

# Standard Design and Construction Guidelines for Microtunneling

This document uses both the  
International System of Units (SI)  
and customary units.

**American Society of Civil Engineers**

# **Standard Design and Construction Guidelines for Microtunneling**

This document uses both the International System of Units (SI) and customary units.



**CONSTRUCTION  
INSTITUTE**

## Library of Congress Cataloging-in-Publication Data

Standard design and construction guidelines for microtunneling / American Society of Civil Engineers.

pages cm

“This document uses both the International System of Units (SI) and customary units.”  
“ASCE/CI 36-15.”

Includes bibliographical references and index.

ISBN 978-0-7844-1363-0 (print : alk. paper)—ISBN 978-0-7844-7857-8 (ebook)

1. Microtunneling—Standards. 2. Underground pipelines—Design and construction—Standards—United States. 3. Trenchless construction—Standards—United States.

I. American Society of Civil Engineers.

TA660.P55S73 2015

621.8'672—dc23

2014050331

Published by American Society of Civil Engineers

1801 Alexander Bell Drive

Reston, Virginia 20191-4382

[www.asce.org/bookstore](http://www.asce.org/bookstore) | [ascelibrary.org](http://ascelibrary.org)

This standard was developed by a consensus standards development process that has been accredited by the American National Standards Institute (ANSI). Accreditation by ANSI, a voluntary accreditation body representing public and private sector standards development organizations in the United States and abroad, signifies that the standards development process used by ASCE has met the ANSI requirements for openness, balance, consensus, and due process.

While ASCE's process is designed to promote standards that reflect a fair and reasoned consensus among all interested participants, while preserving the public health, safety, and welfare that is paramount to its mission, it has not made an independent assessment of and does not warrant the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed herein. ASCE does not intend, nor should anyone interpret, ASCE's standards to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this standard.

ASCE has no authority to enforce compliance with its standards and does not undertake to certify products for compliance or to render any professional services to any person or entity.

ASCE disclaims any and all liability for any personal injury, property damage, financial loss, or other damages of any nature whatsoever, including without limitation any direct, indirect, special, exemplary, or consequential damages, resulting from any person's use of, or reliance on, this standard. Any individual who relies on this standard assumes full responsibility for such use.

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

*Photocopies and permissions.* Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to [permissions@asce.org](mailto:permissions@asce.org) or by locating a title in ASCE's Civil Engineering Database (<http://cedb.asce.org>) or ASCE Library (<http://ascelibrary.org>) and using the “Permissions” link.

*Errata:* Errata, if any, can be found at <http://dx.doi.org/10.1061/9780784413630>.

Copyright © 2015 by the American Society of Civil Engineers.

All Rights Reserved.

ISBN 978-0-7844-1363-0 (print)

ISBN 978-0-7844-7857-8 (PDF)

Manufactured in the United States of America.

## ASCE STANDARDS

In 2014, the Board of Direction approved revisions to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by ASCE. All such standards are developed by a consensus standards process managed by the ASCE Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee and reviewing during a public comment period. All standards are updated or reaffirmed by the same process every five to ten years. Requests for formal interpretations shall be processed in accordance with Section 7 of ASCE Rules for Standards Committees, which are available at [www.asce.org](http://www.asce.org). Errata, addenda, supplements, and interpretations, if any, for this standard can also be found at [www.asce.org](http://www.asce.org).

This standard has been prepared in accordance with recognized engineering principles and should not be used without the user's competent knowledge for a given application. The publication of this standard by ASCE is not intended to warrant that the information contained therein is suitable for any general or specific use, and ASCE takes no position respecting the validity of patent rights. The user is advised that the determination of patent rights or risk of infringement is entirely his or her own responsibility.

A complete list of currently available standards is available in the ASCE Library (<http://ascelibrary.org/page/books/s-standards>).

## PREFACE

These design and construction guidelines for microtunneling have been created by a group of engineers, owners, contractors, suppliers, and manufacturers working over the past several years. The changes to these microtunneling guidelines take into account many of the advances that have occurred since their original publication in 2001. A number of new sections have been added. Many of the existing sections have been updated because of changes in technology as well as changes in construction that make microtunneling a more acceptable means of construction.

Sections have also been expanded and modified so that those reviewing the guidelines can best understand what is needed in detail in order to undertake a microtunneling project. In addition, the methods for preparing construction contract documents,

including drawings, technical specifications, and contractual specifications, have been updated. The qualifications of contractors who construct a microtunneling project as well as those of the engineers who design them have been updated.

The committee that worked on these guidelines acknowledges that there have been significant improvements in best practices and technology since 2001. No document, including this one, can encompass all of the issues on a particular microtunneling project. In addition, improvements in best practices and technology continue to evolve so quickly that consideration of these guidelines in connection with any project must take into account not only the specific characteristics of the particular project but also further improvements in best practices and technology.

## ACKNOWLEDGMENTS

The American Society of Civil Engineers (ASCE), the North American Society for Trenchless Technology (NASTT), and the North American Microtunneling Association (NAMA) acknowledge the work of the Microtunneling Standards Committee. This group comprises individuals from many backgrounds, including consulting engineering, the construction industry, equipment and pipe manufacturing, education, government, design, and private practice.

Principal authors of the standard are

Glenn M. Boyce, Ph.D., P.E., Chair  
Robert D. Bennett, Ph.D., P.E.  
Lester M. Bradshaw Jr.  
D. Craig Camp  
Ralph R. Carpenter  
Dennis J. Doherty, P.E.  
Mark W. Hutchinson, P.E.  
Richard C. Turkopp, P.E.

Other individuals who served and contributed on the Standards Committee are the following:

Michael G. Boyle, P.E. (inactive)  
Mark H. Bruce

Joseph P. Castronovo, P.E.  
Daniel J. Dobbels, P.E.  
D. Thomas Iseley, Ph.D., P.E.  
James K. Kwong, Ph.D., P.E.  
Steve S. Leius  
Robert Lys Jr., P.E.  
Michael P. Murphy, P.E.  
Mohammad Najafi, Ph.D., P.E.  
Alberto G. Solana, P.E.  
Cal Terrasas  
Richard Thomasson, P.E.  
Brenden D. Tippets  
Michael G. Vitale, P.E.

Thank you to Julie McCullough and Xavier Callahan for providing technical editing.

The committee would like to acknowledge the financial support provided by the following companies and associations:

McMillen Jacobs Associates  
North American Microtunneling Association (NAMA)  
North American Society for Trenchless Technology (NASTT)

# CONTENTS

ASCE STANDARDS . . . . .	iii
PREFACE . . . . .	v
ACKNOWLEDGMENTS . . . . .	vii
<b>PART I GENERAL. . . . .</b>	<b>1</b>
1 SCOPE. . . . .	3
2 REFERENCE DOCUMENTS . . . . .	5
2.1 American Society of Civil Engineers (ASCE) . . . . .	5
2.2 American Society for Testing and Materials (ASTM) . . . . .	5
2.3 American Water Works Association (AWWA) . . . . .	6
2.4 American Petroleum Institute (API) . . . . .	6
2.5 European Standards . . . . .	7
2.6 North American Society for Trenchless Technology (NASTT) . . . . .	7
2.7 Other Standards . . . . .	7
3 DEFINITIONS . . . . .	9
4 ACRONYMS, ABBREVIATIONS, AND INITIALISMS . . . . .	15
5 SUMMARY OF PRACTICE . . . . .	17
<b>PART II PLANNING ASPECTS. . . . .</b>	<b>19</b>
6 INITIAL CRITERIA . . . . .	21
6.1 Pipe Diameter and Grade . . . . .	21
6.2 Depth . . . . .	22
6.3 Routing . . . . .	22
6.4 Shafts and Working Space . . . . .	23
6.5 Sustainability . . . . .	23
6.6 Regulations . . . . .	24
7 SITE CONDITIONS . . . . .	25
7.1 Land Use . . . . .	25
7.2 Easements and Rights-of-Way . . . . .	25
7.3 Underground Utilities and Other Facilities . . . . .	25
7.4 Buried Objects . . . . .	26
7.5 In-line Microtunneling . . . . .	26
7.6 Contaminated Ground and Groundwater . . . . .	27
7.7 Special Considerations . . . . .	27
8 PRELIMINARY GEOTECHNICAL CONSIDERATIONS . . . . .	29
9 PROJECT LAYOUT . . . . .	31
9.1 Layout for Efficient Microtunneling . . . . .	31
9.2 Horizontal and Vertical Alignment. . . . .	31

9.3	Service Connections . . . . .	32
9.4	Effects on Adjacent Structures . . . . .	32
10	<b>COST CONSIDERATIONS . . . . .</b>	<b>35</b>
10.1	Direct Cost of Microtunneling . . . . .	35
10.2	Indirect Social Effect Costs . . . . .	37
10.3	Environmental Costs . . . . .	38
10.4	Risk Analysis . . . . .	38
10.5	Contingency Costs . . . . .	39
	<b>PART III DESIGN ASPECTS. . . . .</b>	<b>41</b>
11	<b>DETAILED SITE INVESTIGATIONS . . . . .</b>	<b>43</b>
11.1	General . . . . .	43
11.2	Geotechnical Investigation Approach and Methods . . . . .	43
11.3	Important Geotechnical Characteristics . . . . .	44
11.4	Geotechnical Reports . . . . .	49
11.5	Utility Surveys . . . . .	49
11.6	Traffic Flow and Access for Vehicles and Pedestrians . . . . .	49
11.7	Environmental Conditions . . . . .	50
11.8	Flood Zones . . . . .	50
11.9	Seismic Conditions . . . . .	51
12	<b>MICROTUNNELING EQUIPMENT . . . . .</b>	<b>53</b>
12.1	General . . . . .	53
12.2	MTBM . . . . .	53
12.3	Control System . . . . .	55
12.4	Handling of Spoils . . . . .	56
12.5	Jacking System . . . . .	56
12.6	Pipe Lubrication System . . . . .	57
12.7	Power Supply . . . . .	57
13	<b>MICROTUNNELING DESIGN ELEMENTS . . . . .</b>	<b>59</b>
13.1	Design Memoranda and Technical Memoranda . . . . .	59
13.2	Pipe Material Selection . . . . .	59
13.3	Earth Loads on Pipe . . . . .	60
13.4	Evaluation of Jacking Forces . . . . .	60
13.5	Evaluation of Settlement Risks . . . . .	61
13.6	Drilling Fluid Design . . . . .	62
13.7	Special Considerations for Curved Drives . . . . .	63
14	<b>SHAFT CONSIDERATIONS . . . . .</b>	<b>65</b>
14.1	Location . . . . .	65
14.2	Shaft Design Considerations . . . . .	65
14.3	Groundwater Control . . . . .	65
14.4	Design of Entry and Exit of Shafts . . . . .	66
14.5	Thrust Blocks . . . . .	67
14.6	Construction Shafts . . . . .	68
15	<b>CONTRACT DOCUMENTS . . . . .</b>	<b>69</b>
15.1	General Considerations . . . . .	69
15.2	General Conditions . . . . .	69
15.3	Special and Supplementary Conditions . . . . .	69
15.4	Technical Specifications . . . . .	69
15.5	Plans . . . . .	70
15.6	Geotechnical Investigations and Data . . . . .	71
15.7	Microtunneling Contractor Qualifications . . . . .	71
15.8	Dispute Resolution . . . . .	72

<b>PART IV PIPE MATERIAL ASPECTS . . . . .</b>	<b>75</b>
16 PIPE CHARACTERISTICS . . . . .	77
16.1 General Requirements . . . . .	77
16.2 Material Types . . . . .	77
16.3 Material Selection . . . . .	77
16.4 Reference Product Standards. . . . .	78
16.5 Scope and Range . . . . .	78
16.6 Section Lengths . . . . .	78
16.7 Mechanical Properties . . . . .	78
16.8 Manufacturing and Quality Control . . . . .	78
17 PIPE DESIGN . . . . .	79
17.1 In-Use Loads . . . . .	79
17.2 Installation Loads . . . . .	79
17.3 Dimensional Criteria . . . . .	79
17.4 Lubrication Ports . . . . .	80
17.5 Joints . . . . .	81
17.6 Resistance to the Environment. . . . .	82
17.7 ANSI/NSF International 61 Certification . . . . .	84
18 FIELD ASPECTS . . . . .	85
18.1 Preinstallation Inspection . . . . .	85
18.2 Postinstallation Inspection . . . . .	85
18.3 Damage Correction. . . . .	85
<b>PART V CONSTRUCTION ASPECTS . . . . .</b>	<b>87</b>
19 MICROTUNNELING OPERATION . . . . .	89
19.1 Shafts . . . . .	89
19.2 MTBM Launch. . . . .	89
19.3 Microtunneling Process . . . . .	90
19.4 Drilling Fluid Use during Construction . . . . .	91
19.5 Guidance System. . . . .	91
19.6 Lubricant System. . . . .	93
19.7 Work Hours. . . . .	94
19.8 MTBM Retrieval at Drive Completion . . . . .	94
19.9 Wet Retrieval of MTBM. . . . .	95
20 MACHINE PERFORMANCE . . . . .	97
20.1 Annular Thickness, Annular Wear, and Annular Space . . . . .	97
20.2 Overcut . . . . .	98
20.3 Slurry or Auger System . . . . .	98
20.4 Cutter Wheel Design and Selection . . . . .	99
20.5 Slurry Separation Point. . . . .	100
20.6 Buried Objects and Obstructions. . . . .	101
20.7 Steering . . . . .	102
21 SUBMITTALS . . . . .	103
21.1 Microtunneling . . . . .	103
21.2 Qualifications of Personnel . . . . .	104
21.3 Microtunneling Work Plan . . . . .	104
21.4 Pipe Selection . . . . .	104
21.5 Contingency Plans . . . . .	104
21.6 Dewatering Plan . . . . .	105
21.7 Additional Shop Drawings. . . . .	105
22 SHAFTS AND TEMPORARY STRUCTURES . . . . .	107
22.1 Shaft Design . . . . .	107
22.2 Excavation Technique and Support Systems . . . . .	107

22.3	Permits . . . . .	107
22.4	Responsibility for Design Adequacy. . . . .	107
22.5	Contractor Supervision. . . . .	108
22.6	Public Safety . . . . .	108
22.7	Ventilation Requirements . . . . .	108
23	CONSTRUCTION SUPPORT SERVICES. . . . .	109
23.1	Protection of Adjacent Structures . . . . .	109
23.2	Inspection of the Work. . . . .	109
24	REGULATIONS . . . . .	
24.1	Safety Regulations . . . . .	111
24.2	Pollution Control . . . . .	111
24.3	Erosion Control. . . . .	111
25	INSTRUMENTATION AND MONITORING . . . . .	113
26	RESTORATION AND CLEANUP . . . . .	115
27	MEASUREMENT AND PAYMENT. . . . .	117
27.1	Mobilization . . . . .	117
27.2	Jacking and Receiving Shafts . . . . .	117
27.3	Ground Improvement . . . . .	117
27.4	Pipe . . . . .	118
27.5	Microtunnel Installation . . . . .	118
27.6	Rescue Shafts. . . . .	118
27.7	Manhole and Access Installations . . . . .	118
27.8	Site Restoration. . . . .	118
27.9	Demobilization . . . . .	118
27.10	Differing Site Conditions . . . . .	118
	<b>REFERENCES . . . . .</b>	<b>119</b>
	<b>INDEX . . . . .</b>	<b>121</b>