Mapping of underground utility infrastructure
Legal Notice for Standards

Canadian Standards Association (CSA) standards are developed through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability
This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document’s fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party’s intellectual property rights. CSA does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA makes no representations or warranties regarding this document’s compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA is a private not-for-profit company that publishes voluntary standards and related documents. CSA has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership
As between CSA and the users of this document (whether it be in printed or electronic form), CSA is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA’s and/or others’ intellectual property and may give rise to a right in CSA and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by licence or by law, CSA reserves all intellectual property rights in this document.

Patent rights
Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document
This document is being provided by CSA for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:
• load this document onto a computer for the sole purpose of reviewing it;
• search and browse this document; and
• print this document if it is in PDF format.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to
• alter this document in any way or remove this Legal Notice from the attached standard;
• sell this document without authorization from CSA; or
• make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.
CSA Standards Update Service

S250-11
September 2011

Title: Mapping of underground utility infrastructure
Pagination: 71 pages (ix preliminary and 62 text), each dated September 2011

To register for e-mail notification about any updates to this publication

- go to www.ShopCSA.ca
- click on E-mail Services under MY ACCOUNT
- click on CSA Standards Update Service

The List ID that you will need to register for updates to this publication is 2421375.

If you require assistance, please e-mail techsupport@csa.ca or call 416-747-2233.

Visit CSA’s policy on privacy at www.csagroup.org/legal to find out how we protect your personal information.
CSA Standard

S250-11

Mapping of underground utility infrastructure

Published in September 2011 by Canadian Standards Association

A not-for-profit private sector organization

5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6

1-800-463-6727 • 416-747-4044

Visit our Online Store at www.ShopCSA.ca
The Canadian Standards Association (CSA) prints its publications on Rolland Enviro100, which contains 100% recycled post-consumer fibre, is EcoLogo and Processed Chlorine Free certified, and was manufactured using biogas energy.

To purchase CSA Standards and related publications, visit CSA’s Online Store at www.ShopCSA.ca or call toll-free 1-800-463-6727 or 416-747-4044.

ISBN 978-1-55491-656-6

© Canadian Standards Association — 2011

All rights reserved. No part of this publication may be reproduced in any form whatsoever without the prior permission of the publisher.
Contents

Technical Committee on Mapping of Underground Utility Infrastructure vi

Preface ix

0 Introduction 1

1 Scope 2
1.1 General 2
1.2 Application 2
1.3 Terminology 2

2 Reference publications 2

3 Definitions 3

4 Mapping records 5
4.1 General 5
4.2 Mapping records management 6
4.2.1 General 6
4.2.2 Accuracy 6
4.2.3 Content 6
4.2.4 Record systems 6
4.2.5 Source records 6
4.2.6 Retention 6
4.2.7 Monitoring and auditing 6
4.2.8 Continuous improvement 6
4.2.9 Disaster recovery 6
4.2.10 Training 6
4.3 Accountabilities and responsibilities 7
4.3.1 Owner 7
4.3.2 Locator 7
4.3.3 Excavator 7
4.4 Mapping record characteristics 7
4.4.1 General 7
4.4.2 Validity 7
4.4.3 Map data interoperability 7
4.5 Records lifecycle 7
4.5.1 General 7
4.5.2 Planning and design 8
4.5.3 Construction 8
4.5.4 Operation and maintenance 8
4.6 Types of mapping records 9
4.6.1 General 9
4.6.2 Field records 9
4.6.3 As-built drawing 9
4.6.4 Base mapping 9
4.6.5 Photographs 10
4.6.6 Red-line drawings and records 10
4.6.7 Sketches 10
4.7 Map data sharing 10
4.7.1 General 10
4.7.2 Owner responsibilities 10
4.7.3 Sign-off/transmittal (process of sharing the data) 10
4.7.4 Data sharing 10
4.7.5 Mapping data compatibility 10

5 Reliability and accuracy of mapping records 11
5.1 General 11
5.2 Measuring and recording the location of underground utility infrastructures 11
5.2.1 Owner’s responsibility 11
5.2.2 Competency 11
5.2.3 Open trench and daylighting 11
5.2.4 Trenchless technology 11
5.2.5 Intervals for measurements 12
5.3 Absolute spatial positioning 12
5.3.1 Horizontal and vertical datum 12
5.3.2 Projection or coordinate system 12
5.4 Relative spatial positioning 12
5.4.1 Use of permanent structures 12
5.4.2 Absolute positioning of relative locations 12
5.5 Accuracy of as-built records 13
5.6 Application of spatial accuracy 13
5.6.1 Extent of spatial accuracy 13
5.6.2 Measurements of spatial accuracy 13
5.7 Accuracy of supplementary utility records 13
5.8 Quality levels for underground utility infrastructure mapping 14
5.9 Measurements 14
5.9.1 General 14
5.9.2 Recording measurements 14
5.9.3 Project control points 14
5.9.4 Precision 14
5.9.5 Angles, distances, and vectors 15
5.9.6 Non-conforming information 15
5.9.7 Kinematic GNSS/GPS coordinates 15

6 Feature description 15
6.1 General 15
6.2 Data structure 15
6.3 Symbols 15
6.4 Clarity of information 16
6.5 Line style 16
6.5.1 General 16
6.5.2 Line style attributes 16
6.5.3 Line style appearance 16
6.5.4 Colour 16
6.5.5 Line weight 16
6.5.6 Layers or levels 16
6.5.7 Dimensions 16
6.5.8 Text 16

7 Utility infrastructure specific requirements for mapping records 18
7.1 General 18
7.1.1 Material abbreviations 18
7.2 Water systems 18
7.2.1 Inclusions 18
7.2.2 Exclusions 19
7.2.3 Graphical representation 19
7.3 Wastewater systems 19
7.3.1 General 19
7.3.2 Inclusions 19
7.3.3 Exclusions 19
7.3.4 Graphical representation 19
7.4 Electrical systems 20
7.4.1 Inclusions 20
7.4.2 Exclusions 20
7.4.3 Graphical representation 20
7.5 Liquid petroleum and gas systems 20
7.5.1 Inclusions 20
7.5.2 Exclusions 21
7.5.3 Graphical representation 21
7.6 Telecom systems 21
7.6.1 Inclusions 21
7.6.2 Exclusions 21
7.6.3 Graphical representation 21

Annexes
A (informative) — Commentary 35
B (informative) — Distinction between records and as-built drawings 46
C (informative) — Utility infrastructure corridors 47
D (informative) — Sample layout drawings/GIS output plots 51
E (informative) — Sample mapping change request form and process 54
F (informative) — As-built drawing checklist 58

Tables
1 — Positional accuracy of as-built records 22
2 — Positional accuracy of supplementary utility infrastructure records 22
3 — Colour codes on composite utility maps 23

Figures
1 — Text and dimension orientation 24
2 — Water systems 25
3 — Wastewater systems 27
4 — Electrical systems 29
5 — Liquid petroleum and gas systems 31
6 — Telecom systems 33
# Technical Committee on Mapping of Underground Utility Infrastructure

<table>
<thead>
<tr>
<th><strong>B. Gaspirc</strong></th>
<th>City of Toronto, Toronto, Ontario</th>
<th><strong>Chair</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L. Hanley</strong></td>
<td>Union Gas Limited, Chatham, Ontario</td>
<td><strong>Vice-Chair</strong></td>
</tr>
<tr>
<td><strong>L. Arcand</strong></td>
<td>TSH/TBE Subsurface Utility Engineers, Whitby, Ontario</td>
<td></td>
</tr>
<tr>
<td><strong>J. Arnott</strong></td>
<td>Enbridge Gas Distribution, Toronto, Ontario</td>
<td><strong>Associate</strong></td>
</tr>
<tr>
<td><strong>J. Atherton</strong></td>
<td>UMA Engineering Ltd., Mississauga, Ontario</td>
<td></td>
</tr>
<tr>
<td><strong>F. Briceno</strong></td>
<td>Aecon Utilities, Toronto, Ontario</td>
<td><strong>Associate</strong></td>
</tr>
<tr>
<td><strong>J. Cook</strong></td>
<td>Terra Discovery Ltd., Terra Cotta, Ontario</td>
<td><strong>Associate</strong></td>
</tr>
<tr>
<td><strong>G. Désilets</strong></td>
<td>Public Works Government Services Canada, Ottawa, Ontario</td>
<td></td>
</tr>
<tr>
<td><strong>A. Geden</strong></td>
<td>Aecon Group Inc., Toronto, Ontario</td>
<td></td>
</tr>
<tr>
<td><strong>J. Hale</strong></td>
<td>Department of National Defence, Ottawa, Ontario</td>
<td></td>
</tr>
<tr>
<td><strong>S. Henley</strong></td>
<td>Henley Consulting Inc., Qualicum Beach, British Columbia</td>
<td></td>
</tr>
<tr>
<td><strong>T. Jenkins</strong></td>
<td>Regional Municipality of Peel, Brampton, Ontario</td>
<td><strong>Associate</strong></td>
</tr>
<tr>
<td><strong>G. Jones</strong></td>
<td>SaskEnergy, Regina, Saskatchewan</td>
<td></td>
</tr>
<tr>
<td><strong>T. Kee</strong></td>
<td>Alberta Agriculture and Food, Edmonton, Alberta</td>
<td></td>
</tr>
<tr>
<td><strong>P. Lamb</strong></td>
<td>Ontario Ministry of Transportation, St. Catharines, Ontario</td>
<td></td>
</tr>
<tr>
<td><strong>B. Lawrence</strong></td>
<td>ENMAX Power Corp., Calgary, Alberta</td>
<td></td>
</tr>
<tr>
<td><strong>J. Marshall</strong></td>
<td>Hydro One Networks, Barrie, Ontario</td>
<td><strong>Associate</strong></td>
</tr>
<tr>
<td>Name</td>
<td>Company/Position</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>R. McNabney</td>
<td>Toronto Hydro Electric Systems Ltd., Toronto, Ontario</td>
<td></td>
</tr>
<tr>
<td>M. Morin</td>
<td>ATCO Electric, Edmonton, Alberta</td>
<td></td>
</tr>
<tr>
<td>F. Nagy</td>
<td>Dufferin Construction Company, Oakville, Ontario</td>
<td></td>
</tr>
<tr>
<td>H. Peters</td>
<td>ComPeters Inc., Kitchener, Ontario</td>
<td></td>
</tr>
<tr>
<td>R. Phillips</td>
<td>ATCO Pipelines, Edmonton, Alberta</td>
<td></td>
</tr>
<tr>
<td>K. Philpott</td>
<td>Crann &amp; Associates Inc., Whitby, Ontario</td>
<td></td>
</tr>
<tr>
<td>M. Pollock</td>
<td>Utilicor Technologies Inc., Toronto, Ontario</td>
<td></td>
</tr>
<tr>
<td>R. Robert</td>
<td>Bell Canada, Ottawa, Ontario</td>
<td></td>
</tr>
<tr>
<td>M. Robinson</td>
<td>City of Hamilton Public Works, Hamilton, Ontario</td>
<td></td>
</tr>
<tr>
<td>M. Savard</td>
<td>Municipal District of Foothills, High River, Alberta</td>
<td></td>
</tr>
<tr>
<td>J. Scaife</td>
<td>multiVIEW Locates Inc., Mississauga, Ontario</td>
<td></td>
</tr>
<tr>
<td>D. Shannon</td>
<td>TELUS Communications Inc., Edmonton, Alberta</td>
<td></td>
</tr>
<tr>
<td>K. Shaw</td>
<td>City of Greater Sudbury, Sudbury, Ontario</td>
<td></td>
</tr>
<tr>
<td>M. Shmyr</td>
<td>City of Edmonton, Edmonton, Alberta</td>
<td></td>
</tr>
<tr>
<td>D. Vanier</td>
<td>Consultant, Vancouver, British Columbia</td>
<td></td>
</tr>
<tr>
<td>B. Varrasso</td>
<td>Infrastructure Health and Safety Association, Toronto, Ontario</td>
<td></td>
</tr>
<tr>
<td>S. Virdi</td>
<td>Technical Standards and Safety Authority, Toronto, Ontario</td>
<td></td>
</tr>
<tr>
<td>D. Wulff</td>
<td>Vivax Canada Inc., Markham, Ontario</td>
<td></td>
</tr>
<tr>
<td>J. Young</td>
<td>J.D. Barnes Limited, Markham, Ontario</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Affiliation</td>
<td>Role</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>N. Zembillas</td>
<td>Cardno TBE, Clearwater, Florida</td>
<td>Associate</td>
</tr>
<tr>
<td>M. Braiter</td>
<td>Canadian Standards Association,</td>
<td>Project Manager</td>
</tr>
<tr>
<td></td>
<td>Mississauga, Ontario</td>
<td></td>
</tr>
</tbody>
</table>
Preface

This is the first edition of CSA S250, *Mapping of underground utility infrastructure*. Funding for developing and publishing this Standard was provided by the City of Toronto, the member municipalities of the Regional Public Works Commissioners of Ontario (Regional Municipality of Durham, Corporation of Halldaman County, Regional Municipality of Halton, City of Hamilton, City of London, District Municipality of Muskoka, Regional Municipality of Niagara, Corporation of Norfolk County, City of Ottawa, Regional Municipality of Peel, City of Greater Sudbury, City of Thunder Bay, City of Toronto, Regional Municipality of Waterloo, City of Windsor, Regional Municipality of York), Public Works Government Services Canada, Department of National Defence, Association of Ontario Land Surveyors, and TELUS. This Standard could not have been developed without the generosity of these sponsors, the Technical Committee on Mapping of Underground Utility Infrastructure members, and other supporters.

CSA wishes to acknowledge the contributions of the following individuals who comprised the Feasibility Study Team: Lawrence Arcand, Avi Bachar, Bob Gaspirc, Laverne Hanley, Marshall Pollock, Toni Sani, John Scaife, and Kevin Tierney.

The developers of this Standard wish to acknowledge the contributions of the following individuals who were unable to complete their term on the Technical Committee: Andrea Adley-McGinnis, Kirk Ehgoetz, John Harter, Stan Hogenkamp, Chris Hudson, Harold Miller, Dean Rurak, Mike Scarland, and Gary Shaw.

This Standard was prepared by the Technical Committee on Mapping of Underground Utility Infrastructure, under the jurisdiction of the Strategic Steering Committee on Structures (Design), and has been formally approved by the Technical Committee.

September 2011

Notes:

(1) Use of the singular does not exclude the plural (and vice versa) when the sense allows.

(2) Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

(3) This publication was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as “substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity”. It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this publication.

(4) To submit a request for interpretation of CSA Standards, please send the following information to inquiries@csa.ca and include “Request for interpretation” in the subject line:

(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;
(b) provide an explanation of circumstances surrounding the actual field condition; and
(c) where possible, phrase the request in such a way that a specific “yes” or “no” answer will address the issue.

Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization and are published in CSA’s periodic Info Update, which is available on the CSA website at http://standardsactivities.csa.ca.

(5) CSA Standards are subject to periodic review, and suggestions for their improvement will be referred to the appropriate committee. To submit a proposal for change to CSA Standards, please send the following information to inquiries@csa.ca and include “Proposal for change” in the subject line:

(a) Standard designation (number);
(b) relevant clause, table, and/or figure number;
(c) wording of the proposed change; and
(d) rationale for the change.

September 2011
S250-11
Mapping of underground utility infrastructure

0 Introduction
The purpose of this Standard is to specify the mapping records requirements used to identify and locate underground utility infrastructure. This Standard is intended to promote the use and drive the advancement of mapping records during the planning, design, construction, and operation of underground utility infrastructure.

Underlying the development of this Standard is the two-fold recognition that it is a privilege, not a right, to bury anything underground in the public right of way and that it is in consideration or exchange for that privilege, that the owner is obliged to provide an accurate and retrievable as-built location of that utility infrastructure.

The underground is a maze of pipes and cables. Currently, thousands of kilometres of underground pipes and cables have never been accurately mapped or recorded. Infrastructure in Canada’s older cities was installed more than 100 years ago when as-built drawings, if any existed, referred to surface features that have long since disappeared. Up until recently, recording the presence and location of such utilities was not formally required or was not carried out in an accurate or methodical way. Today, many of the records that do exist are in formats that are incompatible between utilities, making it difficult to position one company’s pipes relative to another’s cables.

With so many communications lines, fibre-optic cables, and petroleum, natural gas, electricity, water and sewer lines, public safety issues arise as to how quickly utility infrastructure can be located and accurately identified in order to avoid an excavation mishap that could result in significant damage, an interruption of service, possible serious injury to workers or the public, or negative impact to the environment.

Municipal authorities and the construction industry are now making a concerted effort to prevent accidental damage to underground utility infrastructure. For example, the Common Ground Alliance (CGA) has launched a “Call Before You Dig” program designed to serve as a national resource for professional excavators. In addition, a new Damage Information Reporting Tool (D.I.R.T) has been developed to catalogue and identify the causes of the estimated 675 000 utility infrastructure strikes that occur each year in Canada and the United States.

But these are reactive measures. There is much that can be done proactively to establish recording, mapping, and reporting standards that will improve the usefulness of the underground mapping record going forward. The work of the Technical Committee is dedicated to that effort.

The as-built drawings, records, and mapping systems are the final component of the design and construction activity. They are the combination of many records created during the planning, design, construction, and operation lifecycle of a utility infrastructure. At the planning and design stages, it is decided and recorded that the plant should be locatable and identifiable during construction. At the construction stage, records are generated on how the plant is laid, how the tracer wire is applied, and how the tracer is tested. At the construction stage, records are generated to illustrate changes to the design, actual clearances from other utilities, and depth of cover. At the operation and maintenance stage, records are generated to illustrate modifications to the utility infrastructure and the repairs made to them at each phase of its lifecycle.

Application of this Standard on a go forward basis does not necessarily mean that utilities need to dispose of their current mapping policies and practices. However, at a minimum, among the benefits associated with adopting this Standard is the opportunity to establish accuracy and quality levels that are consistent across all Canadian jurisdictions. Adoption of a single standard makes it easier for all end users to respond to calls for proposals, eliminates the need for familiarity with the details of multiple standards, and encourages consistency of approach.