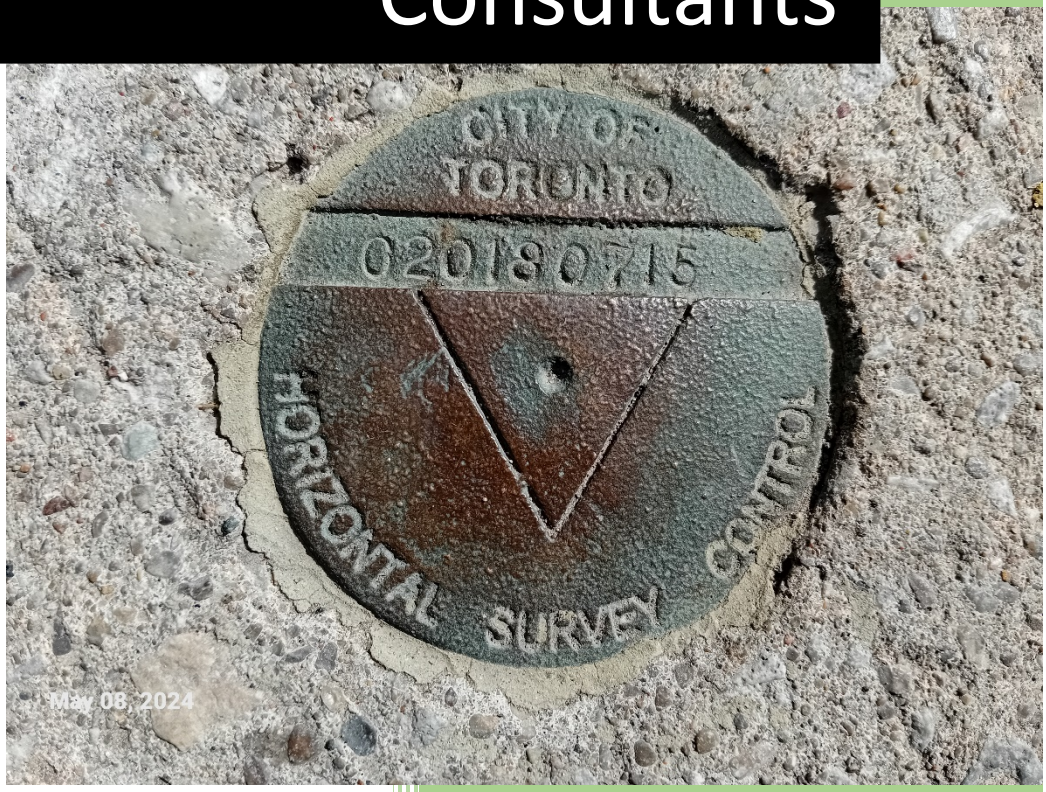
2024

Engineering Survey Standards for Consultants



Engineering Surveys
Engineering & Construction Services
5/1/2024

Engineering Survey Standards for Consultants

TORONTO

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City of Toronto – Engineering Survey Standards for Consultants

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Introduction

This survey standards outlines the minimum requirements for Engineering Survey operations and provides information that is considered essential to the City's engineering surveys ensuring that deliverables are complete, correct, and consistent. The appendixes shall form part of these standards.

Notwithstanding any procedure or standard, survey work shall be conducted in compliance with *Occupational Health and Safety Act* and *Regulations for Construction Projects (Ontario Regulation 213/91)*. Any specific requirements in the contractual Terms of Reference of a project shall also be met in addition to the general requirements of this Standard.

This document applies to all engineering surveys undertaken for the City, by both the City and consultants.

What This Standard Contains

Chapter 1 – Project Control – covers collection of information for all the preliminary survey projects, the leveling process in determining the vertical position(s) of different points below, on, or above the ground, traversing and requirements in establishing horizontal control and criterias to be considered when performing GNSS survey.

Chapter 2 – Pre-engineering Survey – covers all areas required to achieve a comprehensive design of the project.

Chapter 3 – Construction and Layout Survey – covers aspects related to construction layout, construction survey support and working wieth consultants and contractors.

Chapter 4 – As-built Surveys – covers information requested in an as-built survey to be field verified by surveys for the purpose of evaluation or final payment.

Chapter 5 – Survey Records – covers basic requirements of survey records that must be preserved and protected and shall be provided including all aspects related to CADD standards.

Chapter 1 – Project Control

Integrated Survey

Surveys must be integrated in the official City of Toronto coordinate system.

The coordinate system must be established as:

- Horizontal datum: NAD27
- Vertical datum: CGVD 1928 Pre-1978 Adjustment
- The projection: Modified Transverse Mercator Projection (MTM)
- The parameters are as follows:
    - Zone Name = Zone 10
    - Zone Width = 3 Degrees
    - Longitude of Origin = -79.5
    - Latitude of Origin = 0
    - False Easting (X) = 304800m
    - False Northing (Y) = 0
    - Scale Reduction = 0.9999

For more details on geodetic control network, see Appendix A, *Survey Standard Details*.

Reconnaissance – Information Collection

All preliminary survey reconnaissance shall consider the following:

- Horizontal Control Monument (HCMs) used must be verified.
- HCM and Geodetic Bench Mark (GBM) values are published by COntrol Survey INformation Exchange (COSINE) database or provided by City.
- Destroyed horizonal control monuments should be reset if sufficient ties are available.

- All geodetic benchmarks must be verified prior to use and any discrepancies must be report to City Geodetic Surveys unit.
- Verified Geodetic Control Sheet monument status, measured ties, crew names and date must be reported to City Geodetic Surveys unit at email: geodeticsurveys@toronto.ca .
- Survey monuments used must be left in the same condition as found.
- Minimal spray paint marking may only be used for monuments located on public property.
- Project Sub Control Points (SCP)'s must be durable for current and future projects use.
- Project SCP's shall form part of a balanced traverse.
- Project SCP's must be referenced to at least three ties for future use and to enable reset of control point. Ties details must be prepreated and accompanined with a sketch and/or photographs.
- Temporary benchmarks must be described and recorded.

For horizontal control monumnets located on private property, property owners must be contacted prior to property entry and no marks or alterations may be made to the monument or to their property.

Survey Methodology

Vertical Project Control

As part of the leveling process to determine the vertical position(s) of different points below, on, or above the ground, the following parameters are to be considered.

All leveling must begin on a geodetic benchmark and terminate on another geodetic benchmark to verify benchmark stability and published information.

A two-peg test must be performed at the beginning of the project, then additionally if the operator feels the instrument has been compromised. The collimation error shall not be greater than 0.1 millimetres per metre.

The standard of accuracy is Class 2, as specified in Appendix A, *Survey Standard Details*.

- Single run
- Maximum length of sight: 50m
- Maximum difference in sight length: 10m
- Maximum closure: 8 mm x square root of leveling distance in km
- Adjust and balance elevation if closing error is within the tolerance of:
    - 10 mm in 1st km or
    - 8 mm x square root of km

If the closing error is greater than the tolerance, then the leveling must be re-observed or a third benchmark observed.

Leveling must include all project control points.

For bench marks located on private property, property owners must be contacted prior to property entry and no marks or alterations may be made to the monument or to their property.

Horizontal Project Control

A survey traverse may be required to be established via method of surveying in which the lengths and directions of lines between points on the Earth are obtained by or from field measurements and used in determining positions of the point.

The following paramaters shall be considered:

- Project control points set must be observed within a closed traverse which must start on two horizontal control monuments and close on two horizontal control monuments.

- Hanging lines are not permitted.
- Resection points are to be set and verified with a minimum of three observations to existing traversed and adjusted control points or horizontal control monuments.
- Any additional project control points must be integrated into adjust traverse.
- Horizontal control monuments within the project limits, shall be integrated as part of the control point traverse.
- All traverse(s) must be balanced and adjusted.
- Adjustments may be made by Compass Rule or Least Squares.
- Azimuth closure at azimuth check point not to exceed 6 inch per station or 15 inch x square root of number of stations.
- After azimuth adjustment, the position closure should not exceed 1 part in 7000 —Third Order Class 1 of 1/10000 is preferred. If the error is greater, then the traverse must be rerun and corrected.
- Project control points may be set using the Free Station Establishment Program. However, attention must be paid to the geometry of the existing horizontal control monumnets so that a distortion is not created. At least three existing horizontal control monuments are used for this procedure.
- All raw observation data, sketches, and adjustment reports to be provided.

Global Navigation Satellite System Control

A Global Navigation Satellite System (GNSS) survey may be used in the survey. The survey must be checked and documented to a minimum of three (3) known integrated control monuments in the perimeter of the survey area. GNSS must not be used for elevations.

For static GNSS observations the following criteria shall be met:

- Maximum 15 second measurement (epoch) interval

- Minimum 15 minute common observation time
- Minimum of five common satellites
- Position Dilution of Precision (PDOP) of six or less.

The following additional paramaters shall be considered:

- Three receivers are the minimum number recommended for static GNSS networks, and common baselines should be measured between sessions.
- Survey every new control or base station point from a minimum of two base stations.
- Ensure that the appropriate covariance records are collected with each measurement so that a least-squares adjustment can be run.

Chapter 2 – Pre-engineering Survey

The pre-engineering survey shall completely encompass all of the areas required to achieve a comprehensive design of the project as set out by the City.

Numbering Convention

- HCMs: Published Station Number
- Established Control Point Numbers:
    - Primary Control Points: 100 series
    - Secondary Control Points: 200 series
    - Resection Control Points: 300 series
- Topographic features: Starting Point # 1,000

Feature Code and Line Connectivity

The latest version of Feature-Code List must be used.

Consultant must obtain current Feature-Code List prior to commencement of each project.

A curved feature must be defined by sufficient points to accurately depict its true shape, with not less than three points.

- Apply connectivity where applicable in accordance with Bentley InRoads software.
- For details regarding line connectivity, see Appendix C, *Line Connectivity*.

Installation of Project Control

The control points established during the pre-engineering phase of the project shall be used, and all of which must be verifiable, durable, and stable throughout the pre-engineering and construction phase.

If a control point is missing during layout, it shall be re-established from the control data provided in the pre-engineering phase of the project.

The consultant shall supply all control point information, including methodology, descriptions and data, and raw data for the pre-engineering phase of the project.

Documentation or Notes

All raw data must be included in the deliverable. Leveling notes and traverse reports must be submitted.

All data must include the appropriate file type in the deliverable. For details on file type, see Appendix G, *Contents of File Deliverables*.

Subsurface Utility Engineering

Subsurface utility engineering is the process of locating and mapping all underground utilities, such as pipelines, conduits, and maintenance holes, to protect them during construction, excavation, and other activities. Sub-surface utility locates are governed by Subsurface Utility Engineering practices (SUE).

Prior to conducting any field work, all safety hazards must be assessed, and the appropriate safety precaution(s) must be taken in accordance with the *Occupational Health and Safety Act* and *Regulations for Construction Projects (Ontario Regulation 213/91*.

Requested services may include the following:

- Utility record circulation
- Subsurface utility locating
- Survey of underground utility locates surface markings
- Daylighting services
- Survey of test hole locations
- Depiction of survey data in CADD
- Maintenance hole and its associated attributes.

Maintenance Holes

The following attributes shall be recorded when gathering information related to a maintenance hole and its associated attributes:

- Type or purpose of utility, for example storm sewer, sanitary sewer, combined sewer, or watermain
- Size or diameter of pipe and chamber
- Depth to invert, top of pipe, floor depth and so on
- Location of pipe inlet and outlet
- Chamber wall location, if required
- Centre of lid shall be coordinated
- Other details as required. For more details see Appendix H, *Subsurface Utilities Requirements*.

All work related to survey of subsurface utility locates shall be performed in compliance with the following referenced documents:

- Technical Standards and Safety Authority/Environmental Site Assessments (TSSA/ESA)
- Ontario One Call
- ASCE 38-22 Standard Guideline for Investigating and Documenting Existing Utilities (or latest version)
- Ontario Regional Common Ground Alliance
- CCGA Best Practices Latest Version
- Engineering Survey MicroStation V8 Graphic Specification
- City of Toronto's Utility Cut Permit Applications and Municipal Consent Requirements for the Installation of Plant within City of Toronto Streets.
- TS 4.70 Construction Specification for Keyhole Excavation and Permanent Reinstatement of Keyhole Cores

Apply connectivity where applicable in accordance with Bentley InRoads software.

Chapter 3 – Construction and Layout Survey

Discuss the project thoroughly with the consultant, make written notes of the discussions and instructions including attending pre-construction and progress meetings as required, obtaining a copy of the design or construction drawings, and obtaining construction schedule.

Work with consultants and contractor to schedule survey requirements to effectively manage the survey and field layouts to avoid costly re-layouts.

Bring any observed inconsistencies to the attention of the Consultants immediately. Do not continue to work until receiving instructions from the consultants.

Perform and record the construction layout:

- Obtain a record of horizontal and vertical stations along the alignment as provided to enable the accurate construction of the proposed feature.
- Additional control points for layout as required can be established from the provided Horizontal and vertical control network.
- Prepare grade sheets and all other field notes to record and convey the work done.
- Record and make notes and sketches of relevant information that will be of value in the subsequent as-built drawings.
- All critical layout points must be recorded and independently verified to ensure their validity and correctness.
- All match points must be verified to satisfy existing conditions.
- Layout and offset points and the reference feature must be recorded digitally for verification and future reference.

Complete specific requests from the consultants during the construction support phase, which may include the following:

- Provide assistance and input on issues that may arise, requiring revision to completed surveys, and provide remedial work.
- Provide grade checks on forms and string lines prior to pouring concrete.
- Provide assistance for the tie-in of underground infrastructure.
- Assist in final quantity measurements when a dispute arises.
- Perform an as-built survey where applicable.

Chapter 4 – As-built Survey

An as-built survey is a standard operating procedure in the life cycle of an engineering project. This survey applies to City-owned underground utilities such as water main, storm and sanitary sewers. Projects with water main components require an as-built survey, while other infrastructure may be requested by the consultant. Information requested will be field verified by surveys for the purpose of evaluation or final payment or both.

All elevations and alignment must be referenced to the same vertical and horizontal control respectively, as established in the original pre-engineering survey.

Watermain Projects

The following watermain data shall be collected:

1. Top or invert of newly installed pipe, wherever possible. Measurement along trench cut for alignment only. For example, valve chamber to valve chamber in conjunction with the as-built.

2. Utility nodes or key features includes such as horizontal bends in the pipe and vertical bends, wherever possible. Tees, crosses, hydrants, valves, valve boxes, and chambers.

3. Identify type, material, diameter of exposed utilities.

4. Upon request from consultants, measurement can be taken for driveways materials, asphalt cuts, sidewalk, and sod. If sod is to be measured, surveys must be notified as soon as the restoration is complete.

Sewer System Projects

The following sewer data shall be collected when requested:

1. Exposed existing utilities – private and public.

2. New and existing chambers, maintenance holes or structures; and

3. Coordinate a reference feature, for example a gutter, if a pre-engineering survey is not available.

4. Identify type, material, diameter of exposed utilities.

5. Measure-up is surveyed from centre line (CL) of lid to CL of lid, unless actual pipe length is requested.

6. If radial pipe is being installed, surveys must be contacted to tie in its location during construction.

All data shall be according to City sewer and watermain as-built standards. For more details, see Appendix P, *Sewer and Watermain Design As-built Required Features*.

Road Projects

At the request of the consultant, road surface features within the project scope measure-up survey will be conducted to determine the surface area, volume of material, length adnd location of civil feature(s) and so on for the purpose of verification.

The following features shall be collected when requested:

1. Pavement – Grind Area

    - Surface asphalt area calculation within edge of pavement to edge of pavement of newly construction area

    - Side street(s): exact location of new asphalt meeting existing asphalt. Collection of data by GNSS (surface area only) or Total Station (Surface area and grades)

2. Sidewalk – surface concrete area calculation as specified.

3. Sod area – upon request.

All data shall be according to City transportation features as-built standards. For more details, see Appendix P, *Sewer and Watermain Design As-built Required Features*.

Chapter 5 – Survey Records

Survey record plays a critical part in the operation of our business. It includes documents in both paper and electronic format. This includes letters, emails, plans, drawings, old survey notes, new notes, mark-up control sheets, mark-up drawing and so on. Survey records are the property of the City and must be preserved and protected and shall be provided to Engineering Surveys unit.

Field Notes

Field note must be prepared at the time of survey. For a guideline on field notes, see Appendix B, *Field Notes*.

Data Collector File Output

All downloaded files containing field raw data must not be edited, manipulated or processed. A copy of the raw data files will be used for processing and editing.

Survey Folder – Field

Use the check list as shown in Appendix D, *File and Folder Structure* to ensure that the required items are in the survey folder.

Digital Data

Survey record plays a critical part in the operation of our business. It includes documents in both paper and digital format.

CADD Standards

All files must be created using Bentley MicroStation V8i and InRoads Version 8.05 or greater.

For file naming convention, see Appendix O, *File Naming Convention*.

Project Directory must be created in accordance with Appendix D*, File and Folder Structure*.

Create output files in according to Appendix G, *Contents of File Deliverables*.

Create an as-constructed survey drawing.

Appendix A – Survey Standards Detail

Geodetic Control Network

The geodetic control network used by the City references the following:

Horizontal Datum

The North American Datum of 1927 (NAD27). Must be able to supply information in “The North American Datum of 1983 (NAD83)” when legislated by the Province of Ontario.

Vertical Datum

CGVD 1928 (Pre-1978 Adjustment)

The Projection

Modified Traverse Mercator Projection (MTM)

The parameters are as follows:

- Zone name = Zone 10
- Zone width = 3 degrees
- Longitude of Origin = –79.5
- Latitude of origin = 0
- False Easting (X) = 304800m
- False Northing (Y) = 0
- Scale Reduction = 0.9999

Sub-control

Elevation: Second order

Class 1 – control for large engineering projects

- Double run: forward and backward each section
- Maximum length of sight: 60m
- Maximum difference in length: 5m
- Maximum closure: 6mm x square root of km

Class 2 – for engineering projects and support for local survey

- Double run or single run
- Maximum length of sight: 70m
- Maximum difference in length: 10m
- Maximum closure: 8mm x square root of km

Other Considerations Related to Control Setup

Run fly levels between at least two Geodetic Bench Marks (BM).

Establish geodetic elevations on all Geodetic Horizontal Control Monuments (HCM) and project Control Points (CP).

All Back Sights (BS) and Fore Sights (FS) on fly levels must be estimated to the nearest 0.001m, to minimize any rounding off errors in closures.

Difference in elevation between adjacent bench marks's as obtained from fly levels and check-flys, not to exceed 6mm.

Do not use Intermediate Sights (IS) on fly levels.

Adjust and balance elevation if misclosure is within the tolerances of:

- 10 mm in 1st km, or
- 8 mm x square root of km

If tolerances are greater than (a) or (b) then the fly levels must be corrected and re-run.

Horizontal

As with all traverses the following standards shall apply.

Any project control points set with a closed traverse, must start from two fixed horizontal control monuments and close on two fixed horizontal control monuments.

Azimuth closure at azimuth check p'oint not to exceed 6 inch per station or 15 inch x square root of number of stations.

After azimuth adjustment, the position closure should not exceed 1 part in 7,000 (Third Order Class 1 of 1/10,000 is preferred). If the error is greater, then the traverse must be rerun and corrected.

Project control points may be set using the Free Station Establishment Program. However, attention must be paid to the geometry of the existing horizontal control monument's so that a distortion is not created. At least three existing horizontal control monuments are used for this procedure.

Graphic Files

The standard graphic user interface for the City Engineering Surveys is MicroStation V8i (Bentley Systems, Incorporated).

The electronic field book information must be processed using InRoads software (Bentley Systems, Incorporated) in accordance with the City Engineering Survey unit standards.

The following resource files are to be used to create MicroStation design files with InRoads software.

Resource file name	**Resource file purpose**
EngSrv_v8i_v020200.xin	InRoads XIN
EngSrv_Elevv8i_v020200.xin	InRoads XIN for Elevation Drawing
EngSrv_V8_Cells_V020200.dgnlib	MicroStation V8 Cell library
EngSrv_V8_Levels_v020200.dgnlib	MicroStation V8 Level library
EngSvy_Linestyles.rsc	MicroStation Custom LineStyle resource file
EngSrv_V8_Seed.dgn	MicroStationV8 3-D seed file

EngSrv_V8_2D_Seed.dgn	MicroStationV8 2-D seed file

Note:

- For correct working units use EngSrv_V8_Seed.dgn as the seed file.
- For correct display the MicroStation default colour table (color.tbl) is used.
- No custom fonts are used.
- All annotation in InRoads uses MicroStation delivered fonts.
- These resource files will be provided by Engineering Surveys unit.

Appendix B – Field Notes

Field notes should contain a clear and detailed account of everything found, done, and observed in the field, in the course of the survey and shall show:

- A North arrow
- Description and location of survey
- Date on each page and the names of the crew's members or their initials
- A job number and a contract number if available.
- Identify offset lines and traverse lines.
- Pages should be numbered, and each page should indicate the total number of pages used.
- Annotate the occupied stations interline points, points of intersection and so on.
- Reference to record of field calculations.
- After the field survey has been completed, entries on hardcopy field notes found to be incorrect should not be erased but stroked out in such a manner that they remain legible, but obviously discarded.
- Field notes should be recorded at the time of observation and where it is deemed necessary to redo field notes, the original field notes should be retained and attached to the copies.
- A copy of all the construction related control and layout notes/data must be provided such as layout reports, drawings, control points and referencing documents.

Appendix C – Line Connectivity

Numeric coding shall be used when completing Engineering Survey projects. All coding components are numeric, separated by dots instead of spaces. There are three parts to each numerically coded feature. The first part identifies the feature, second part identifies the line number, and the third part is the control code.

For example, when shooting the gutter (CURB Bottom at Gutter) on the right side of the road, the feature would be coded as below.

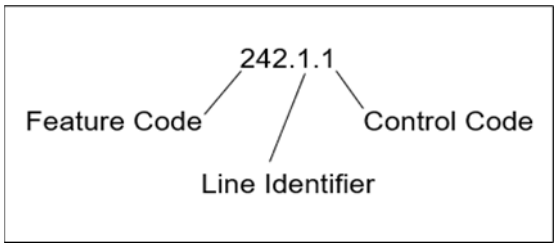

Figure 1: Line connectivity code example

All linework must be connected using the numeric control codes listed in Figure 2 below.

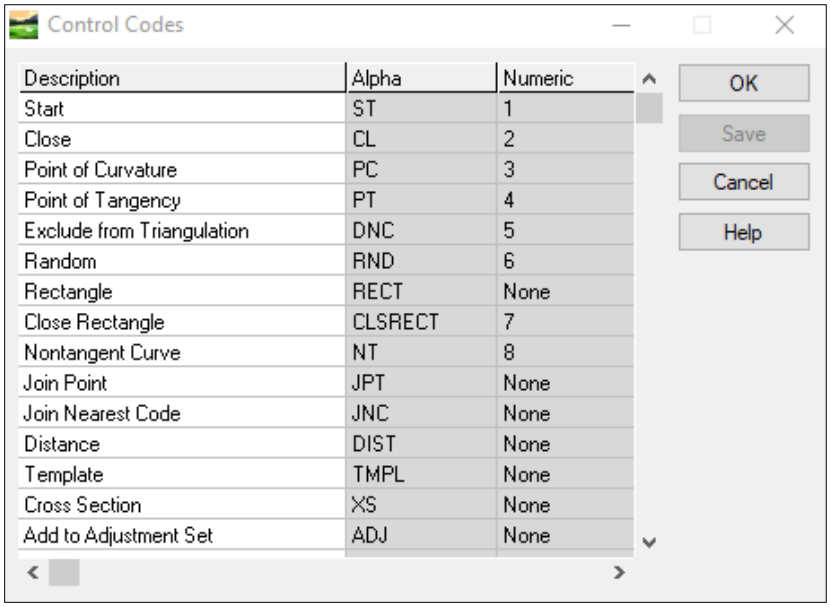

Figure 2: Line connectivity control code list

A set of “CURB Bottom at Gutter” shots would be coded as follows:

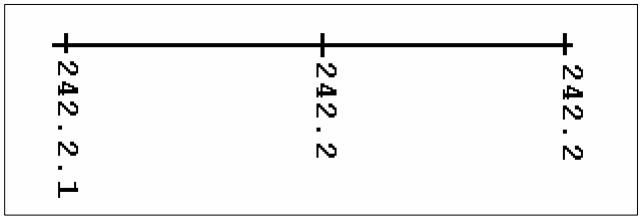

Figure 3: Line connectivity example: Curb bottom at gutter

The first shot includes the feature code (242), the line identifier (2) indicating the right side of the road (2) and the control code (1) indicating the start of a breakline. The subsequent shots along the feature include only the feature code and the line identifier.

A breakline with a curve would be coded as follows:

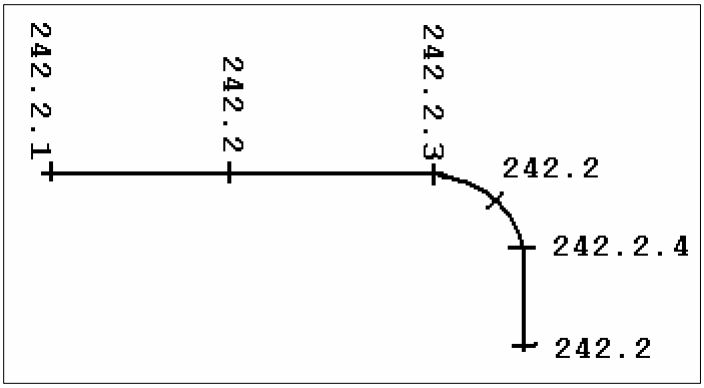

Figure 4: Line connectivity example: A breakline with a curve

The shot coded as 242.2.3 indicates the Point of Curvature (PC) and the point coded as 242.2.4 is the Point of Tangency (PT).

Appendix D – File and Folder Structure

File Structure

For file structure details, see Appendix O, *File Naming Convention.*

Folder Structure

Folder structure should be set up as follows:

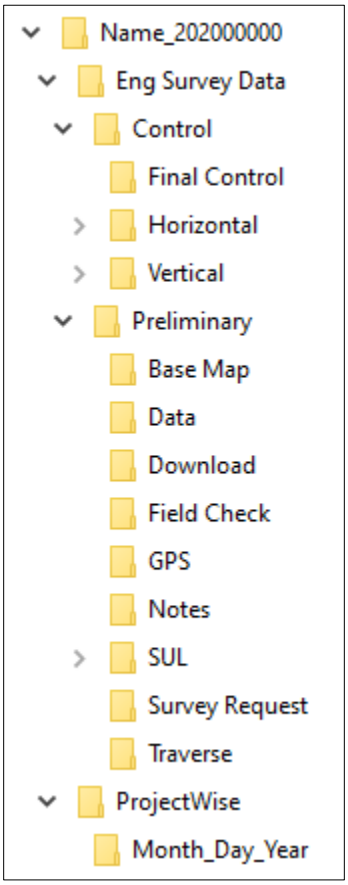

Figure 5: Project folder structure

Note:

Final deliverable files should be placed in the ProjectWise subfolder; Month_Day_Year.

The folder should be named to reflect the date the files were delivered.

All working files should be saved in the Eng Survey Data folder.

Appendix E – Content of a Survey Folder

Check List

The content should be checked at the end of each project phase.

Pre-engineering Phase

- Used horizontal control monuments and their mark-up COontrol Survey INformation Exchange (COSINE) sheets
- Used geodetic benchmarks and their COSINE sheets
- Field notes as described in Appenidix B, *Field Notes*: cover page, traverse, level and sketch
- Control adjustment report
- Digital list such as text, Excel formats of final co-ordinates and elevations for the horizontal control monuments and project control points.

Construction and Layout Phase

- Design – engineering – drawings and proposed layout
- Digital record of offset points
- Reference note to any changes or revision
- Grade sheets

As-built Phase

- Used horizontal control monuments and geodetic benchmarks and their COSINE sheets
- Field note: cover page, sketch, utility depths and dimensions
- Survey report (optional)

Appendix F – Graphic Specifications

For feature code table details, refer to *Engineering Surveys Microstation V8i Graphic Specification* Manual.

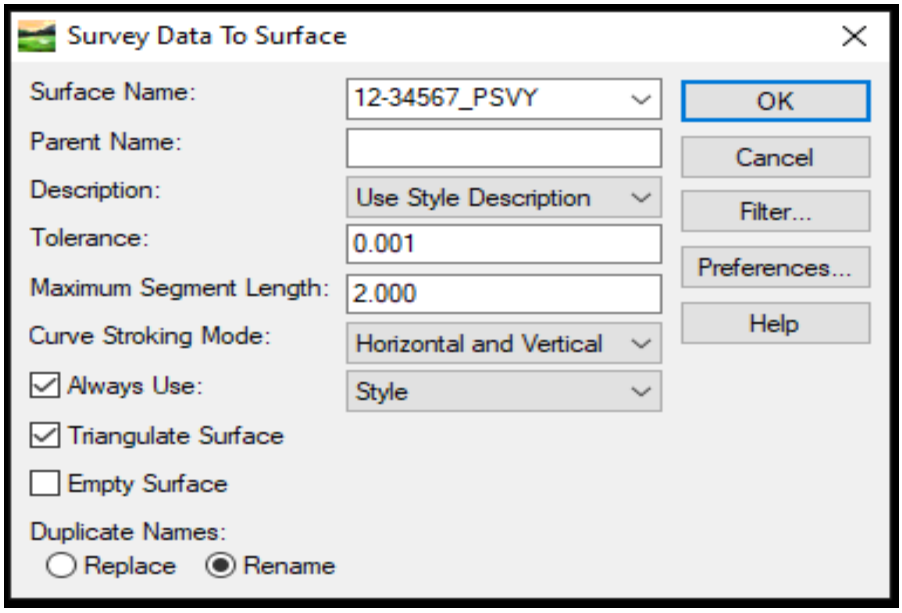

Figure 6: Setting options for survey data to surface, InRoads – Step 1

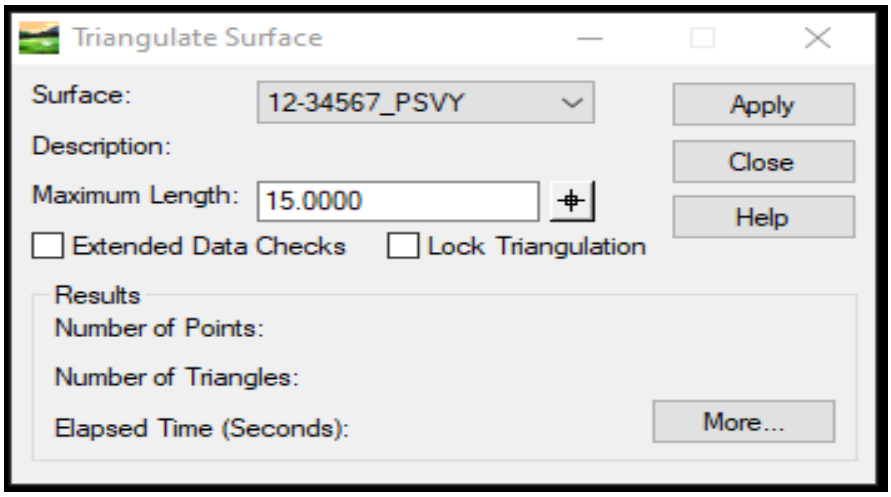

Figure 7: Setting options for triangulate surface, InRoads – Step 2

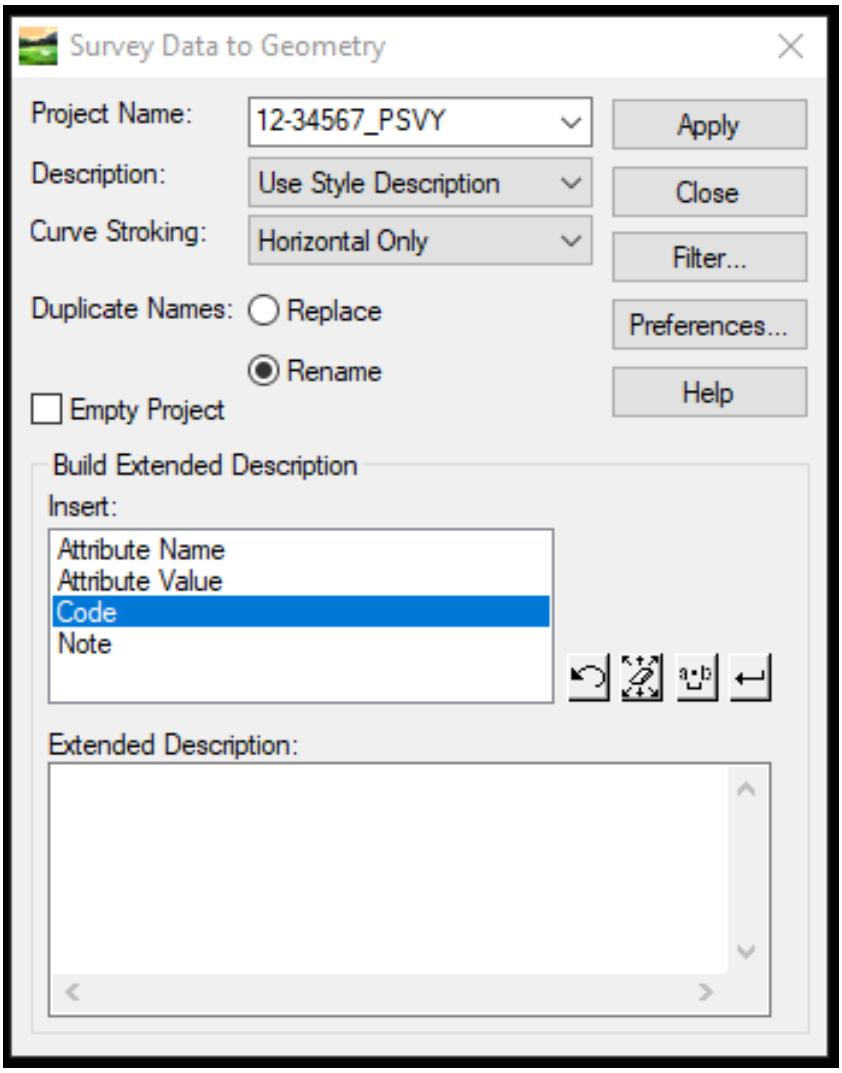

Figure 8: Setting options in survey data to geometry, InRoads

Appendix G – Contents of File Deliverables

Deliverables

The following contents shall be included as part of the survey folder file deliverables:

GNSS Raw File: File containing Datum and Parameters used, number of satellites acquired, and multiple initializations on established control points.

Traverse Report: File showing all errors, method and parameters used to apply corrections.

3 Dimensional Drawing (dgn): A graphical representation of existing conditions containing the field pick-up points in a three dimensional drawing which uses the design standards set out by the District Design groups such as levels, weights, styles, colours, cells and so on.

2 Dimensional Drawing (dgn): A graphical representation of existing conditions containing the field pick-up points in a two dimensional drawing which uses the design standards set out by the District Design groups such as levels, weights, styles, colours, cells and so on.

Elevation Drawing (dgn): A graphical representation containing only the elevations of each point picked up in the field of the existing conditions. The elevations are written graphically to the appropriate levels dictated by the XIN with reference to the feature picked up.

Digital Terrain Model (dtm): Bentley InRoads file containing the triangulated surface exported from existing survey data dictated by the XIN. For more details, see Appendix F, *Graphic Specifications*, Figure 6 and 7.

Geometry Project (alg): A Bentley InRoads file containing horizontal alignments exported from existing survey data. Features included are Crown of Road, Curb Front at Road or Edge of Pavement, Bottom of Curb at Gutter, Top Back of Curb, Front of Sidewalk, Back of Sidewalk, and one other line running parallel behind the sidewalk or curb if no sidewalk is present.

For geometry details, see Appendix F, *Graphic Specifications*, Figure 8.

Ascii Text file (txt): This file contains all existing survey points. This file formatted as a comma delimited point file should include the following information:

- point number
- northing
- easting
- elevation
- feature code.

Utilities depth report (csv): This file contains the centre point location of all utility lid such as northing, easting and elevation locations as well as the measured invert depths, invert elevations and direction of the invert. For watermains, top of pipe and/or top of spindle depth measurements are required.

To see a sample report, see Appendix H, *Subsurface Utilities Requirements.*

Appendix H – Subsurface Utilities Requirements

Point Name	Northing	Easting	Elevation	Code	Depth_N	Depth_NE	Depth_E	Depth_SE	Depth_S	Depth_SW	Depth_W	Depth_NW	Top of Pipe (Water)	Top of Spindle (Water)	Floor (Water)	Comments
2311	4841121.872	314655.464	146.995	538		2.1					2.25					NE Pipe 250mm_ W Pipe 300mm_ E Pipe END
2406	4841144.359	314665.122	148.212	613									2.08	1.54	2.18	
2407	48 41144.508	314667.487	148.28	538			1.72		1.73		1.38					E Pipe 250mm_ W Pipe 350mm_ S Pipe 300mm
2408	4841143.049	314667.675	148.214	538	1.7		1.6		1.75							N Pipe 200mm_ E Pipe 200mm_ S Pipe 200mm
2409	4841138.616	314662.842	147.901	613												MH Stuck
2415	4841132.084	314658.097	147.517	613									2.0	1.42	2.26	
2557	4841228.968	314655.023	153.218	538	1.55				1.57							N Pipe 300mm_ S Pipe 400mm
2696	4841245.512	314643.861	154.388	538	1.8						1.81					N Pipe 100mm_ W Pipe 200mm
2779	4841264.663	314650.466	155.139	538	1.53				1.48		1.38					N Pipe 250mm_ S Pipe 200mm_ 11 150mm

Figure 9: Sample utility depth report for subsurface utilities

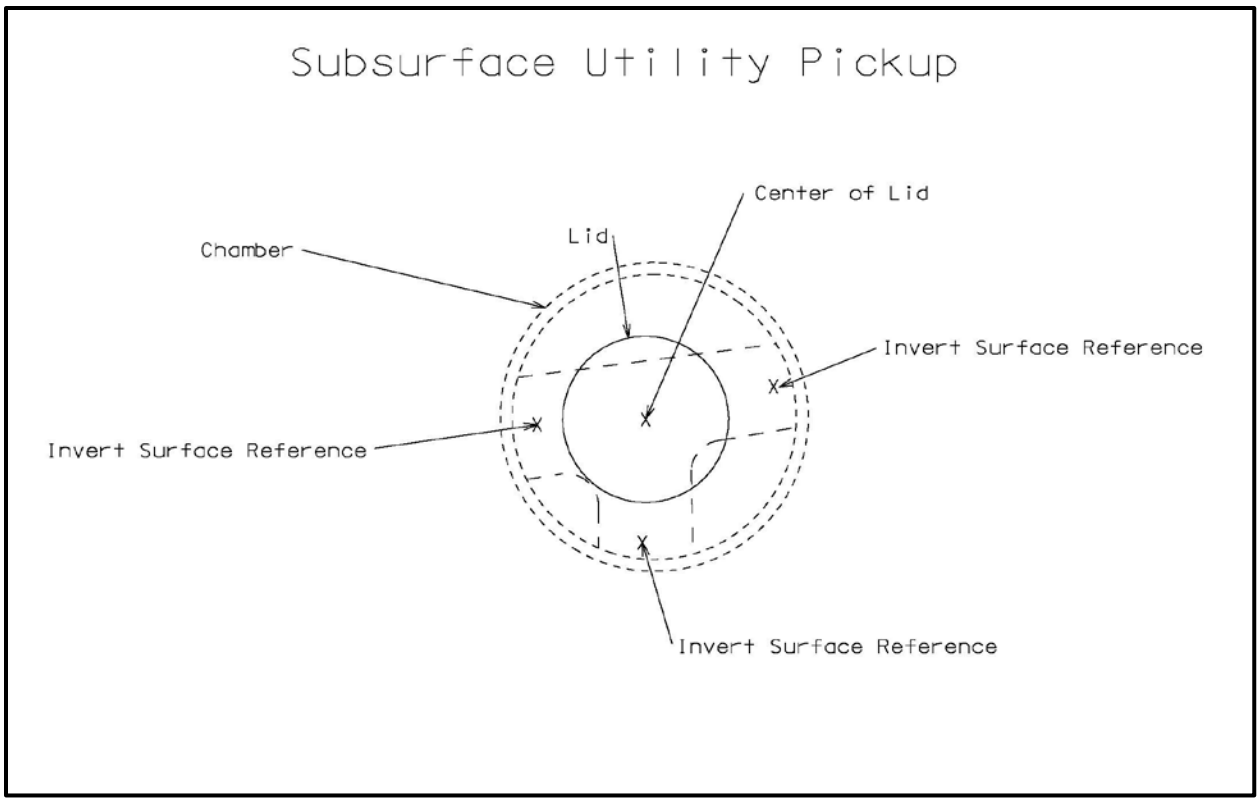

Figure 10: Illustration of subsurface utility pickup

Appendix I – Intersection Survey Requirements

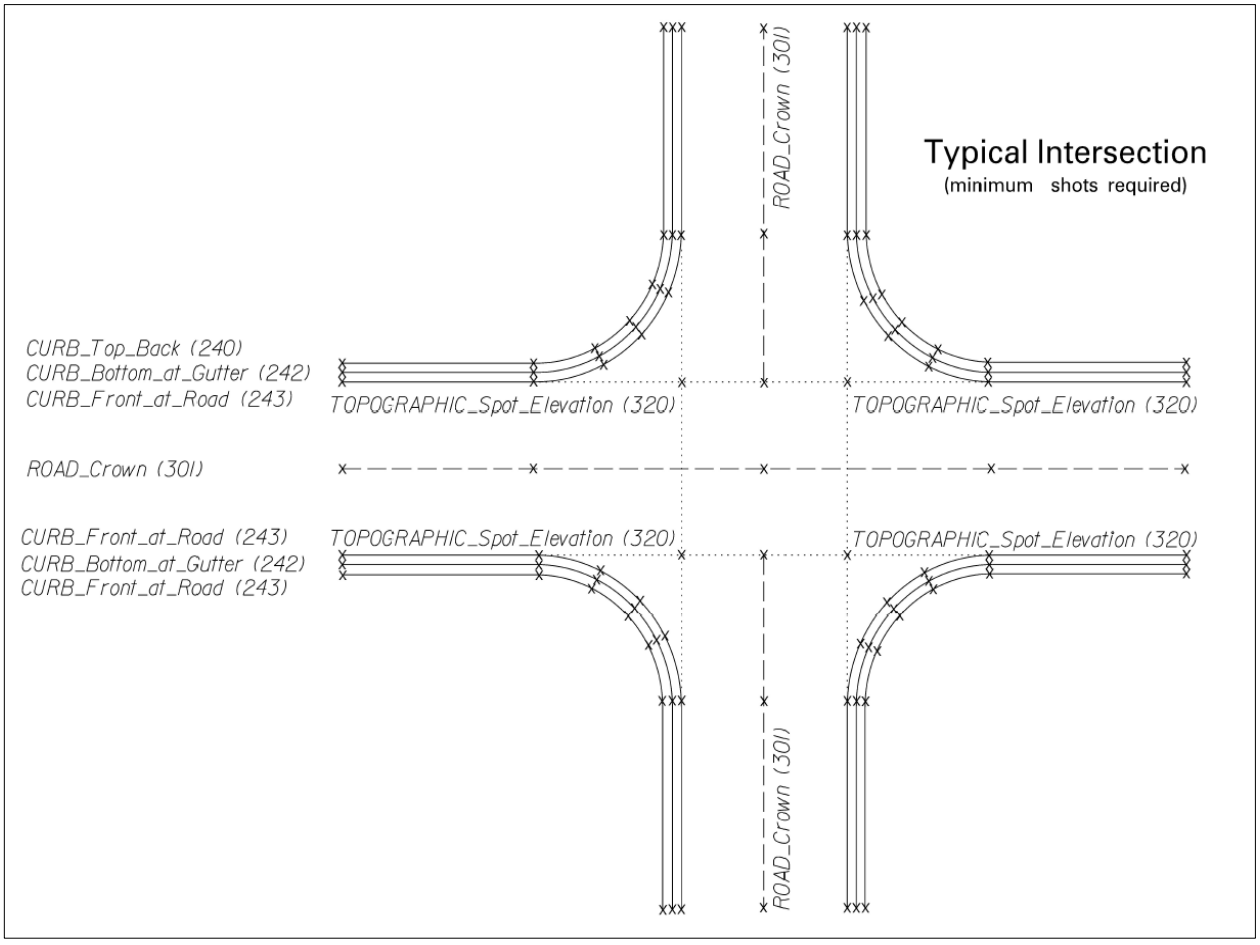

Figure 11: Typical intersection minimum survey shots required

Appendix J – Catch Basin Survey Requirements

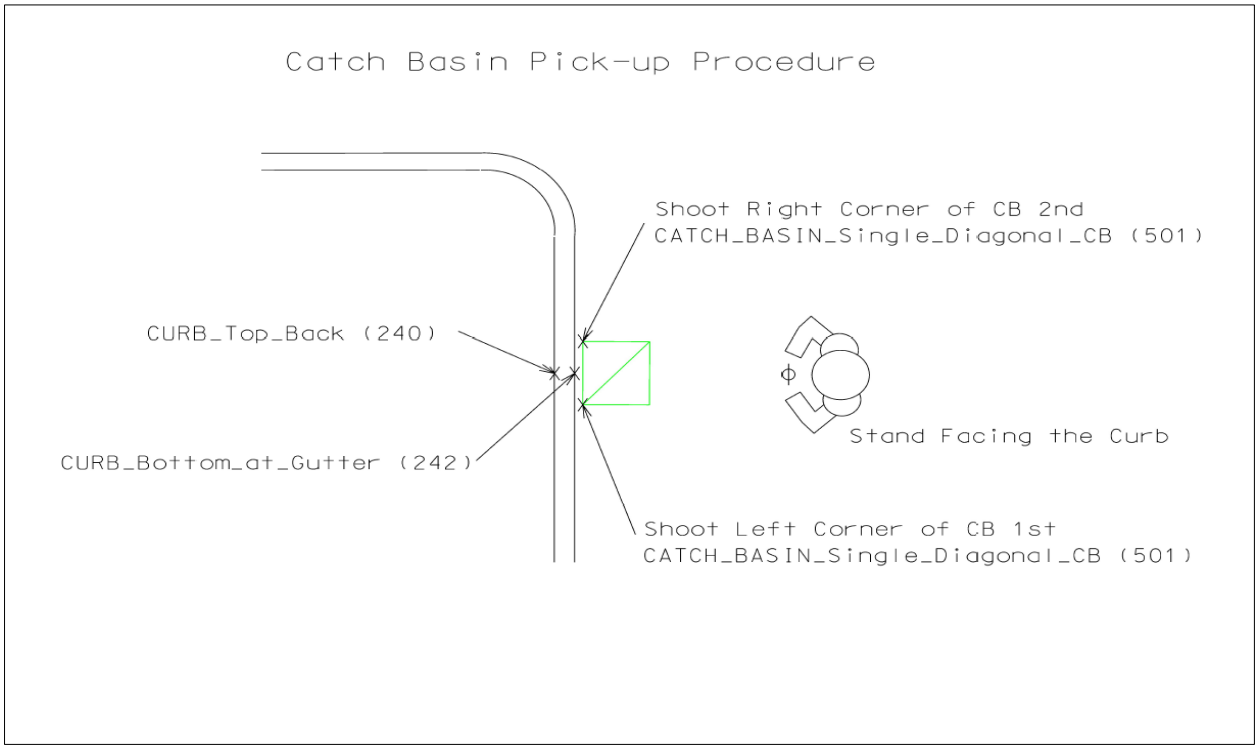

Figure 12: Survey requirement and pick-up procedure for typical catch basin

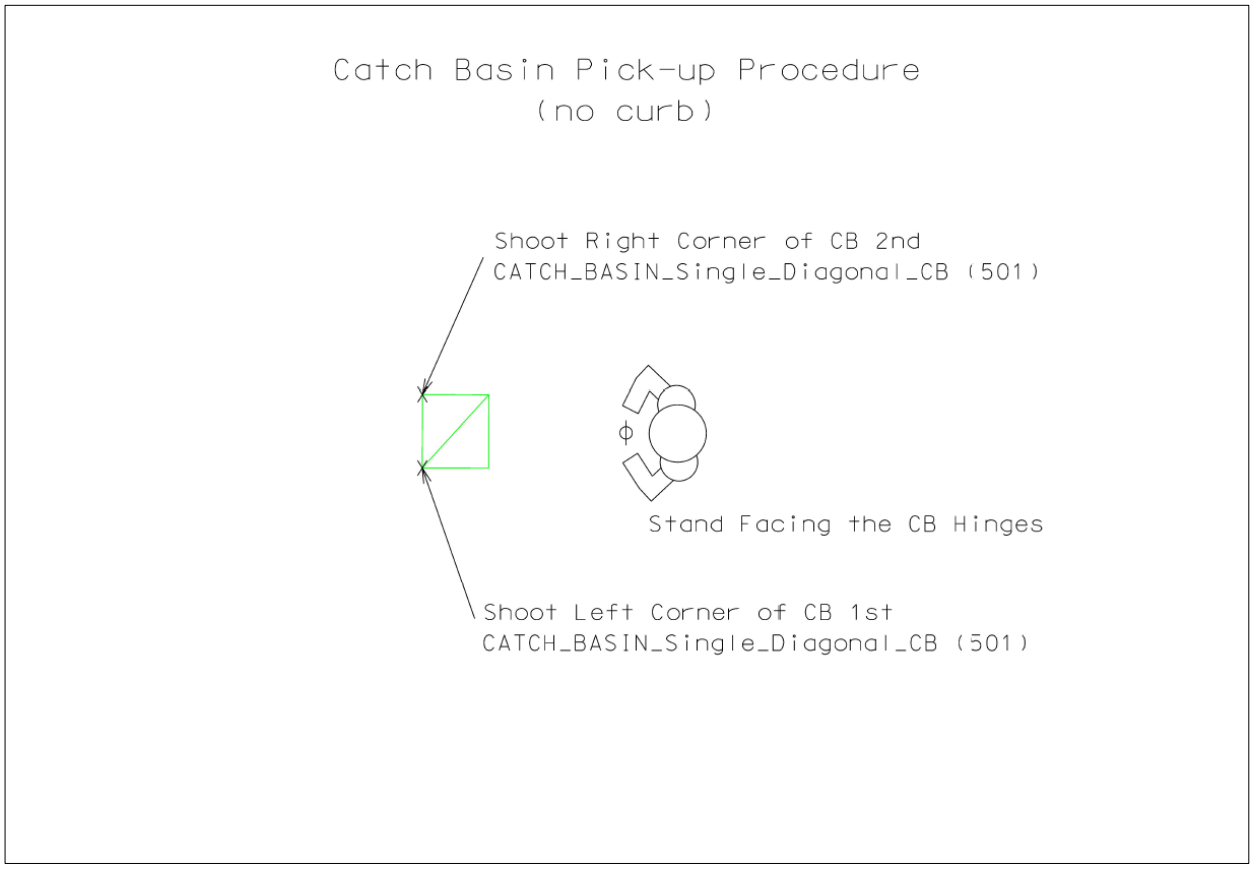

Figure 13: Survey requirement and pick-up procedure for catch basin with no curb

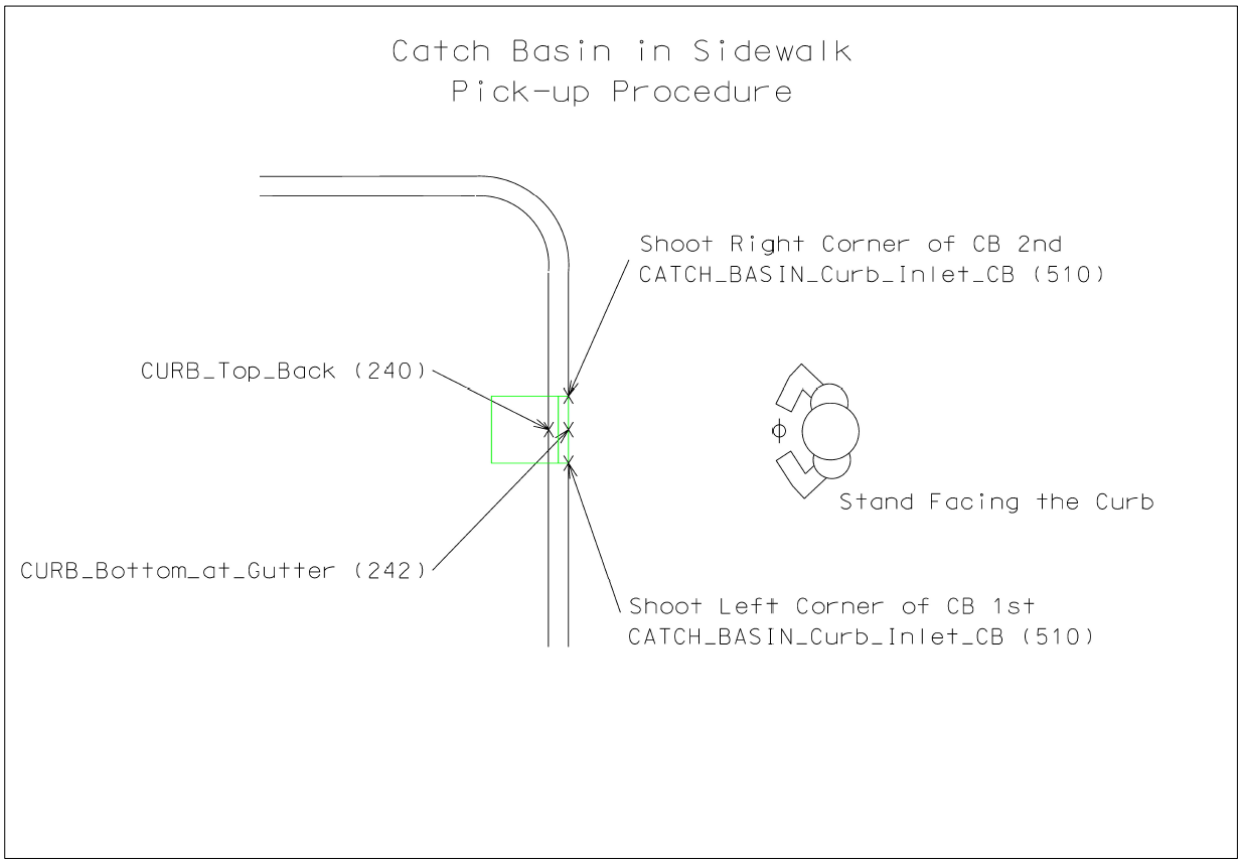

Figure 14: Survey requirement and pick-up procedure for catch basin in sidewalks

Appendix K – Curb Depression Survey Requirements

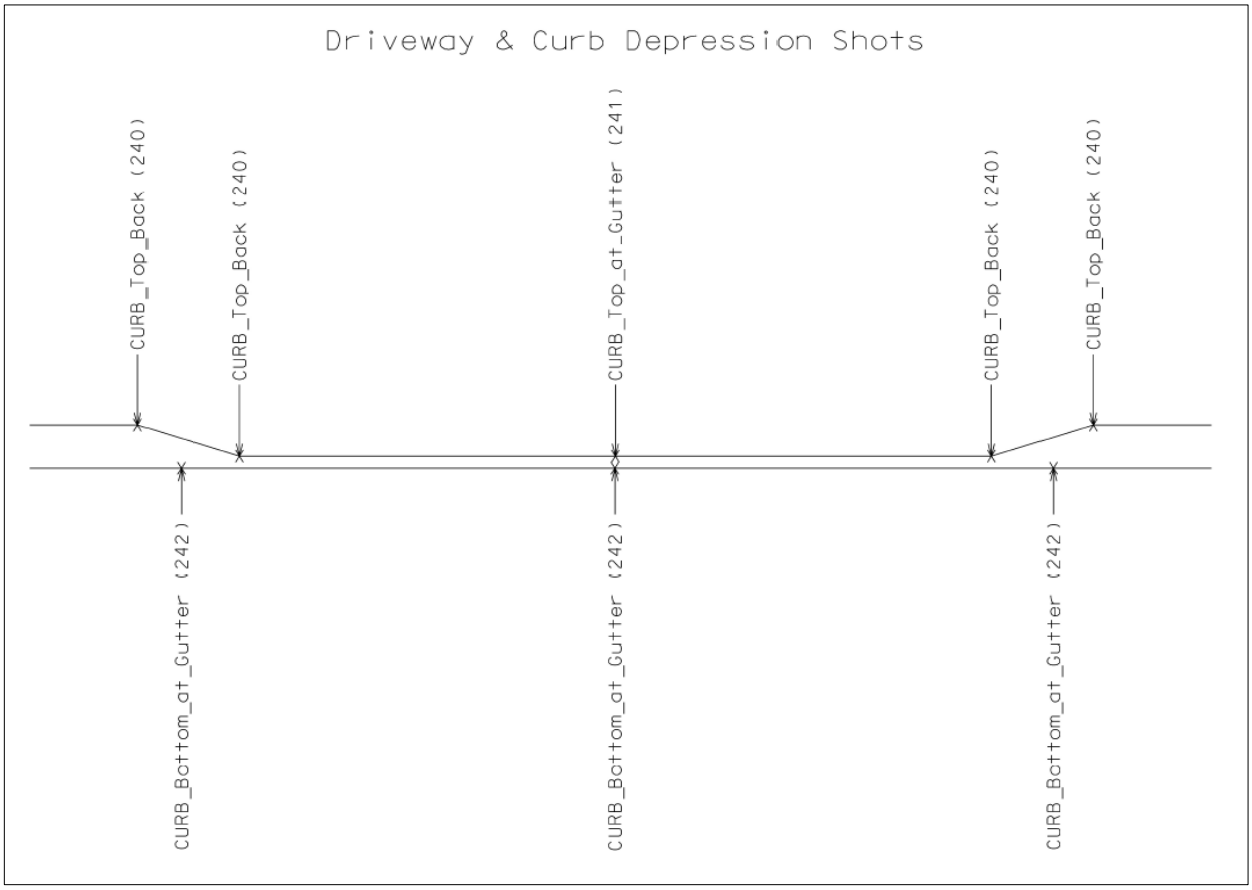

Figure 15: Typical curb depression survey requirements with descriptions and codes

Appendix L – Typical Survey Requirements

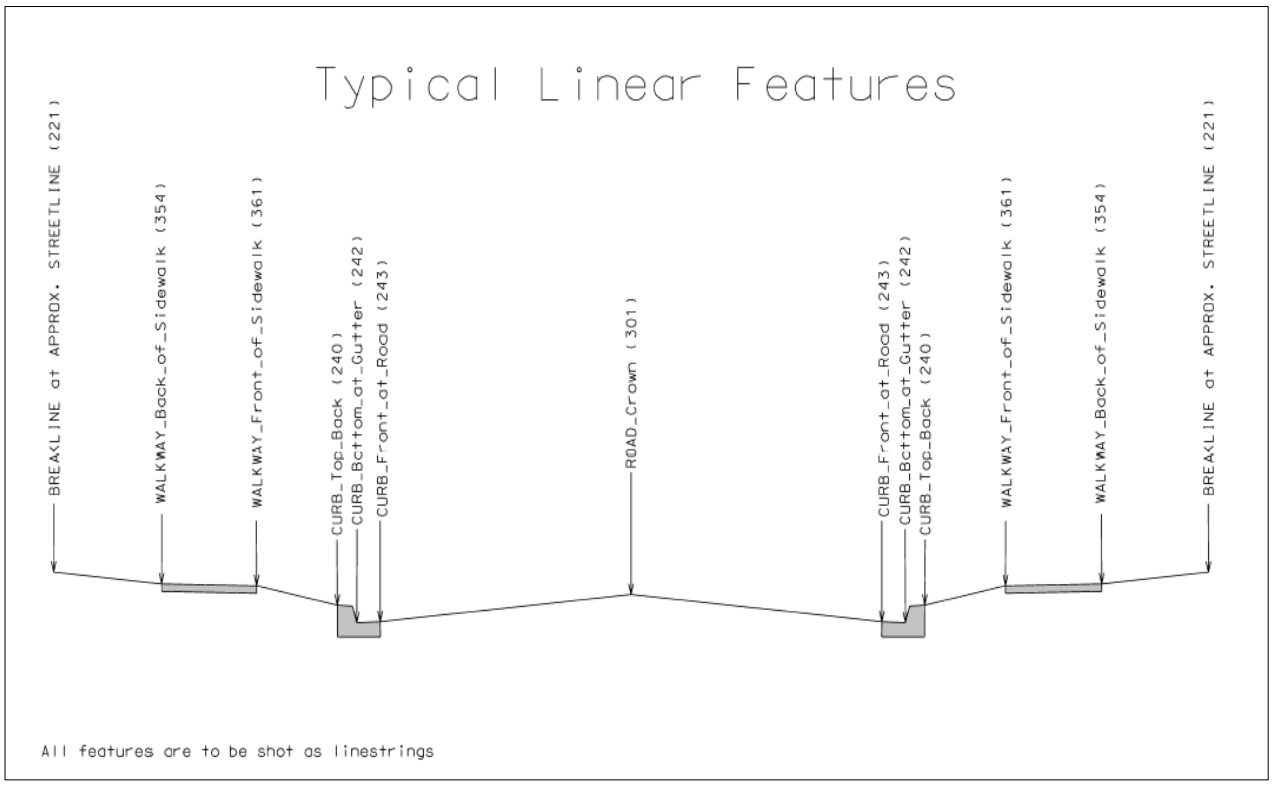

Figure 16: Typical linear feature for road cross-section with descriptions and codes

Appendix M – Pedestrain and Sidewalk Ramp Survey Requirements

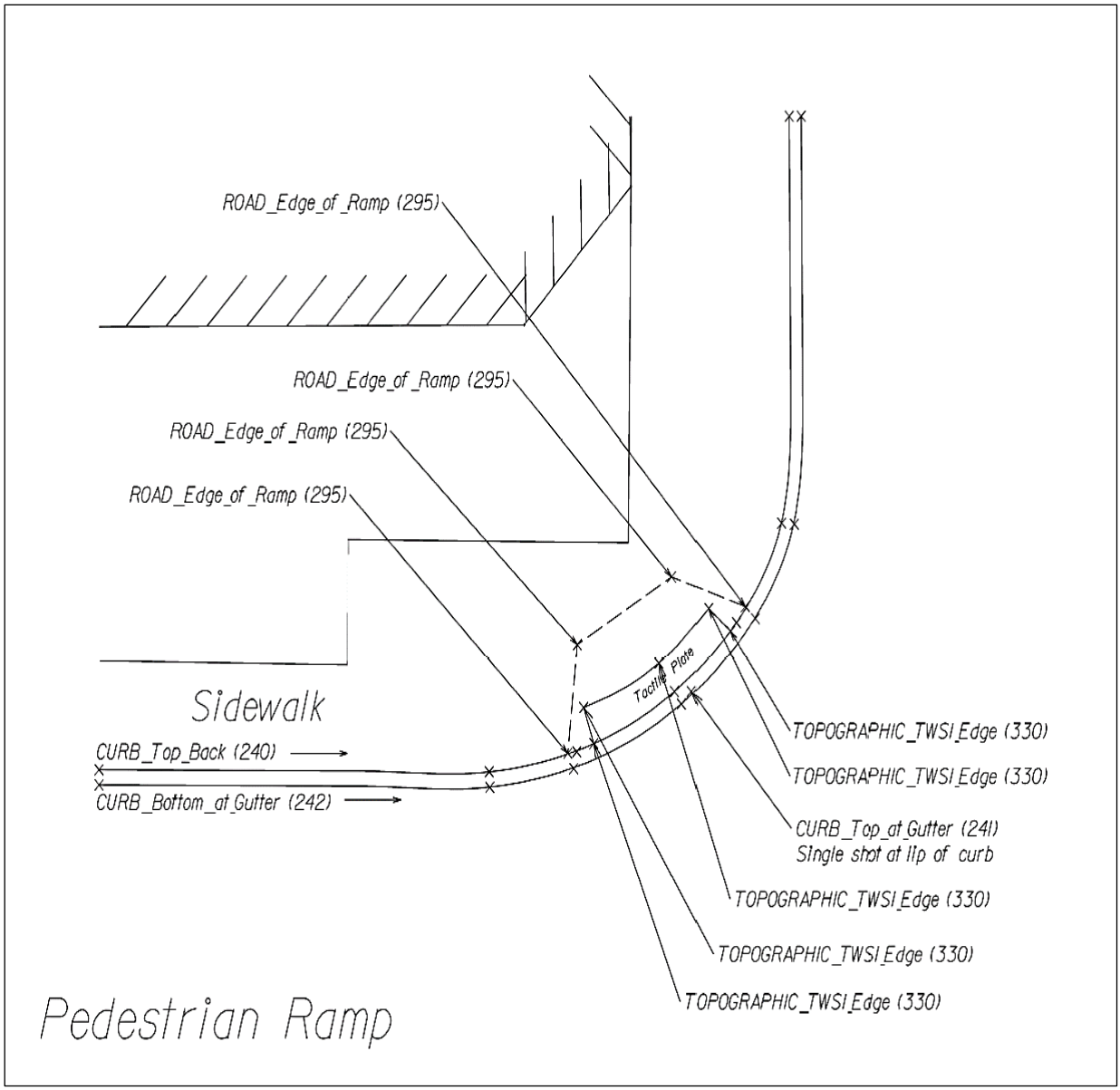

Figure 17: Survey requirement and pick-up for pedesetrain and sidewalk ramps

Appendix N – Driveway Curb Ramp Survey Requirements

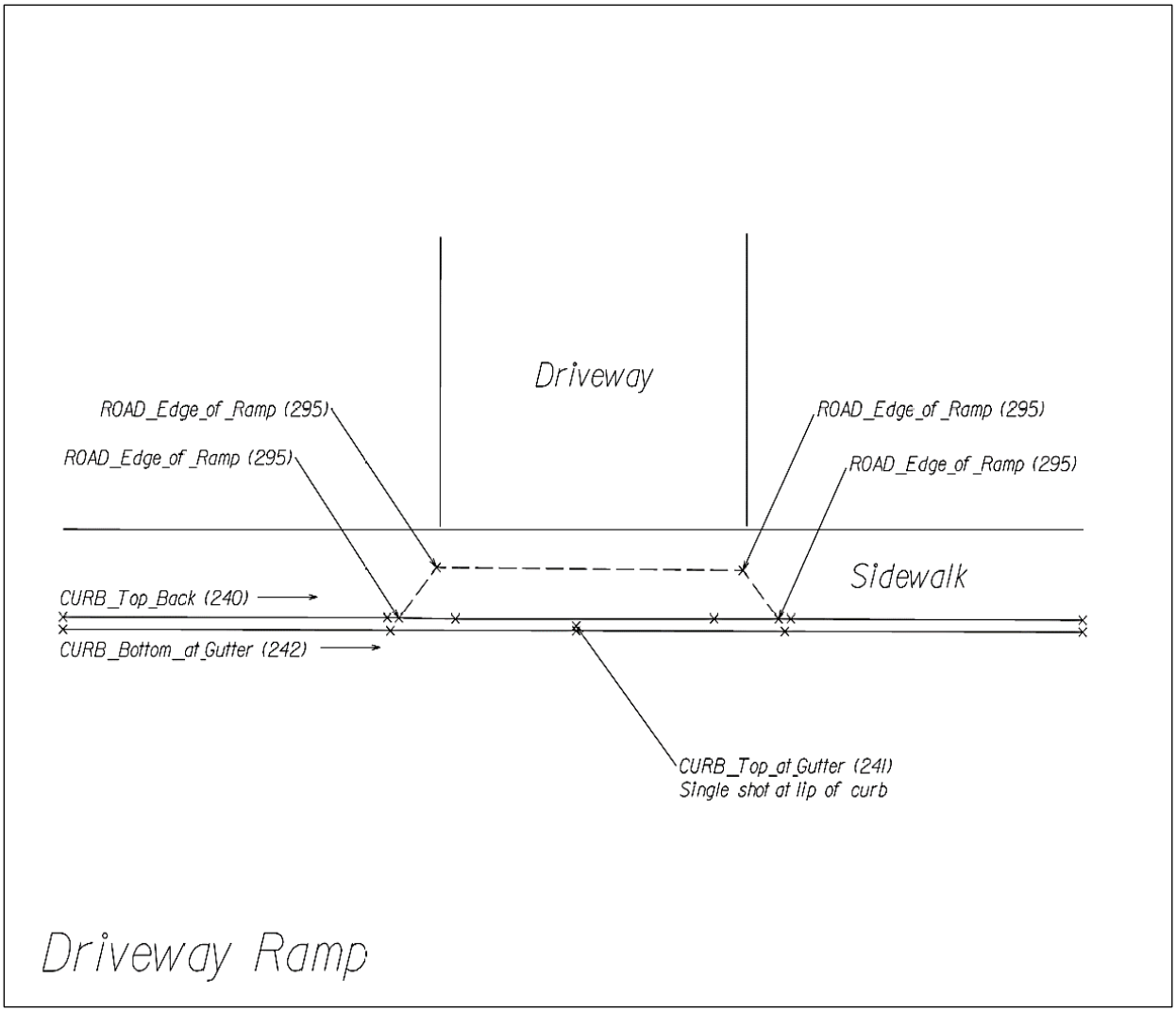

Figure 18: Survey requirement and pick-up for driveway ramps

Appendix O – File Naming Convention

The Engineering Surveys unit file naming convention is a combination of prefixes, suffixes, and the project number.

The proposed naming convention would be as follows: 12-34567_*SVY.***

- Project number is used for tracking the ongoing project: 12-34567_*SVY.***
- The inclusion of the SVY denotes that the files are produced through direct surveying: 12-34567*SVY.***
- The prefix denotes the type of survey: 12-34567*SVY**.***
- The suffix denotes the type of drawing. A suffix would only be used for certain drawings: 12-34567*SVY**.***

The proposed prefixes are:

- P – preliminary survey — pre-engineering
- F – final survey — as-built
- M – miscellaneous survey, for example sod, asphalt, area measure-ups and so on
- B – base mapping
- L – digital layout files
- U – utility depth report

The proposed suffixes are:

- 2D – 2-dimensional drawing
- EL – elevation drawing

Note: 3-dimensional drawing would have no suffix.

Examples:

Preliminary	
12-34567_PSVY2D.dgn	2 Dimensional MicroStation Drawings
12-34567_PSVY.dgn	3 Dimensional MicroStation Drawings
12-34567_PSVYEL.dgn	Elevation MicroStation Drawing
12-34567_PSVY.alg	In-Roads Geometry Project
12-34567_PSVY.dtm	In-Roads Digital Terrain Model
12-34567_PSVY.txt	Point Text File (Pt, N, E, Elev, Code)

As-built	
12-34567_FSVY2D.dgn	2 Dimensional MicroStation Drawing
12-34567_FSVY2D.dgn	3 Dimensional MicroStation Drawing
12-34567_FSVYEL.dgn	Elevation MicroStation Drawing
12-34567_FSVY.txt	Point Text File (Pt, N, E, Elev, Code)

Base mapping	
12-34567_BSVY.dgn	12-34567_BSVY.dgn

Miscellaneous

12-34567_MSVY.dgn	Microstation drawing

Appendix P – Sewer and Watermain Design As-built Required Features

This appendix is to be read in conjunction with the as-built drawing sections in Chapter 4, *Field Construction Procedures* and Chapter 5, *Development Engineering / Engineering Transit Review* of the Field Services Manual.

In the case of rehabilitating existing sewers, maintenance holes, appurtenances, and structures, capture the dimensions after rehabilitation.

Storm Drainage

Storm drainage features are intended to move rainwater and groundwater. As-built drawings will indicate all necessary information about the storm drainage system to evaluate whether the constructed features will be able to function as intended by the design. Information will be field verified or surveyed or both as outlined in the following table. The following table indicates what features are required and by whom should provide the information.

Table 1: Storm drainage features

Storm drainage features	Field verify (contractor and inspector)	Survey (engineering surveys unit or consultants surveyors)	Indicate on as-built drawing (drawing preparer or engineer)
pipe	size, material, class of pipe, bedding type, drop pipe size	inverts, drop pipe inverts, location of end of stub or bulkhead	Redraw pipe on drawing if pipe has moved more than 300 mm horizontally or 150 mm or more vertically. Recalculate slope on record length and surveyed inverts. Indicate new information on plans such as slope, length, and diameter and so on.
catchbasins, maintenance holes, outfalls, inlet structures	size, type, cover type, safety platforms, flow regulator, overflow, weir, grate type	rim elevation location of feature, overflow weir invert inlet /outlet inverts	Redraw structure on drawings if it moved 300 mm or more. Indicate new information on plans such as size, type and so on.
culverts	size, material, shape, seepage collars	location of ends of culverts and inverts	Redraw culvert on drawings if has moved more than 300 mm. Recalculate slope based on recorded length and surveyed inverts. Indicate new information on plans such as slope, length, and diameter and so on.
subdrains	pipe locations, material, cleanout locations		Redraw subdrains on drawings if it moved 300 mm or more.
laterals	size, material, class, bedding		Indicate locations on plan.
other drainage features			Redraw feature on drawings if it moved 300 mm or more.

Stormwater Management

Stormwater management features are intended to control the rate and quality of the rainwater runoff. As-built drawings will indicate all necessary information about the stormwater management system to evaluate whether the constructed features will be able to function as intended by the design. Information will be field verified or surveyed or both as outlined in the following table. The following table indicates what features are required and by whom should provide the information.

Table 2: Stormwater management features

Stormwater management features	Field Verify (contractor and inspector)	Survey (engineering surveys unit or consultants surveyors)	Indicate on as-built drawing (drawing preparer or engineer)
storage tanks	material, type, size, control systems such as orifice size and weir dimensions	control structure location, control elevations such as orifice inverts, weir elevations bottom elevations and access locations	Redraw structure on drawing if moved more than 300 mm horizontally or 150 mm or more vertically. Indicate new information on plans such as size, type and so on.
ponds	size, shape	control structure location, control elevations such as orifice inverts and weir elevations overflow elevation topographic survey including bottom elevations final volumes	Redraw pond on drawing if moved more than 3.0 m or more. Recalculate volume based on water surface shape and depth. Indicate new information on plans such as size, type, volume and so on.
wetlands		boundary of created or modified wetlands	Redraw wetland on drawings if moved more than 3.0 m or more. Recalculate volume based on water surface shape and depth. Indicate new information on plans such as size, type, volume and so on.

Table 2: Stormwater management features (continued)

Stormwater management features	Field Verify (contractor and inspector)	Survey (engineering surveys unit or consultants surveyors)	Indicate on as-built drawing (drawing preparer or engineer)
grease interceptor oil/grit separation	size, material, vault, dimensions	horizontal location of four corners of vault where applicable	Indicate vault dimensions and size, inverts.
infiltration systems, French drains	material, size, pipe such as size, type and diameter	inlet invert outlet invert	Redraw feature on drawings if it moved 300 mm or more.

Water Distribution Systems

Water system features are intended to move or hold potable water. As-built drawings will indicate all necessary information about the water system to evaluate whether the constructed features will be able to function as intended by the design. Information will be field verified or surveyed or both as outlined in the following table. The following table indicates what features are required and by whom should provide the information.

Table 3: Water distribution systems features

Water distribution features	Field verify (contractor and inspector)	Survey (engineering surveys unit or consultants surveyors)	Indicate on as-built drawing (drawing preparer or engineer)
pipe and fittings	manufacture–material, size, class, bedding, joint type, fittings, measure distance between fittings–centre of tees, crosses, bends crossing invert–location and invert of any utility crossings depth of pipes during installation at every fitting and appurtenances, vertical bends location where insulation used	top of pipe, location of valve, horizontal location of bends, tees and crosses	Redraw pipe on drawing if pipe has moved more than 300 mm horizontally or 150 mm or more vertically. Recalculate slope on record length and surveyed inverts. Indicate new information on plans such as slope, length, and diameter and so on.
valves in chamber such as gate valve, air valve, and butterfly valve			Redraw structure on drawings if it moved 300 mm or more. Indicate new information on plans such as size, type and so on.

Table 3: Water distribution systems features (continued)

Water distribution features	Field verify (contractor and inspector)	Survey (engineering surveys unit or consultants surveyors)	Indicate on as-built drawing (drawing preparer or engineer)
hydrants	manufacturer hydrant bury depth	horizontal location of hydrant–centre of valve of stem	Redraw hydrant on drawings if it moved 300 mm or more. Indicate new information on plans.
water service lines	material, size, location		Redraw service line on drawings if it moved 300 mm or more. Indicate new information on plans, for example existing size, type, and so on.
mainline flow meters chambers	type, size, vault or box and size	horizontal location of centre of box, horizontal location of four corners of vault, location of lid, rim elevation	Redraw vault or box on drawings if it moved 300 mm or more. Indicate new information on plans, for example, size, type, and so on.
pressure reducing valve chamber	size, vault size, vault drain data	horizontal location of four corners of vault, location of lid, rim elevation	Redraw vault on drawings if it moved 300 mm or more. Indicate new information on plans, for example, size, type, and so on.
backflow devices at street line–exterior to building	device brand type, size, service line size, location of drain	horizontal location of four corners of vault or centre of box	Redraw vault or box on drawings if it moved 300 mm or more. Indicate new information on plans, for example, size, type, and so on.
backflow devices–interior to building	device brand, type, size, service line size, general location within building		

Sanitary or Combined Sewer

Sanitary or combined sewer system features are intended to transport sanitary waste into a collection system. As-built drawings will indicate all necessary information about the water system to evaluate whether the constructed features will be able to function as intended by the design. Information will be field verified or surveyed or both as outlined in the following table. The following table indicates what features are required and by whom should provide the information is shown in parentheses:

Table 4: Sanitary or combined sewer features

Sanitary combined sewer features	**Field verify (contractor and inspector)**	**Survey (engineering surveys unit or consultants surveyors)**	**Indicate on as-built drawing (drawing preparer or engineer)**
maintenance holes	Maintenance hole diameter, type, manufacturer, safety platform, flow restrictors, overflow	horizontal location of centre of maintenance hole, horizontal location of centre of lid, rim elevations and all invert elevations, overflow weir invert	Note all changes and correct elevations.
pipe–gravity sewer main	size, material, class of pipe, bedding type, drop pipe size	length–horizontal length of pipe from centre of manhole to centre of manhole. Inverts, drop pipe inverts, locations of end of stub/bulkhead inverts, drop pipe inverts, location of end of stub or bulkhead	Redraw pipe on drawing if pipe has moved more than 300 mm horizontally or 150 mm or more vertically. Recalculate slope on record length and surveyed inverts. Indicate new information on plans such as slope, length, and diameter and so on.

Table 4: Sanitary or combined sewer features (continued)

Sanitary combined sewer features	Field verify (contractor and inspector)	Survey (engineering surveys unit or consultants surveyors)	Indicate on as-built drawing (drawing preparer or engineer)
pipe and fittings–force main	manufacturer–material, size, class, bedding, joint type, fittings measure distance between fittings–centre of tees, crosses, bends crossing invert–location and invert of any utility crossings depth of pipes during installations at every fitting and appurtenance.	horizontal location of main:	Redraw pipe on drawings if it moved 300 mm or more. Indicate new information on plans, for example, slope, length, size, and so on.
laterals	material, size, locations, backflow valve		Indicate location on plans.
cleanouts	size	rim elevations, centre of box, horizontal location of centre of box	Redraw structure on drawings if it moved 300 mm or more indicate new information on plans.
grease interceptor or oil grit separators	pipe materials, size, vault dimensions and size	horizontal location of four corners of the vault and inverts	Show vault dimensions and size. Show pipe elevations.

Transportation

Transportation system features are intended to transport vehicle and pedestrian traffic. As-built drawings will indicate all necessary information about the transportation system to evaluate whether the constructed features will be able to function as intended by the design. Information will be field verified or surveyed or both as outlined in the following table. The following table indicates what features are required and by whom should provide the information.

Table 5: Transportation features

Trans-portation features	**Field verify (contractor and inspector)**	**Survey (engineering surveys or consultants surveyors)**	**Indicate on as-built drawing (drawing preparer or engineer)** **Redraw on record drawing any and all transportation features listed if moved 300 mm or more.**
pavement	material, depth, width, type – rigid or flexible	elevations	Note all changes and correct locations indicated on plans
curb and gutter	location of face curb		
driveways	location, width, type – commercial or residential		
signage	location, size, type of sign		
sidewalk	location, type – light or heavy, material, width	elevations	
street lighting	height, wattage, material		
monument cases	location, materials		
conduit	location, depth, materials, size, owner		
handwell	location, conduit entrance, type – street lighting, traffic		

Other Utilities

As-built drawings will indicate all necessary information about other utilities to evaluate whether the constructed features will be able to function as intended by the design. Information will be field verified or surveyed or both as outlined in the following table. The following table indicates what features are required and by whom should provide the information.

Table 6: Other utilities features

Other utilities features	Field verify (contractor and inspector)	Survey (engineering surveys unit or consultants surveyor)	Indicate on as-built drawing (drawing preparer or engineer)
other utilities	identify location and depth of all existing utilities encountered and new utilities constructed		Show utilities encountered and their depth.

List of Revisions

Date	Version	Description of change
January 23, 2009	1.1	Addition of sidewalk ramping pick-up diagrams "Appendix O", "Appendix P", "Appendix Q".
February 9, 2009	1.2	Addition of new revised Toronto Water As-Built Feature Requirements “Appendix N” Dated January 2009.
February 25, 2009	1.3	Revised the contact person for the City of Toronto Control Surveys on page 3. Repaired all broken links on pages 6,7 and 15.
March 4, 2009	2.0	Added Engineering Survey Microstation V8 Graphic Specification Reference on Page 13. Amended Page 9 to reflect Microstation V8 files.
October 1, 2010	2.5	Added GPS survey to page 4. Amended "Appendix G" to include GPS. Raw file deliverable. Amended folder structure of "Appendix D". Amended "Typical Intersection" Drawing to include point code numbers.

Date	Version	Description of change
		Amended "Catch Basin Pick-up Procedure" Drawing to include point code numbers. Amended "Driveway and Curb Depression Shots" Drawing to include point code numbers. Amended "Typical Linework Picked Up" Drawing to include point code numbers. Addition of InRoads settings for "Survey Data to Surface" and "Survey Data to Geometry".
February 9, 2023	2.6	Contact/address/title page/ phone numbers/CADD title updates. GNSS title updated from GPS. CADD software title and file naming convention updates.
March 14, 2023	2.6	Updated Appendix E to match service manual, dated June 21. Version 2.6 issued.
April 13, 2023	2.7	Added Purpose and Scope section title. Added additional comments to Purpose section. Added new Scope Section. Update or revised document SUL/SUE, minor changes Section 7.0, 10.0, 11.0.

Date	Version	Description of change
July 18, 2023	2.8	New format, changes to Sections 1.0, 3.0, 6.0, 7.0 and minor changes throughout.
August 20, 2023	2.9	New format, changes to Sections 2.0, 4.0, 5.0, 7.0, 8.0, 9.0 and minor changes throughout.
September 14, 2023	2.9	Reference correction to Section 3.0 and minor change to Section 4.0 with edits and updates throughout.
May 1, 2024	3.0	Document updated to new template and re-processed to meet AODA standards to reflect the City's Digital Accessibility Standard (PDF) and Corporate Accessibility Policy.

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