the Precedence Diagramming method.

Critical path method scheduling generally consists of constructing a project model that:

- Lists all work activities required for completion, generally using a work breakdown structure (a breakdown of a project into smaller elements to enhance the detail available for use in cost estimate and schedule development and control)
- Identifies the duration required to complete each of those activities
- Identifies the dependencies that exist between activities, and the activity start and completion dates (or interim milestones) required to accommodate those dependencies
- Identifies logical end-dates and deliverables associated with them.

The Precedence Diagramming Method (also commonly used) employs a box and line diagram that identifies activities (nodes) connected by arrowed lines showing dependencies.

These Project Schedules thus show the sequence and interdependence of activities required for complete performance of the work. They begin with the Contract Start Date, and conclude with the Contract Completion Date. The maximum duration of any physical work activity cannot exceed twenty working days, unless approved by the Project Management Office's Senior Planner.

iii. Scheduling Tools

The AMRP Project Management Office uses the industry-accepted Primavera Advanced P6 tool to maintain project schedules. Liberty engaged in a demonstration with the organization's Senior Planner. This demonstration covered the hierarchy from the master schedule at the top down through detailed level schedules. The demonstration addressed both engineering and construction scheduling.

Management has online access to baseline and updated schedules. The schedules for work in 2013 and 2014 began with construction schedules developed for use in the field. Engineering schedule development came later, and sought to produce the work required to support construction schedule requirements. Program management appears now to be approaching completion of efforts to integrate engineering and construction schedules. The goal was to begin producing integrated schedules for 2015 work. In addition, the AMRP has now reached a point where it can load the Peoples Gas construction work into master schedules as well. Earlier construction schedules included only contractor work.

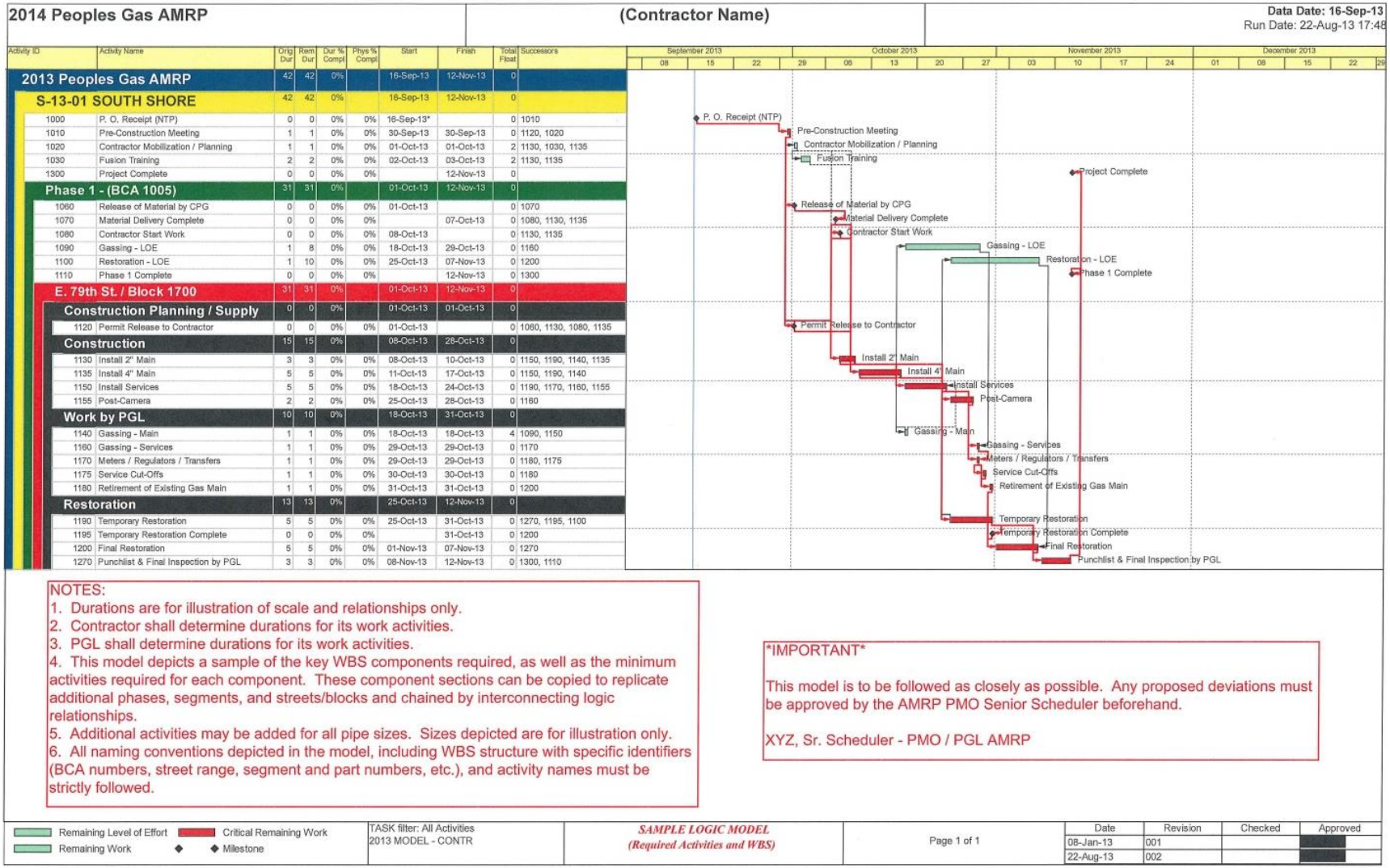
There has not been a plan, beyond engineering and construction, to develop schedules for other work groups, or to integrate their activities into engineering and construction schedules.

iv. Scheduling Logic

All AMRP contractors must use a "Logic Model" for project schedule creation. The next diagram illustrates the model's required work breakdown structure and correct logic sequence for work activities for a sample project (from 2013). Specialized projects (*e.g.*, high-pressure mains) have unique Logic Models. The Peoples Gas back end work is integrated with contractor construction work. The Logic Model identifies all required activities for each project, phase and street/block number, establishing the level of detail required for each.

The Logic Model depicts a "zero total float critical path." Float identifies the amount by which an activity can be delayed without threatening the project's end date. An activity with zero total float has no float. Thus, any delay in completing it will delay total project completion. The model ensures that contractor baseline schedules will contain a zero total float critical path. Contractors receive an electronic file of the Logic Model (compatible with AMRP management's automated system, Primavera P6), enabling contractors to use it as the basis for building a project schedule in Primavera P6.

Illustration H.3: Sample Logic Model



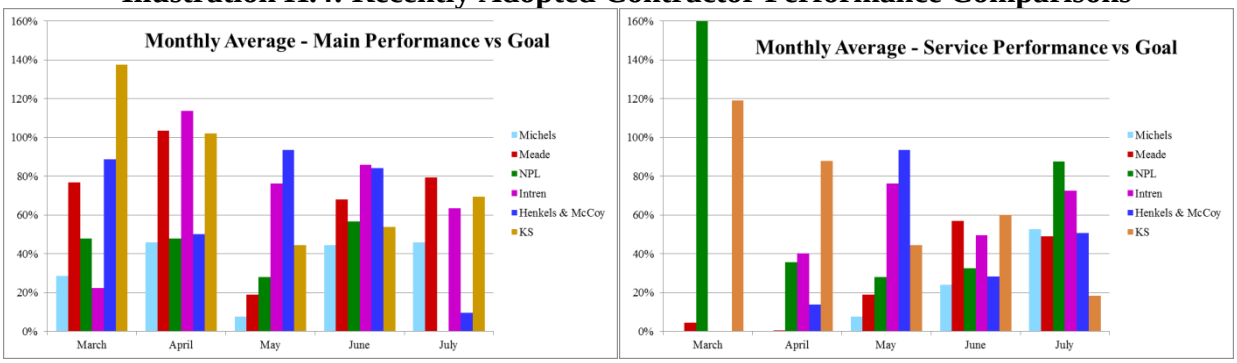
c. Production Targets in Schedules

To date, the AMPR tied no schedules to quantities of work performed. the industry commonly uses S-curves to depict quantities installed over time. These curves display cumulative quantities, costs, labor hours or other variables plotted against time. The term derives from the fact that curves typically are flatter early, become steeper in the middle, and then turn flatter again at the end of a project. This shape typifies most project courses, which follow a slow but increasing early pace, and experience a decelerating end phase as required work approaches completion.

Peoples Gas agrees with the need to begin to tie schedules with quantities, and has reported an initiative to develop and employ that approach. If completed expeditiously, this initiative should produce significant enhancement in progress and performance monitoring and management. The Company has recently required both their internal workforce and contractors to submit quantity-based schedules. Some contractors reportedly need to deal with logistics and phase-in difficulties in meeting this requirement. Two of the six major contractors have already demonstrated the capability to submit compatible schedules with quantity S-curves. Management expects that all 2015 installation schedules will be quantity-based.

Peoples Gas currently submits its work quantities to contractors. Through an interim, manual process, contractors then submit their and the Peoples Gas quantities to an AMRP analyst for inclusion in Weekly Progress Reports and Monthly Status Reports. Plans are underway to enable the contractors to report installed quantities electronically through the project schedule tools. In July 2014, AMRP planners began to analyze contractor performance against goals. Monthly comparisons addressing the production of each contractor now form part of the Monthly Status Reports. The next charts illustrate the performance comparisons that began in July 2014.

Illustration H.4: Recently Adopted Contractor Performance Comparisons



AMRP management also monitors production at the crew level, as the next tables summarize.

Table H.5: Contractor Crew-Level Production Monitoring
Weekly Main/Crew Average (ft)

Michels	168
Meade	384
NPL	21
Intren	254
Henkels & McCoy	182
KS	422

Weekly Services/Crew Average	
Michels	1.5
Meade	2.3
NPL	0.8
Intren	3.7
Henkels & McCoy	1.6
KS	5.6

d. Resource-Loaded Schedules

Resource-loaded schedules provide a timeline that details resources allocated to planned activities and preset milestones. Such schedules provide a visual representation of how available project resources align with specific, scheduled activities. These schedules depict the planned use of project resources throughout scheduled project time. This depiction permits continual evaluation of the sufficiency of resources and of their effectiveness in meeting established schedule milestones.

AMRP management did not resource load the construction schedule for the Peoples Gas internal workforce, citing bargaining unit objections. There was also a concern about maintaining the ability to divert resources from AMRP work to perform emergency work. An initiative now underway seeks to incorporate resource loading and crew make-up, in order to enable monitoring of production in the "Meters/Regulators/Transfers" activities of Shop construction schedules.

During the early part of each calendar year (after the bid-winning contractors submit their schedules), AMRP management seeks to allocate the internal resources needed to install and move meters in step with contractor main and service installations. Loading the internal resource at the city-block level requires assumptions about availability and productivity of internal work crews. Collaborative planning sessions with Shop supervisors, using NetPoint, seek to support this resource-leveling process. NetPoint is an industry-accepted tool that supports interactive and collaborative planning and scheduling in a manner that promotes real-time adjustments and visual depictions.

Contractors then receive the resulting activity durations for incorporation into their schedules. Competing demands for internal labor resources, variability in the resources required from block to block, delays in service markings, and delays in obtaining permits from the City, however, exemplify the difficulties that make production estimated by this model challenging to meet. Such issues also made maintenance of the model and the contractor schedules complicated.

AMRP management responded by limiting resource leveling and duration forecasting to the phase level (*i.e.*, abandoning the block-by-block approach) for 2014 AMRP projects. This revised approach bases productivity assumptions on the number of meters that the internal workforce in each Shop can generally produce on a given day. This approach does not consider the particular mix of meters involved or difficulty in obtaining access to work on specific blocks or at specific addresses. This output of this revised process provides contractors with: (a) an estimated overall duration for Peoples Gas Meters/Regulators/Transfers activities, and (b) a forecasted date for completion of retirement activities by project phase.

The Construction Planning Group also uses these models in information exchanges with the City, to provide anticipated dates (by quarter) of retirement and final restoration. Using planned retirement sequences, management applies NetPoint to levelize Peoples Gas resources, and project completion dates for the installation of meters in a given phase. Following levelization, management forecasts retirement and final restoration dates.

AMRP contracts generally use unit-price or lump-sum pricing mechanisms. Contractor schedules have not been resource-loaded. Tracking their crew counts occurs weekly, as the next illustration depicts.

Table H.6: Weekly Contractor Crew Count Reports

Shop	Central		North		South		Contractor Total	
	Installation	*Restoration*	*Installation*	*Restoration*	*Installation*	*Restoration*	*Installation*	*Restoration*
Meade	1		2	1	14	3	17	4
NPL	6	1	3	8	4	6	13	15
H&M		2	1		3	2	4	4
KS	3	5	5	1			8	6
Michels			20	14			20	14
Intren	6	5	2		2	1	10	6
Totals	**16**	**13**	**33**	**24**	**23**	**12**	**72**	**49**

e. Schedule Changes and Updates

When project changes make schedule delay expected, contractors complete a "Schedule Impact Notice." These notices identify causes affecting work activities, and include a fragmentary network (fragnet). A fragnet displays a sequence of new activities proposed to be added to the existing schedule (*e.g.* due to a change in scope). A Form of Authorization process can be initiated to secure additional funding to address the work changes involved.

Liberty sought to identify any schedule variance analyses performed by AMRP management on a periodic basis. Peoples Gas observed that the monthly status report explains all schedule variances by project. The following table (extracted from the year-end 2014 report) shows almost 80 percent of projects behind schedule (108 out of 137). Liberty has not found any analyses of these delays. Such analysis would enable identification of common or systemic issues that should be addressed by corrective action plans.

Table H.7: AMRP Reporting of Contractor Schedule Status

Contractor	Number of Shops	Number of Active Phases	Average Variance (days)	Number of Phases with Negative Variance (Behind Schedule)
Henkels	2	6	-19	2
Intren	3	17	-54	12
KS	3	18	-94	16
Meade	3	58	-121	50
Michels	2	12	-58	9

Nash	2	6	-76	6
NPL	3	18	-112	13
Total		137	-94	108

3. Conclusions

H.1 The AMRP Plan does not include schedules at an overall program level; detailed generic schedules existed at the construction level, but not the production support level. ***(Recommendation H.1)***

The AMRP plan should include, at a minimum, schedules at an overall program level, at a production support level, and at a detailed process level. Management has not prepared or used them.

The AMRP does not have the capability to assess in a credible way whether the program's 20-year duration remains achievable. Nor can management quantify the length of any anticipated delay. The program has used detailed generic schedules addressing construction activities only for the current and the following year. These generic schedules reflected physical work only. They did not address the work activities needed to support construction.

H.2 Individual project schedules initially reflected only contractor work, but now include physical work performed by the internal workforce, and Peoples Gas is integrating engineering schedules into them. ***(Recommendation H.2)***

Schedules should reflect the requirements of each work group required to support overall production targets. That has not been the case historically for the AMRP, which until recently, included schedules only for contractor work.

Project schedules normally begin with the engineering and design phase, and then integrate construction and completion work. The AMRP scheduling function begins in reverse, with the completion of contractor schedules for projects. AMRP scheduling then adds the back end work activities of the Peoples Gas crews. Then, management develops engineering schedules for the projects, based on the construction schedules. Efforts underway now seek to provide for the development of engineering schedules first. The construction schedule can then be developed by adding to the Project Baseline Schedule (provided by the awarded contractor) the associated work activities performed by internal Peoples Gas personnel. This new approach will ensure a natural flow of scheduled project activities from inception to completion.

H.3 AMRP schedules have not been quantity driven, although efforts underway seek to make them so. ***(Recommendation H.5)***

Schedules should contain sufficient detail to define the expected contribution to total estimated quantities to be installed, using clear production targets for each replacement project or group of such projects. The AMRP, however, has only recently begun to develop quantity-driven schedules that will begin to meet this need.

All in-house and contractor crews should remain aware of the production expectations underlying their work activities. Quantity-driven scheduling, now under development, will bring this

awareness a step closer to achievement. The effort remains underway. Four contractors must solve logistical issues in moving to such scheduling. AMRP management expects resolution of the problems in time to support schedule development and monitoring during 2015. Completing the transition to quantity-driven scheduling will also give Peoples Gas a single source of reporting for quantities installed. Management has not had this tool so far.

H.4 Detailed work schedules of individual projects are consistent with higher-level annual plan schedules.

Peoples Gas needs to develop and maintain its detailed work schedules in a way that provides consistency from the highest levels down to the schedules that guide construction work crews. The AMRP scheduling meets this need. The short-term generic schedules Liberty reviewed show consistency with higher-level schedules. The use of a well-respected tool in the industry (Primavera P6) supports such consistency. Liberty also found capable professionals in the AMRP scheduling function.

H.5 Peoples Gas resource-loads detailed schedules for the internal workforce, but not contractors, and not for other work groups whose efforts support AMRP field work. *(Recommendation H.3)*

Detailed work schedules should be resource-loaded. The Company's effort to do so for the work that its employee crews perform has a sound basis. Peoples Gas, however, has not implemented it with full effectiveness. The Company faces significant competition between the AMRP and other needs met with internal resources. Liberty did not find sufficient efforts to assess the adequacy of internal resources to meet all requirements, including, but not limited to AMRP work. The Company's history shows that the emergence of other urgent needs has diverted resources assigned to AMRP. Scheduling alone cannot solve that problem. However, proper and complete resource loading of AMRP work will permit a more informed understanding of the impacts of other work. Resource loading will also lay a foundation for considering the degree to which Peoples Gas should dedicate minimum levels of its resources to AMRP work.

Liberty also found construction inspection resource loading an area of concern. The Company has an appropriate target of one inspector per contract crew, but has yet to achieve it. More attention to the resource-loads of this inspection group will promote needed enhancement in efforts to oversee the quality and production of main and service installation work.

H.6 The AMRP has not used focused analyses of the AMRP schedule delays experienced to date, and has not demonstrated a pattern of aggressive action to address such delays. *(Recommendation H.4)*

Project activities experience delay for many reasons, some controllable and some uncontrollable. Construction management, which manages work daily in the field, discusses sources of delay in weekly progress meetings. Some of the problems encountered (*e.g.*, permit issues and securing property owner access permission), while repetitive, do not lend themselves to correction by crews. Liberty found no consistent effort to analyze the root causes of recurring problems and to recommend solutions to mitigate them.

4. Recommendations

H.1 Peoples Gas should develop a Scheduling Master Plan. *(Conclusion H.1)*

The Company recognizes this need, and has begun a significant effort to develop a Master Plan. It needs to incorporate a master schedule plan that conforms to a well-defined AMRP scope and a newly formed, credible cost plan. To maintain this master schedule plan on a real-time basis, Peoples Gas also needs to develop the capability to assess how cost issues may affect schedule, and (vice versa) how schedule issues will affect costs at the AMRP program level.

H.2 Peoples Gas should develop a complete project schedule for every new project, and it should address all aspects of the work required, from engineering to construction and through completion. *(Conclusion H.2)*

After four years, AMRP scheduling development has not matured at the pace required. Scheduling should address all major steps required to prepare a project for service. At a minimum, generic schedules should delineate, interrelate, and define the schedule requirements for: project selection, design, preliminary cost estimate preparation, contract bid and award, final cost estimate preparation, project authorization, City permit approval, permitting, material requisition, document control, work planning, field planning, construction scheduling, material delivery, gas main installation, services installation, gassing mains, meter and regulator installation, service cut-offs, restoration, inspection, and project close outs. Identifying and depicting all essential activities permits support groups to plan logically to ensure the availability of resources adequate to support projects on a timely basis.

H.3 Peoples Gas should resource-load schedules to address all physical work resources (including internal workforce and contractors) and construction inspectors. *(Conclusion H.5)*

The Company needs to complete promptly the effort currently underway to resource-load the schedules for the internal workforce. Peoples Gas should load the lump-sum and unit-cost contractor resources into the schedule as well. This enhancement will give construction management the visibility to gauge the sufficiency of contractor resources. At present, AMRP management must wait until production falls behind schedule to identify resource shortages. The change will also give Peoples Gas the ability to assess, for long-term resource planning purposes, the comparative productivity levels of contractors. This information will support the development of performance targets, and assist Peoples Gas in assessing the benefits of and planning for the use of internal workforces to perform some main and services installation work.

H.4 Peoples Gas should regularly perform schedule variance analyses to identify recurring or systemic issues, and plan corrective actions. *(Conclusion H.6)*

In 2014 alone, 108 out of 137 phases of projects experienced delay. This experience dramatizes the need for a timely and effective source of analysis of the causes that drive schedule delay. Peoples Gas needs to develop, and then regularly apply the capability to determine what impact uncontrollable events (*e.g.*, inclement weather) have had, and are likely to continue to have on schedule progress. It must then seek regularly to isolate the impacts of remaining influences. That isolation will enable management to determine which are subject to full or partial control, what

changes it will take to mitigate their impacts, and the costs of and benefits to be gained from taking mitigating actions.

The Company needs to understand all of the root causes that underlie schedule delays. It also needs to meet the challenge of gaining that understanding with the recognition that what appears uncontrollable at first can often be affected after full explorations of causation. Regular, ongoing analysis of schedule delay provides the basis for gaining that understanding and for planning and executing effective corrective actions. The permit problem with the City of Chicago offers an example. Schedule delays have caused deterioration of relationships with the City. Lack of permits, expired permits, and failure to perform restoration when and as required by the City caused a large number of permit violations.

H.5 Peoples Gas should complete promptly its efforts to ensure that construction schedules become quantity-based for the internal workforce and for contractors. *(Conclusion H.3)*

This recommendation may prove largely to be a function of resolving the logistics problems that four contractors now have in providing quantity-based schedules. At any rate, Peoples Gas needs to ensure that the effort to develop such schedules comes to fruition as soon as possible.

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Chapter I: Resource Planning

1. Background

This chapter:

- Examines the overall strategy for planning AMRP craft resources
- Assesses the planning processes used to ensure sufficient craft resources
- Evaluates craft availability and training
- Reviews planning and staffing for the engineering and inspection resources required to support AMRP work.

Resource plans require close integration and consistency with cost and schedule plans. The assumptions driving resource plans require sound derivation, structured documentation, and continuing examination and revision as work progresses, and as experience with resource-related drivers grows. Plans for producing the particularly high AMRP production quantities contemplated also require careful consideration of resource availability. That consideration ensures that plans for acquiring resources recognize quantity and quality in relation to what the marketplace can be expected to offer. Liberty evaluated the AMRP's staffing strategies and the support underlying them. This review included the sources of work crews, productivity assumptions for the required categories of craft workers, overtime assumptions, and unit costs. Liberty's inquiries extended beyond direct construction resources to include support group resource adequacy.

2. Findings

a. Overall AMRP Craft Staffing Strategy

After approval of the Infrastructure Cost Recovery ("ICR") rider, AMRP management developed an overall annual installation target to increase replacement of high-risk gas mains from about 50 to between 100 to 150 miles per year. Averaging about 100 miles per year would put the AMRP on a 20-year completion course. At that time, crews consisting of Peoples Gas employees were performing most work needed to maintain the network (*e.g.*, addressing instances of leaks and corrosion). Contractors were performing most capital work. A basic principle behind this approach was consistency over time in internal resource numbers, while using contractors to perform work above the base, sustained level, and thus subject to variation. This strategy applies widely in the gas and electric industries. It can provide overall economy, and avoid disruptions that come with frequent increases and decreases in employment in affected positions.

What differs principally among utilities are the uses and amounts of contractor resources. At AMRP inception, management determined that contractors could perform main installation work more productively and with better quality. Making this approach work required the Company to work with its bargaining units to secure flexibility needed to make major portions of the significantly expanded work of the AMRP open to contracting. Management viewed that flexibility as providing a method for avoiding the need to procure major equipment and develop internally a suitably trained and experienced workforce to handle the much increased work load.

Peoples Gas secured two important changes; *i.e.*, a substantial compression of the bargaining unit progression system, and increased cross-assignment of personnel. Peoples Gas succeeded through