

Pipe Ramming Projects

*ASCE Manuals and Reports
on Engineering Practice
No. 115*



Documents

Document Sharing Hub

Provided by IHS

Licensee=University of Texas Revised Sub Account/5620

No reproduction or networking permitted without license from IHS , 10/04/2014 01:12:24 MDT

Full document details: ASCE MOP 115 2008

Pipe Ramming Projects

Prepared by
the Pipe Ramming Task Force of
the Trenchless Installation of Pipelines (TIPS)
Committee of the American Society of Civil Engineers

Edited by
Mohammad Najafi, Ph.D., P.E.

ASCE *American Society
of Civil Engineers*

AVA **Documents**
Document Sharing Hub

Library of Congress Cataloging-in-Publication Data

Pipe ramming projects : ASCE manuals and reports on engineering practice no. 115 / prepared by the Pipe Ramming Task Force of the Trenchless Installation of Pipelines (TIPS) Committee of the American Society of Civil Engineers ; edited by Mohammad Najafi.

p. cm.

Includes bibliographical references and index.

ISBN 978-0-7844-0979-4

1. Pipelines—Design and construction. 2. Trenchless construction.

I. Najafi, Mohammad. II. American Society of Civil Engineers.

TA660.P55P54 2008

621.8'672—dc22

2008021011

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191

www.pubs.asce.org

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document.

ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefor. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

Photocopies and reprints. You can obtain instant permission to photocopy ASCE publications by using ASCE's online permission service (<http://pubs.asce.org/permissions/requests/>). Requests for 100 copies or more should be submitted to the Reprints Department, Publications Division, ASCE (address above); e-mail: permissions@asce.org. A reprint order form can be found at <http://pubs.asce.org/support/reprints/>.

Copyright © 2008 by the American Society of Civil Engineers.

All Rights Reserved.

ISBN 13: 978-0-7844-0979-4

ISBN 10: 0-7844-0979-X

Manufactured in the United States of America.

16 15 14 13 12 11 10 09 08 1 2 3 4 5

MANUALS AND REPORTS ON ENGINEERING PRACTICE

(As developed by the ASCE Technical Procedures Committee, July 1930, and revised March 1935, February 1962, and April 1982)

A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his or her everyday work, rather than findings that may be useful only occasionally or rarely. It is not in any sense a “standard,” however; nor is it so elementary or so conclusive as to provide a “rule of thumb” for nonengineers.

Furthermore, material in this series, in distinction from a paper (which expresses only one person’s observations or opinions), is the work of a committee or group selected to assemble and express information on a specific topic. As often as practicable, the committee is under the direction of one or more of the Technical Divisions and Councils, and the product evolved has been subjected to review by the Executive Committee of the Division or Council. As a step in the process of this review, proposed manuscripts are often brought before the members of the Technical Divisions and Councils for comment, which may serve as the basis for improvement. When published, each work shows the names of the committees by which it was compiled and indicates clearly the several processes through which it has passed in review, in order that its merit may be definitely understood.

In February 1962 (and revised in April 1982) the Board of Direction voted to establish a series entitled “Manuals and Reports on Engineering Practice,” to include the Manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such Manual or Report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past Manuals. Numbering would be consecutive and would be a continuation of present Manual numbers. In some cases of reports of joint committees, bypassing of Journal publications may be authorized.

MANUALS AND REPORTS ON ENGINEERING PRACTICE

No.	Title	No.	Title
13	Filtering Materials for Sewage Treatment Plants	80	Ship Channel Design
14	Accommodation of Utility Plant Within the Rights-of-Way of Urban Streets and Highways	81	Guidelines for Cloud Seeding to Augment Precipitation
35	A List of Translations of Foreign Literature on Hydraulics	82	Odor Control in Wastewater Treatment Plants
40	Ground Water Management	83	Environmental Site Investigation
41	Plastic Design in Steel: A Guide and Commentary	84	Mechanical Connections in Wood Structures
45	Consulting Engineering: A Guide for the Engagement of Engineering Services	85	Quality of Ground Water
46	Pipeline Route Selection for Rural and Cross-Country Pipelines	86	Operation and Maintenance of Ground Water Facilities
47	Selected Abstracts on Structural Applications of Plastics	87	Urban Runoff Quality Manual
49	Urban Planning Guide	88	Management of Water Treatment Plant Residuals
50	Planning and Design Guidelines for Small Craft Harbors	89	Pipeline Crossings
51	Survey of Current Structural Research	90	Guide to Structural Optimization
52	Guide for the Design of Steel Transmission Towers	91	Design of Guyed Electrical Transmission Structures
53	Criteria for Maintenance of Multilane Highways	92	Manhole Inspection and Rehabilitation
54	Sedimentation Engineering	93	Crane Safety on Construction Sites
55	Guide to Employment Conditions for Civil Engineers	94	Inland Navigation: Locks, Dams, and Channels
57	Management, Operation and Maintenance of Irrigation and Drainage Systems	95	Urban Subsurface Drainage
59	Computer Pricing Practices	96	Guide to Improved Earthquake Performance of Electric Power Systems
60	Gravity Sanitary Sewer Design and Construction, Second Edition	97	Hydraulic Modeling: Concepts and Practice
62	Existing Sewer Evaluation and Rehabilitation	98	Conveyance of Residuals from Water and Wastewater Treatment
63	Structural Plastics Design Manual	99	Environmental Site Characterization and Remediation Design Guidance
64	Manual on Engineering Surveying	100	Groundwater Contamination by Organic Pollutants: Analysis and Remediation
65	Construction Cost Control	101	Underwater Investigations
66	Structural Plastics Selection Manual	102	Design Guide for FRP Composite Connections
67	Wind Tunnel Studies of Buildings and Structures	103	Guide to Hiring and Retaining Great Civil Engineers
68	Aeration: A Wastewater Treatment Process	104	Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures
69	Sulfide in Wastewater Collection and Treatment Systems	105	Animal Waste Containment in Lagoons
70	Evapotranspiration and Irrigation Water Requirements	106	Horizontal Auger Boring Projects
71	Agricultural Salinity Assessment and Management	107	Ship Channel Design and Operation
72	Design of Steel Transmission Pole Structures	108	Pipeline Design for Installation by Horizontal Directional Drilling
73	Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors	109	Biological Nutrient Removal (BNR) Operation in Wastewater Treatment Plants
74	Guidelines for Electrical Transmission Line Structural Loading	110	Sedimentation Engineering: Processes, Measurements, Modeling, and Practice
76	Design of Municipal Wastewater Treatment Plants	111	Reliability-Based Design of Utility Pole Structures
77	Design and Construction of Urban Stormwater Management Systems	112	Pipe Bursting Projects
78	Structural Fire Protection	113	Substation Structure Design Guide
79	Steel Penstocks	114	Performance-Based Design of Structural Steel for Fire Conditions
		115	Pipe Ramming Projects

CONTENTS

PREFACE	vii
ACKNOWLEDGMENTS	ix
1 GENERAL INFORMATION	1
1.1 Introduction and Background	1
1.2 Method Description	2
1.3 Recent Innovations (Combining Pipe Ramming and Horizontal Directional Drilling)	3
1.4 Organization of This Manual	7
1.5 Related Documents	7
2 THE PLANNING PHASE	9
2.1 Planning Activities	10
2.2 Predesign Surveys	12
2.3 Environmental Impact and Benefits	16
2.4 Social Impact and Benefits	16
2.5 Permits	16
2.6 Jobsite Logistics Requirements	17
2.7 Length and Accuracy of Installation	18
2.8 Geotechnical Considerations	18
2.9 Working (Drive and Receiving) Pits	20
2.10 Cost Considerations	21
3 THE DESIGN AND PRECONSTRUCTION PHASE	23
3.1 Feasibility and Risk Assessment	23
3.2 Steel Casing Design	23

3.3	Carrier Pipe Design and Installation	26
3.4	Contract Documents	28
3.5	Contractor Prequalification and Submittals	32
4	CASING MATERIALS	35
4.1	Physical Properties	35
4.2	Auxiliary Properties or Features	37
5	CONSTRUCTION PHASE	41
5.1	Workspace	41
5.2	Work Plan	43
5.3	Equipment	44
5.4	Lubrication Systems	44
5.5	Productivity	46
5.6	Dewatering	46
5.7	Installation of Casing	46
5.8	Inspection and Monitoring	47
5.9	As-Built Drawings and Documentation	47
5.10	Measurement and Payment	48
5.11	Typical Costs for Pipe Ramming	48
5.12	Safety Issues	48
6	CASE STUDIES	49
6.1	Case Study No. 1: Pipe Ramming Helps Relieve Fire and Flood Problems in Los Alamos	49
6.2	Case Study No. 2: A Record Ram	54
6.3	Case Study No. 3: Gas Main Installation Proves the Power of Pipe Ramming	59
	GLOSSARY	63
	REFERENCES	69
	INDEX	71

PREFACE

This manual of practice was prepared by the Pipe Ramming Task Force of the ASCE Committee on Trenchless Installation of Pipelines (TIPS), under supervision of the Pipeline Division. The manual describes current pipe ramming practices used by engineers and construction professionals in designing and constructing pipelines under roads, railroads, streets, and other constructed and natural structures and obstacles. The TIPS Committee, under the leadership of Ahmad Habibian, P.E. (Past Chair) and Timothy Stinson, P.E. (Current Chair), is responsible for the efforts leading to this publication. The committee would like to thank contributors, task force members, and blue ribbon reviewers, whose names follow, for their support, time, and effort. The efforts of Baosong Ma, Professor, College of Engineering, China University of Geosciences, Wuhan, who was a visiting scholar at the Center for Underground Infrastructure Research and Education at The University of Texas at Arlington during the time this manual was being developed, is greatly appreciated.

Mohammad Najafi
ASCE Pipe Ramming Task Force Chair

This page intentionally left blank



ACKNOWLEDGMENTS

Contributors

Chapter 1—General Information

Kevin P. Nagle, TT Technologies

Collins Orton, TT Technologies

Chapter 2—The Planning Phase

Terry McArthur, HDR Engineering, Inc.

Chapter 3—The Design and Preconstruction Phase

George Davis, Missouri Department of Transportation

Chapter 4—Casing Materials

Jeff Bikshorn, Edgen-Murray Corporation

Dave Mittler, Permalok Corporation

Terry Moy, Woolpert Inc.

Mike Sechelski, Northwest Pipe Company

Chapter 5—Construction Phase

Fred Burlbaw, Hammer Head Mole

Hanson Turnbull, Hammer Head Mole

Chapter 6—Case Studies

Robert Carpenter, *Underground Construction Magazine*

Baosong Ma, China University of Geosciences

Collins Orton, TT Technologies

Task Force Officers

Mohammad Najafi, Chair

Larry Slavin, Vice Chair

Craig Camp, Secretary

Blue Ribbon Reviewers

Dennis Doherty, Jacobs

Ahmad Habibian, Black & Veatch Corporation

John Hair, J.D. Hair & Associates, Inc.

Mike Schwager, TT Technologies

ASCE Representatives

Matt Boyle, Manager, Book Production

Verna Jameson, Senior Coordinator, Technical Activities

John Segna, Director, Technical Activities

Pipeline Division Executive Committee

Ahmad Habibian, Ph.D., P.E., *Past Chair*

Michael T. Stift, P.E., *Chair*

Mohammad Najafi, Ph.D., P.E., *Vice-Chair*

Tom Iseley, Ph.D., P.E., *Senior Member*

Joe Castronovo, P.E., *Senior Advisor*

John Hair, P.E., *Secretary*

Terry McArthur, P.E., *New Member*

Tim Stinson, P.E., *Incoming Member*

Randy Robertson, P.E., *TAC Representative*

**Documents**

Document Sharing Hub

CHAPTER 1

GENERAL INFORMATION

1.1 INTRODUCTION AND BACKGROUND

This manual addresses pneumatic pipe ramming, which is widely used for installation of steel pipes and casings. The manual does not address other types of trenchless technology methods, which are also used for the installation of casings and pipelines, such as horizontal auger boring or horizontal directional drilling (see Section 1.5 for related documents).

Pipe ramming is a technique for inserting a steel pipe from a launch (drive) pit by means of ramming or pushing the pipe through soil using a pneumatic percussion hammer or rammer or a hydraulic jacking system. The pneumatic percussion hammer method uses the dynamic force and energy transmitted by the percussion hammer, which is attached to the end of the steel pipe, to drive the pipe through the soil. The hydraulic pipe jacking method uses the cyclical thrust of the hydraulic jacks to force the pipe through the soil. Steel pipe is used in essentially all applications because of its ability to withstand the ramming forces and typical loading conditions encountered. Steel pipe has been installed in lengths exceeding 400 feet (122 m) for diameters up to 60 in. (1,524 mm) and, for relatively short distances (e.g., 100 ft or 30 m), in diameters exceeding 120 in. (3,048 mm).

Pipe ramming is most appropriate for installation of large-diameter pipes over a short distance and for shallow-depth installations. It is suitable for all ground conditions except those for which the entire pipe perimeter is engaged with solid rock and is often successful where some other trenchless methods can lead to unacceptable surface settlement. Pneumatic pipe ramming is most commonly used in applications with a

horizontal orientation, but it can also be used for vertical applications, such as driving piles or micropiles. The primary applications of this method are the placement of casings beneath roadways or railroads at crossings, or at crossings beneath streams. The casings may contain water or wastewater pipelines or serve as a utility gallery for electric, telecommunications, or fiber optic cables. The installed casing can also be used directly as a storm culvert or product pipeline in which interior coatings are applied after spoil is removed. Pipe ramming has also been used to install a larger pipe in place of an existing pipeline. Pipe ramming is an economical alternative to open trenching because it can reduce pavement damage, traffic disruptions, and the social costs associated with pipeline installations.

This manual of practice has been prepared to assist engineers, contractors, and owners who are using the pipe ramming method to design and execute pipe installation projects effectively, safely, and in conformance with project requirements and site conditions. The objective of this manual is to give a clear understanding of the method's capabilities and limitations; to outline important design and construction considerations; and to identify potential problems and prevention measures, thereby instilling confidence in the use of the method. The guidelines provided are based on case studies, workshops, project reviews, technical papers, and other information contributed by industry experts.

1.2 METHOD DESCRIPTION

The two major categories of pneumatic (or percussive) pipe ramming are closed-face and open-face.

The technique for closed-face pipe ramming (also called piercing, impact moling, or compaction method) includes welding a cone-shaped head to the lead end of the first segment of pipe (casing). The head penetrates and compresses the surrounding soil, and the casing is rammed forward. The soil-pipe installation interaction with this technique is similar to what occurs during soil-compaction methods. The soil is displaced and compressed around the outer surface of the steel pipe. This technique can be used for pipe up to 8 in. (200 mm) in diameter. This method is mainly used for installation of cables and small-diameter conduits under roads and streets. This method is widely used on nonengineered jobs.

Open-face pipe ramming allows the front end of the lead steel casing or conduit to remain open. With this technique, most of the soil particles remain in place, with only slight soil compaction occurring around the pipe during the ramming process. One advantage of open-face pipe ramming is the ability to swallow large rocks and boulders during the

ramming process. Rocks and boulders as large as the inner diameter of the steel pipe can be swallowed by the casing. This technique is used for pipes larger than 8 in. (200 mm) in diameter.

To facilitate the open-face pipe ramming process, the lead edge of the first casing is usually reinforced by welding a steel band 12 to 14 in. (305 to 356 mm) wide around the exterior face of the pipe. The banding provides two advantages: (1) it reinforces the lead edge, and (2) it decreases the frictional drag around the casing. A steel band can also be welded around the inside edge of the lead section of pipe. This band adds further reinforcement, protects the casing end from damage if cobbles or boulders are encountered, guides the boulders into the casing for removal, and creates clearance for the soil within the casing. This clearance helps during the cleanout process and reduces the frictional drag within the casing. For small-diameter casings, after the casing installation is complete, the soil that has entered the casing can be removed by applying compressed air or water from either end. For larger diameters, augers can be used to mechanically remove the soil from inside the casing.

For either the closed-face or open-face process, bentonite or polymer lubricants may be needed for large-diameter pipes with longer ram lengths, or in some soil conditions, such as stiff clays or sands. A small steel supply pipe installed on top of the steel casing delivers the lubricant. The start of the supply pipe should be installed at a point approximately 24 in. (600 mm) behind the leading edge. The supply line is used to supply water, bentonite, or polymer lubricants outside or inside the casing (or both); to aid in spoil removal; to reduce exterior or interior skin friction; and to maintain the integrity of the hole being created.

1.3 RECENT INNOVATIONS (COMBINING PIPE RAMMING AND HORIZONTAL DIRECTIONAL DRILLING)

Some of the most interesting and impressive trenchless projects have been accomplished through the use of directional drilling. However, drill operators and manufacturers are finding new and creative ways of addressing particularly difficult projects and situations by using pipe ramming technology to assist directional drills. The techniques are changing the way drillers approach projects and respond to problems on the job.

Several techniques have been successfully used to help prevent failures in directional drilling projects or salvage bores by using pipe ramming technology. Thus, properly configured pneumatic pipe rammers can be used to salvage product pipes, remove stuck drill stems, and assist drills during product pullback, overcoming hydrolock, or other problems that may hamper the pipe installation. Drilling contractors throughout North

America have successfully used all of the directional drilling assist techniques described below.

1.3.1 Bore (Product Pipe) Salvage

A pneumatic pipe rammer may often be effectively used to salvage a stuck product pipe. For this procedure, a pneumatic pipe rammer is attached to the exposed end of the partially installed product pipe in an orientation that tends to pull the pipe from the ground. This can be accomplished through a fabricated sleeve (Fig. 1-1). A winch or other type of pulling device is used to assist the rammer during the pipe removal operation. The percussive power of the pipe rammer is often sufficient to free the stuck pipe and to then allow it to be readily removed from the ground.

1.3.2 Drill Stem Recovery

There are two possible configurations for applying a pneumatic pipe rammer to assist in drill stem recovery. Depending on the situation, contractors can directly pull the drill stem from the ground using the power of a ramming tool or, if the stem is still attached to the drill rig, they can use the ramming tool power to push on the opposite end of the stem to assist with the drill rig pullback action (Fig. 1-2).

1.3.3 Pullback Assist

The pullback assist technique helps install the product pipe in problematic situations. For example, when drilling underwater or in loose



FIGURE 1-1. Bore salvage.

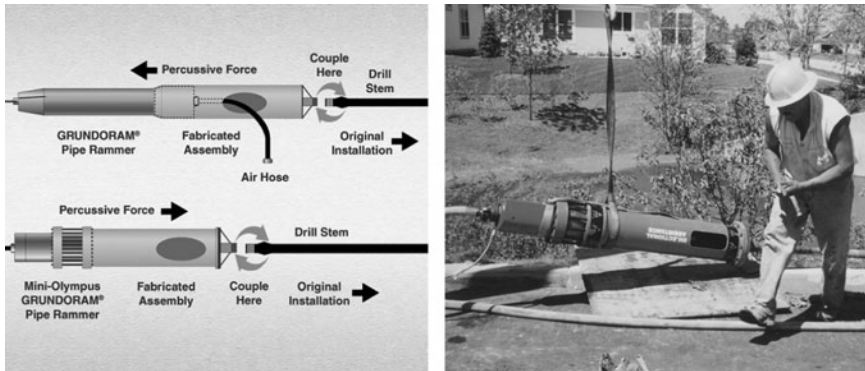


FIGURE 1-2. Drill stem recovery.

flowing soil conditions, or when there is loss of drilling fluid circulation, a condition known as hydrolock can occur. Hydrolock results when the pressure at the leading end of the product pipe restricts its forward movement. Alternatively, soil pressure along the side of the pipe due to partial collapse of the borehole may cause additional frictional drag, thus inhibiting the pipe movement. In such cases, the required pull forces may exceed the drill rig's pullback capability or the product pipe's tensile strength. The percussive pushing action of a pipe rammer applied at the tail end of the product pipe may be used to help free the immobilized pipe.

The pullback assist technique has been successfully used on steel pipe as well as high-density polyethylene. The technique can be used initially as a precaution in anticipation of possible problems, such as those described above, or after the pipe has become immobilized (Fig. 1-3). Response time, however, is a key factor. The rate of success greatly improves as the response time decreases. Therefore, many drilling contractors bring ramming equipment to directional drilling sites to be able to respond quickly to problems that may develop.

1.3.4 Conductor Barrel

The success of a drilling operation can often be determined before initiating the drilling operation. If the soil conditions at the planned entry point are problematic, the success of the entire project may be jeopardized. In such cases, the conductor barrel process may be appropriately used.

The conductor barrel technique differs slightly from the preceding methods because it is incorporated into the initial boring plan, rather than being deployed only in the event of a problem that may arise at some

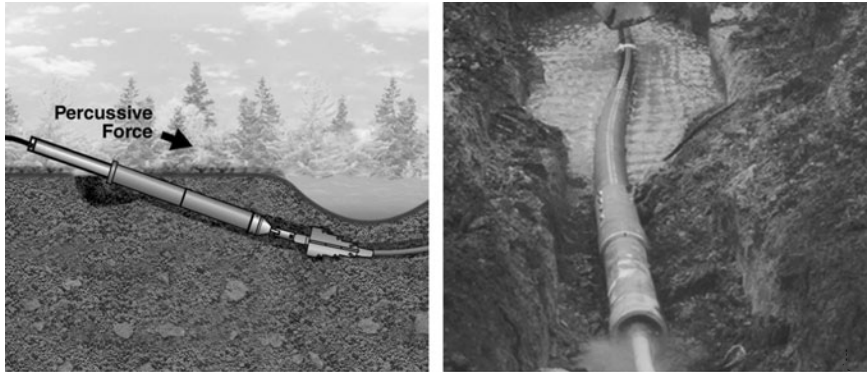


FIGURE 1-3. The pullback assist technique.

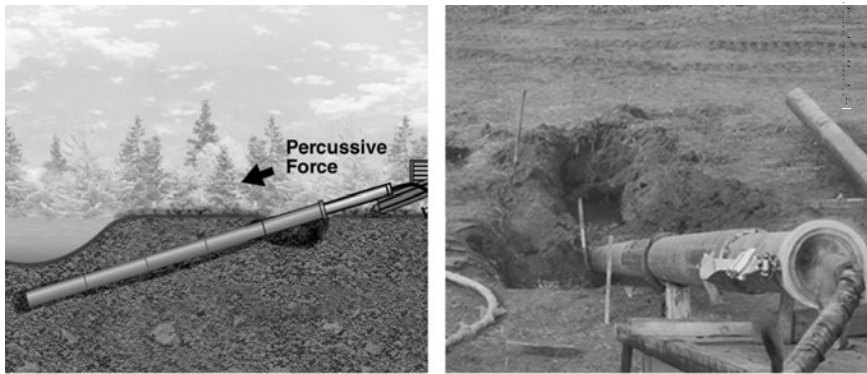


FIGURE 1-4. The conductor barrel process.

stage. In this method, a clear pathway is created through poor soil conditions, allowing the actual drilling operation to begin in more preferable soil conditions. Areas with loose, unsupported soils are prime candidates for the conductor barrel method.

During the conductor barrel process, open-face casings are rammed into the ground at a predetermined angle until desirable soil conditions are met. The spoil is removed from the casing with an auger or core barrel. Drilling then proceeds within the casing, beginning at a point where more desirable soil conditions are encountered. In addition to assisting drilling operations at the start of the installation, the conductor barrel can prevent situations in unstable soils in which drilling fluids under pressure force their way into waterways or wetlands, acting in a similar fashion to containment cells. The conductor barrel may also serve as a low friction section, facilitating pullback (Fig. 1-4).

1.4 ORGANIZATION OF THIS MANUAL

This manual of practice presents detailed information on pneumatic pipe ramming and hydraulic pipe jacking technology, supplemented by analysis of limitations and applications of these facts. Chapter 2 discusses the planning phase. Chapter 3 addresses the design and preconstruction phase, Chapter 4 provides information on the pipe materials, Chapter 5 discusses the construction phase, and Chapter 6 presents several case studies. At the end are a glossary and a list of references.

1.5 RELATED DOCUMENTS

- American Society of Civil Engineers. (1996). *Pipeline Crossings*, ASCE Manuals and Reports on Engineering Practice No. 89. ASCE, New York.
- American Society of Civil Engineers. (2002). *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data*, CI/ASCE 38-02. ASCE, Reston, Va.
- American Society of Civil Engineers. (2004). *Horizontal Auger Boring Projects*, ASCE Manuals and Reports on Engineering Practice No. 106. ASCE, Reston, Va.
- American Society of Civil Engineers. (2004). *Pipeline Design for Installation by Horizontal Directional Drilling*, ASCE Manuals and Reports on Engineering Practice No. 108. ASCE, Reston, Va.
- American Society of Civil Engineers. (2007). *Geotechnical Baseline Reports for Construction—Suggested Guidelines*, ASCE, Reston, Va.
- American Society of Civil Engineers. (2007). *Pipe Bursting Projects*, ASCE Manuals and Reports on Engineering Practice No. 112. ASCE, Reston, Va.
- Najafi, M. (2005). *Trenchless Technology: Pipeline and Utility Design, Construction and Renewal*. McGraw-Hill, New York.
- Guidelines for Pipe Ramming*. (2007). TTC Technical Report No. 2001.04, available at: http://www.latech.edu/tech/engr/ttc/publications/guidelines_pb_im_pr/ramming.pdf.

This page intentionally left blank

CHAPTER 2

THE PLANNING PHASE

The planning of a project has a major effect on the overall success because of the leveraging effect that decisions made at this phase have on all subsequent project activities. Planning is performed by all parties in different stages of the construction process, but initial planning is typically done by the project owner using the services of an engineer.

The nature of the project may have a great effect on the planning process itself. The planning phase for a planned and budgeted capital improvement can proceed in a more regulated and orderly fashion than that for an emergency pipe replacement caused by a collapse in a major roadway, i.e., an unexpected, unscheduled, unbudgeted, unwanted, and extremely urgent project. For an accelerated schedule appropriate for an emergency, the speed of completion often outweighs all other priorities. This may lead to the selection of a project delivery system and contracting method that focuses on speed, such as design-build, cost plus, etc., rather than preparation of bidding documents, including bid advertisement, opening, review, and award. These issues should be identified and considered in the first activity (background assessment) of the planning phase.

It is important in the planning process for the project owner to clearly identify, define, and communicate the project priorities to all those working on the project. The project owner should also perform a self-evaluation of his or her project management team to help ensure that these priorities are being followed and that conflicting priorities are not inadvertently introduced that may affect project performance.

Some suggested planning activities are listed in this section along with more detailed considerations for the various elements. The planning activities are listed in typical chronological order, which in general proceeds from the more general to the more specific concerns, with each

activity relying, to some degree, on the previous activity's results. However, as discussed above, the project background and priorities may require modification, consolidation, rearrangement, or other changes to these suggested activities.

2.1 PLANNING ACTIVITIES

Proper planning helps to ensure that the project will meet the needs and priorities of the owner. The major activities that typically are performed during the planning phase include the following:

- background assessment,
- identification and screening of alternatives,
- data collection, and
- evaluation and selection of design alternatives.

A detailed discussion of each activity is presented below.

2.1.1 Background Assessment

The background assessment evaluates various factors, usually of a nontechnical nature, that establish the conditions and limitations of the project, including the project priorities. Some factors that may be considered include the following:

- Is the project a planned improvement or an emergency condition?
- What is the project budget limit?
- What is the project schedule?
- Are there any political considerations?
- What are the effects and ramifications to public safety and health?
- What are the constraints on construction (by any method)?
- What are the regulatory considerations and effects?

2.1.2 Identification and Screening of Alternatives

A general screening of potential alternatives based on the technical conditions and project needs serves to further eliminate candidate solutions and identify the type of preliminary design data that must be collected for the project to proceed. Some items that may be considered include the following:

- Installation of a new pipe, rehabilitation of the existing pipe, or repair of the existing pipe.

- What are the existing and future land uses for the areas served by this pipe?
- What are the current and future service requirements for this pipe?
- What is the ability of this pipe to meet the identified service requirements?
- Is the existing location of this pipe favorable to its continued use in the future?
- Construction method: conventional trenching vs. trenchless, or a combination of these methods.
 - What are the surface conditions?
 - What are the subsurface conditions?
 - Which alternative is more attractive overall: installation of a new pipe, rehabilitation of the existing pipe, or repair of the existing pipe?
 - What is the potential for settlement and other geotechnical issues?
 - Are there special safety considerations in the project area?
- Methods and materials based on present and future conditions.
 - What flow capacity is required?
 - What is the optimal diameter of the pipe for the identified service conditions?
 - What effects will the subsurface conditions have on the methods and materials being considered?
 - What are the pipe service conditions?
 - What are the line and slope tolerances?
- Any additional special considerations or data that may be required to successfully complete this particular project. For example, are there concerns about potential soil contamination?

2.1.3 Data Collection

This activity includes investigations to provide the information required to identify, screen, and evaluate candidate alternatives for consideration in the design phase. The purpose of data collection is to provide information relating to the following:

- Service conditions:
 - What are the existing and future service areas and land use?
 - What is the internal corrosion potential for the proposed pipe materials?
 - What are the structural requirements?
- Physical conditions:
 - What is the topography?

- What are the surface features?
- What and where are the existing utilities?
- Should subsurface utility engineering be undertaken?
- What and where are the sensitive areas within the project site?
- What historical data are available for the project site?
- Subsurface conditions:
 - What are the general soil types, locations, and in situ conditions?
 - What is the potential for the presence of rocks, cobbles, or boulders?
 - Is groundwater present, and if so, what is its depth?
 - What is the soil's corrosion potential for the pipe exterior?
 - What is the soil's settlement potential?
- Possible soil contamination:
 - Is the soil contaminated?
 - Is special handling required to protect the equipment and work staff?
 - What are the requirements for disposal?

2.1.4 Evaluation and Selection of Design Alternatives

The last planning activity consists of the final screening and selection of the various alternatives to be addressed during the design phase. This final screening is based on the data collected above in addition to data regarding the following:

- Determination of the pipe service requirements and conditions:
 - What length of pipe is under consideration?
 - What are the structural requirements?
- Constructability and site limitation:
 - What are the surface effects of the construction techniques?
 - What are the easement needs of the construction techniques?
 - What effects will groundwater have?
 - What is the effect of other utilities?
 - Are there special restrictions on allowable noise levels?

The following sections examine in greater detail some of the factors listed above and their interrelationships.

2.2 PREDESIGN SURVEYS

Predesign surveys help to identify and obtain preliminary information needed for the design of the project. Although the responsibility for the surveys is not assigned to a specific party, it is preferable that

and the engineer obtain as much of this information as possible and incorporate it into the design, rather than require the contractor to collect such information. Information critical to the successful completion of the project can then be verified by the contractor in the field before beginning the work. The bidding and contract documents should delineate the extent to which the bidders (and ultimately the contractor) can rely on information supplied by the owner.

2.2.1 Land Use

The existing and future land use in the area affected by the line being installed or replaced is perhaps the most important detail that must be faced in planning capital expenditures. The land use will help identify the service conditions and service life of the pipeline (e.g., water or sewer). Such an obvious consideration has been overlooked in many projects. For example, installation of a culvert in an area that will undergo dramatic land use changes may soon have inadequate hydraulic capacity. This consideration may affect service conditions and design life expectations of the pipe under consideration. Appropriate state and local hydraulic design guidelines must be followed for pipe size selection.

2.2.2 As-Built Drawings

The as-built drawings and any available documentation from other projects in the vicinity of the project being considered should be reviewed. If previous soil borings are available, they should be reviewed and included with the supplemental information available to the bidders. Although extremely useful, the existing as-built drawings should not be assumed to determine the precise location of existing pipes, but they should be verified based on the other surveys described.

2.2.3 Site Conditions and Surface Survey

Site conditions, including surface improvements, must be thoroughly investigated and documented. The following details should be part of this documentation:

- the location of other existing utilities, both parallel and perpendicular to the line in question (see Section 2.2.4 of this chapter). This information must include the height or clearance limits of these other utilities.
- detailed notes showing surface improvements, such as trees and shrubs, type of ground cover, paving, and its condition. All pedestrian and motor vehicle traffic paths must be shown.

When any of the above details cannot be ascertained, the plans should be noted to reflect that the information is missing. All the information must be field verified by the contractor before beginning work.

2.2.4 Subsurface Survey

When designing and specifying trenchless construction, the existing underground site conditions (subsurface) should be investigated and documented to the degree appropriate for the technology selected. The following items may be considered for pipe ramming:

- subsurface soil conditions, including types of soils, rocks, and groundwater;
- existing buried utility locations, including types, sizes, depths, and crossing requirements (see Section 2.2.5 of this chapter);
- the potential for the presence of contaminated material; and
- other underground construction.

Some of the available subsurface technologies (such as ground penetration radar) may not work successfully in certain ground conditions. Proper information at the planning stage is essential for selecting the proper materials and methodology for the project.

2.2.5 Utility Locating

The predesign survey should locate and identify all of the existing underground utility lines in the area within 15 feet (5 m) laterally of the proposed pipe ramming operation. This effort can be accomplished by a variety of techniques, each yielding differing levels of information and certainty, including review of the as-built drawings available from the different utility owners, geographic information system (GIS) data, utility maps, pipeline markers, One-Call location and marking, carefully exposing the utility by excavation (usually by vacuum methods), and field surveying its location with respect to the project coordinate system. In some cases, additional field visits and exploratory efforts may be appropriate.

2.2.6 Subsurface Utility Engineering

The following discussion of subsurface utility engineering (SUE) is based on ASCE 2002.

Subsurface utility engineering can be defined as “a branch of engineering practice that involves managing certain risks associated with utility mapping at appropriate quality levels, utility coordination, utility relocation design and coordination, utility condition assessment,

Copyright 2008 by ASCE, Inc. All rights reserved.