WATERCOURSE MAPPING STANDARDS
VER. 2.0

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WATERCOURSE MAPPING STANDARDS: MUNICIPALITY OF ANCHORAGE
VER. 2.0

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INTRODUCTION

Maps of local hydrography are critical to a variety of Municipality of Anchorage (MOA) activities, including flood and storm water drainage planning, design, and regulatory oversight, and environmental management of receiving waters. Mapping requires application of feature classification, representation and location standards. Definitions used in classification of hydrographic features relevant to environmental and storm water management are described in the Watershed Management Services Division (WMS) document "Municipality of Anchorage Hydrography" (WMS document WMP APg04001) and elsewhere. Digital representation of hydrographic features is described in documents supporting the Municipality's Hydrography Geodatabase, including specifically the 'Hydrography GeoDataBase (HGDB) Data Dictionary'. Municipal standards used in locating hydrography features, most specifically watercourses (streams and drainageways), are described in this document.

WATERCOURSE MAPPING STANDARDS

Standard methods for mapping Municipal watercourse features (streams and drainageways) are necessary to ensure mapping efficiency and consistent data quality, and to allow users to select and apply comparable data. For all watercourse mapping, feature location accuracy is assessed with respect to the true ground position of the watercourse centerline. However, because mapping may be performed at different accuracies and resolutions, methodologies have been developed to support a hierarchy of mapping quality "levels". Six watercourse mapping levels are established under the Municipality's watercourse mapping program, and are coded in the HGDB digital datasets as follows:

1. Photo Interpretive Mapping
2. Reconnaissance Base Mapping
3. Certified Map-Grade Survey
4. Continuous Map-Grade Survey
5. Controlled Land Survey
6. Unknown Mapping Quality

The MOA performs mapping both to locate new watercourse systems as well as to update existing mapping information. As a result, different levels of mapping accuracy will apply to different segments of individual features. Therefore, the quality ("level") of mapped information for watercourses is an attribute that is assigned to segments of hydrologic features and not to the feature as a whole. The six major mapping levels are described in the following text.

Level 1: Photo Interpretive Mapping

At this level, watercourses are mapped and digitized by using existing mapping and aerial photography to identify features, and then translating identified features to coincide with visible features or indicators observable in digital orthoimagery. This mapping method represents a level of effort that focuses on fast, economical characterization and location of hydrographic features. No field verification or other quality assurance testing is performed. However mappers include features at this mapping level only where reliable existing mapping or definitive photo indicators substantiate the presence of a feature. As a result, for example, lower-order, smaller stream features (typically with bank-full widths of less than one meter) are not mapped.

The method includes three essential steps:

1. digitizing known watercourse mapping and orthoimagery into common map projections
2. "snapping" known mapped features to features visible in the selected orthoimagery
3. applying photointerpretive techniques to confirm, refine and update existing mapping

For example as a first step in stream mapping, existing stream maps and digital orthoimagery are selected and converted to a common map projection. Source maps are compiled from any suitable planimetric map source (including hard copies) along with any available metadata (mapping method, source, date and base map projection). Orthoimagery is any digital orthographic map projections of geographic features presented in a photographic format and prepared from any appropriately controlled telemetry that has been processed to correct for displacement errors resulting from tilt and relief. Orthoimagery may be prepared from aerial photography or from satellite imagery.

After existing maps have been digitally compiled and overlaid on the orthoimagery, stream centerlines from the existing mapping are "snapped" (translated in the horizontal plane) to coincide with the same features observed in the orthoimagery. "Snapping" is manually performed while viewing the orthoimagery at scales of 1:2400 or larger.

After existing mapping has been transferred and "snapped" to match features in the orthoimagery, the resulting digital maps are further refined through photo-interpretation of recent aerial photography. It is at this point that photo-interpreters will apply hydrographic criteria to distinguish between Municipal watercourse feature types (streams or drainageways).

Because field checks are typically not done at the "photo interpretive" level of mapping, identifications of features are based substantially on the local knowledge and professional judgment and expertise of the interpreter. Typically identification and location of mapped features is determined by the nature and reliability of any existing mapping, knowledge of the local area, and by observation of photographic indicators including for stream, for example, tonal and textural signatures, morphology (as viewed in a stereoscopic model), and presence of correlated features. Because quality of final map information is in large part dependent upon the capabilities of interpreters, these interpreters must be proficient in skills appropriate to identifying target features. For example, for streams interpreters should be skilled in the geologic and hydrologic sciences and in analysis of stereo aerial photography and other imagery, and have some knowledge of local geography.

For all features, source photography or other source mapping used by interpreters must provide sufficient detail to allow general identification and differentiation of target features to two meters or less in smallest dimension. In no instance is any mapping modified where the information supporting such modification does not have a higher level of confidence than that supporting the original mapping. Features not identifiable through inspection of magnified stereo inspection of aerial photographic contact prints flown at a scale of 1:12000 or smaller (typically streams less than about one meter wide) may not be mapped except where existing mapping is available. In general, final photo-corrected locations will be compiled so as to achieve *estimated* correct location of 95% of mapped features to within ±25 meters of their true ground position.

Level 2: Reconnaissance Base Mapping

Reconnaissance mapping includes all elements of "photo interpretive" mapping but improves mapping resolution and accuracy through additional iterative photo interpretive and field reconnaissance efforts. At this mapping level, limited field reconnaissance is performed after the initial 'desk-top' mapping. Field reconnaissance focuses on resolving small-scale features (for example, streams with bank full widths less than one meter wide that are not mapped in a Level 1 effort) and in providing some confirmation and refinement of photo-interpreted locations. Level 2 mapping may also include collection of position information using map-grade GPS technology. However, field inspections at this mapping level are performed only with the purpose of ensuring that feature classifications, locations and assigned attributes are representative and generally within stated accuracy limits. Quality control procedures do not include quantitative testing sufficient to confirm that stream centerline locations are statistically within stated accuracy limits.

However, feature location accuracy and resolution is improved at this mapping level as a result of ground truthing and periodic map-grade GPS data collection. Though no quantitative confirmation is made of target location accuracies, final locations will be performed so as to achieve estimated location of 95% of mapped features to within ±20 meters or better of their true ground position. Level 2 Municipal mapping of stream features will generally provide base map information that will conform with horizontal accuracy standards at larger map scales as specified by the Federal Emergency Management Agency (FEMA) in its "Guidelines and Specifications for Flood Hazard Mapping Partners" (April, 2003).

Level 3: Certified Map-Grade Survey

Municipal base map stream surveys are tested and certified to conform with specific horizontal accuracy standards at select map scales as specified by the Federal Emergency Management Agency (FEMA) in its "Guidelines and Specifications for Flood Hazard Mapping Partners" (April, 2003). Reported horizontal locations of any mapped watercourse feature mapped at this level will have a certified positional accuracy with respect to true ground position that is equal to or better than 10 meters (about 30 feet), as confirmed at the 95% confidence level.

Level 4: Continuous Map-Grade and Point Survey Data

At this mapping level, GPS location data are used to *continuously* map entire features or point locations. That is, map-grade GPS techniques are used to accurately locate a series of points sufficient, when connected to form a series of arcs, to accurately represent the location of part or all of a watercourse centerline or a single point to represent a localized feature along that watercourse.

In this method, GPS-located point data is used to continuously locate line and point features. Point features are located by a single GPS feature point. "Arcs" used to map the linear position of features are located through use of a series of GPS data points connected by straight-line segments which, taken as a whole, will describe the *centerline* of the feature. The centerline of a watercourse feature is for streams and natural channelized drainageways the line connecting the midpoints of all surface water cross sections measured at the bankfull stage, or at the stage of the peak flow for a 1.5 year return event. For constructed drainageway features it is the centerline of the channel or pipe feature. The maximum error in the reported horizontal location of the centerline using this method shall be no more than one-half the bankfull width (1.5 year return event) plus 15 feet for streams and natural drainageways, and no more than one-half the feature width for constructed drainageways or point features, at a 95% confidence level.

Level 5: Controlled Land Survey

Controlled land survey mapping incorporates photo interpretive mapping with standardized land surveying techniques (including high-resolution GPS survey methods) to acquire accurate horizontal locations of watercourse features. Similar to map-grade GPS methods, controlled land survey mapping may be used to accurately locate either relatively discrete point features along a watercourse, or an associated series of points that will be used to represent the feature centerline as defined above.

Horizontal accuracy of surveyed points at this level is performed so as to meet nationally established land survey standards, and generally as specified under Municipal controlled land survey standards. However, survey of linear watercourse features using controlled land survey methods must meet additional representational requirements. Specifically, land surveys performed to locate the horizontal position of watercourse centerlines (including those of stream features) for platting or other land survey purposes must be performed such that the horizontal error in reported location of the watercourse centerline with respect to its true ground position shall be no more than one-half the bankfull width plus 15 feet, at a 95% confidence level.

Level 6: Unknown Mapping Quality

In some Municipal areas, existing, older mapping is used to provide basic geographic information. Metadata for this mapping, including information about the map data quality, may be limited or unavailable. Where the Municipality has incorporated hydrographic data into its datasets with incomplete or unknown data quality, a mapping quality level is not assigned.

WATERCOURSE SEGMENTATION

As part of the Municipal mapping process watercourse features may be segmented to reflect characteristic qualities along a particular segment. Both streams and drainageway features may be segmented.

Drainageway watercourse types are partitioned into 'segments' and 'subsegments'. Usually drainageways are segmented on the basis of common conveyance characteristics (open- versus closed conduit, cross sectional geometry, conveyance material composition, etc.). During initial mapping drainageway segmentation is usually performed only at the coarsest level, typically to differentiate between open and closed channel configurations and natural and constructed features. Additional characterization and segmentation may be desirable during later systems analyses and is done at that time.

Each segment of a drainageway is coded with a drainageway identity uniquely distinguishing it from all other segments within the Municipal drainageways map set. The code is comprised of three numbers concatenated from its network, segment and subsegment identities. A drainageway 'network' represents all the drainageway elements that drain to the same single point of discharge (specifically to a receiving water or to an infiltration point). A drainageway network is assigned a code uniquely identifying it for the population of all networks across the entire Municipality. Each part of a drainageway watercourse, then, is first coded to identify the network (the 'NetworkID') within which it is located. Then, its segment and subsegment identities ('SegmentID' and 'SubsegmentID') are assigned (these are unique only within the individual network). Combined, all three codes form the drainageway identity, DWayID, uniquely distinguishing each drainageway segment. Detailed drainageway attributes are referenced to drainageway segments.

Table 1
MOA STREAM ATTRIBUTES AND VALUES

Feature	Attribute	Values	Description
Reach	Reach Slope	0.nnnn (dimensionless)	Ratio of reach endpoint elevation change and reach length
Subreach	Flow Type	Perennial, intermittent	Spatial or temporal continuity of flow
	Convey Type	OpnChannel, pipe, xing, control, continuity, routing	Conveyance characteristic
	Profile Type	1-pool/riffle, 2-estuarine, 3-run, 4-braided, 5-step pool, 6-cascade, 7-bog, 8-multi-channel, 9-flat, 10-piped, 11-continuity	Longitudinal channel character
	Maximum Bankfull Depth	nn.n feet	Max. channel depth to bankfull stage at thalweg
	Mean Bankfull Depth	nn.n feet	Mean depth, bed surface to bankfull stage
	Bankfull Width	nnn.n feet	Mean stream width at bankfull stage
	Width/Depth Ratio	nn.n feet	Ratio of bankfull width to mean bankfull depth
	Floodprone Width	nnn.n feet	Flood surface width at 2x maximum bankfull depth
	Entrenchment	n.n (dimensionless)	Ratio of floodprone width to bankfull width
	Sinuosity	1-s<1.2, 2-1.2≤s≤1.4, 3-s>1.4	Ratio of stream centerline length to down-valley length
	Bed Material	1-d<100μ, 2-100μ≤d<420μ, 3-420μ≤d<25mm, 4-25mm≤d <150mm, 5-150mm≤d, 6-peat/root, 7-bedrock/cemented, 8-armored	Surface channel bottom material
	Bank Material	same as Bed Material	'In-place' bank material
	Roughness	0.nnn (dimensionless)	Manning's n
	CEM Class	1-dynamic equilibrium, 2-vertical erosion, 3-lateral erosion and bed aggradation, 4-aggradation	Channel evolutionary stage
	Channel Modification	1-unmodified, 2-slightly modified, 3-moderately modified, 4-highly modified	Degree of human modification to stream channel
	Undercut Bank	1-uc≤10%, 2-10%<uc≤30%, 3-30%<uc≤50%, 4-50%<uc≤75%, 5-75%<uc	Overarching bank structure with overhang >0.5 feet; 100%=both banks
	Canopy	Same as Undercut Bank	Overarching vegetation cover over bankfull width

Table 1
MOA STREAM ATTRIBUTES AND VALUES

Feature	Attribute	Values	Description
	Fish Habitat	Whole no. 1 to 9 (dimensionless)	Fish habitat index (reflects qualitative presence of 9 elements)
	Invertebrate Habitat	Whole no. 1 to 6 (dimensionless)	Invertebrate habitat index (reflects qualitative presence of 6 elements)

In the same fashion as drainageways, streams may also be segmented, but into 'reaches' and 'subreaches' rather than segments and subsegments. Reaches are stream management units that reflect common *contributing watershed* characteristics, *riparian terrain*, and *channel slope*. To the extent possible, the beginning and ending points of a reach are selected so as to ease their location on the ground. Subreaches are segments associated with one and only one stream reach and that reflect common *stream habitat*, *channel morphology*, and *stream modification* characteristics. Though reaches may be identified during initial stream mapping, subreaches are more often identified and mapped in separate stream characterization programs. Detailed stream attributes (Table 1) are referenced to subreach segmentation.

Streams and stream segments are coded with unique digital identities. Coding consists of consecutive numbering of reaches and subreaches starting at the downstream end of each stream (the 'outlet') and continuing to the upstream end of the stream feature (the 'source'). Identification codes assigned to stream segments must conform to standard Municipal practices as described in Appendix A.

ACCURACY AND RESOLUTION

Resolution of watercourse features is dependent upon the mapping level as described in the previous text. General accuracy goals and standards applied in WMS mapping practices is described in the WMS document 'WMS Mapping Data Quality Standards'. In addition, horizontal accuracy standards for MOA watercourse features vary by each individual mapping level and are summarized in the following text.

Mapping Method

WMS watecourse mapping applies survey techniques to locate points along the centerline of a feature and then connects these points to represent the location of the watercourse. Accurate location of the point data may be established using any number of practices and may apply a wide range of standards dependent upon the selected survey method or purpose and the agency requiring the mapping information, but nevertheless is usually well established for each practice. Accurate representation of the location of the thread of the stream through adequate number and placement of surveyed points is less well established, however, particularly so for smaller features. Establishing acceptably accurate representations of the threads of streams using surveyed point data is specified for each of the mapping levels described above, and is the same for all survey methodologies. The following discussion summarizes basic practices acceptable for collection of accurate point data used in Municipal stream (and drainageway) mapping.

Municipal Rights-of-Way officers select, review and establish acceptable Municipal controlled land survey methods and standards. These standards shall be applied for all application of controlled land survey to mapping of Municipal streams. Controlled land survey techniques performed using practices adequate to meet specified accuracy requirements may be applied to collect stream location data at any mapping level described above. However, in addition to requirements specified by RsOW officers, number and location of turning points shall be sufficient to conform with feature centerline representation accuracy as specified above.

Map-grade GPS data collection methods may be applied at Levels 2 through 4 to support Municipal watercourse mapping. The term 'map-grade GPS data collection' is used here to identify any GPS method that has a demonstrated capability to locate point features over vegetated terrain similar to the project area at the minimum accuracies specified for the selected Municipal mapping level. Conformance may be demonstrated through: (1) collection of sufficient project-specific control data to demonstrate confidence in the required accuracy for each data collection effort, or (2) through use of a standard ‘practice’ that has been certified through field testing at precision locations to achieve such conformance. In both instances, selection of controls or precision locations with an appropriate range in canopy and terrain types must be established.

Municipal map-grade GPS methods used to collect point location data should typically control for a minimum horizontal accuracy of vertex locations of two (2.0) meters or better at a 95% confidence. Because different map-grade GPS instrument brands vary in control settings and parameters, operation protocols designed to achieve this accuracy are not readily standardized. However, the Watershed Management Services Division has developed practices using GPS map-grade receivers manufactured by Trimble Navigation Limited that we believe will meet WMS’ minimum map-grade GPS accuracy standards for unobstructed conditions, as follows:

Mobile Equipment:

- Trimble GeoXH
- Zephyr external antenna
- 2.04 meter mast

Base Station:

- Station type   CORS
- Minimum satellite elevation $\geq 10^0$
- Maximum point dilution of precision (PDOP) ≤ 6 PDOP
- Optimum base station/mobile separation   <10 kilometers
- Maximum base station/mobile separation   50 kilometers

Data Point Collection:

- Coordinate system   lat/long, NAD83 datum (post-2004 data)
- Minimum observable satellites ≥ 4 satellites
- Minimum satellite elevation $\geq 15^0$
- Maximum point dilution of precision (PDOP)   <8 PDOP
- Minimum signal to noise ratio (SNR) ≥ 8 SNR
- Minimum point occupation time ≥ 40 seconds @ 1sec logging interval (minimum 40 position points; 10 positions points may be collected for ‘suspect’ data point)
- Collect and export (1) all Position Points (1 point per not-in-feature position) and (2) all valid Feature Positions
- Collect and export mobile unit data metadata
    - Receiver type
    - Data Dictionary Name
    - Data file name
    - Date recorded
    - Time recorded
    - PDOP
    - Total positions
    - Filtered positions
    - Standard deviation
    - Vertical precision
    - Horizontal precision
    - Position
    - Height
- Field Data Dictionary   use standard domains including project identification.

Photo-Identifiable Control Points:

- Minimum control points/project ≥1 control
- Maximum separation from project data points 2 kilometers
- Minimum control point occupation time ≥3 minutes @ 1 sec logging interval
- Minimum control point re-occupation ≥1 time per day, each control point
- Minimum re-occupation separation time ≥1 hour

Post Processing:

- Perform data download at minimum of once per field day
- Download and archive mobile gps data files
- Download and archive base station gps data files
- Perform differential correction at post-processing and archive corrected gps data files
- Export spatial and attribute data (both feature position points and not-in-feature position points) to ESRI compatible file formats
- Project export files to WMS standards
  - Coordinate System Lat/Long, 6 decimal places
  - Datum WGS 1984
  - Horizontal Units Feet, 1 decimal place
  - Vertical Units Feet, 1 decimal place
  - Vertical Reference MSL
- Summarize position point quality (standard deviation, precision, data validity)
- Confirm acceptable post-process accuracy at photo control point(s)

Project Management:

- List survey equipment
- Provide map-grade practice and precision location testing certification
- Confirm minimum 4 hour field crew training on listed equipment
- Maintain feature point data collection hardcopy field logs, including descriptive information, and correct and scan to digital archive

Scale

Municipal stream mapping will be appropriate for viewing at different map scales, depending upon the initial feature mapping accuracy (Municipal 'mapping level'). Level 1 mapping can provide good feature location representations at map scales of 1:24000 or smaller, while Level 2 mapping will accurately depict feature locations at map scales of 1:12000 or smaller. However, often Level 2 Municipal mapping can provide useful graphic map content at a map scale as large as 1:3600. Dependent upon the selected mapping level, either all stream features will be resolved (Level 2 or better), or all stream features with a bank-full width greater than 1 meter will be resolved (Level 1). Stream attributes are resolved as representative characteristics of whole streams or of segments of streams ("reaches" and "sub-reaches"). Drainageway attributes are resolved as representative characteristics of whole drainageways or of segments of drainageways ("segments" and "subsegments").

Accuracy

Required horizontal accuracy for locating watercourses has been discussed above as an element of each of the WMS map levels. Table 2 summarizes these standards.

Table 2: Municipal Stream Mapping Accuracy

LEVEL	METHODOLOGY	CONF.	ACCURACY	FEATURE	MAP SCALE
1	**Photo Interpretive**	Est.	±25 meters	≥1meter width	1:12000
2	**Reconnaissance Base**	95% @	±20 meters	Feature C/L	1:6000
3	**Certified Map-Grade**	95% @	±10 meters	Feature C/L	1:6000
4	**Continuous Map-Grade**	95% @	± ½ BFW + 15' or ± ½ width ± 6.5' or ± ½ width	Feature C/L C/L Vertex/Point	1:3600
5	**Controlled Survey**	95% @	±1/2 BFW + 15' Project specified	Feature C/L C/L Vertex/Point	1:1200
6	**Unknown**		Unknown	Feature C/L	1:25000

BFW=Bankfull Width for streams; ½ width for constructed channels and point features
C/L=Centerline

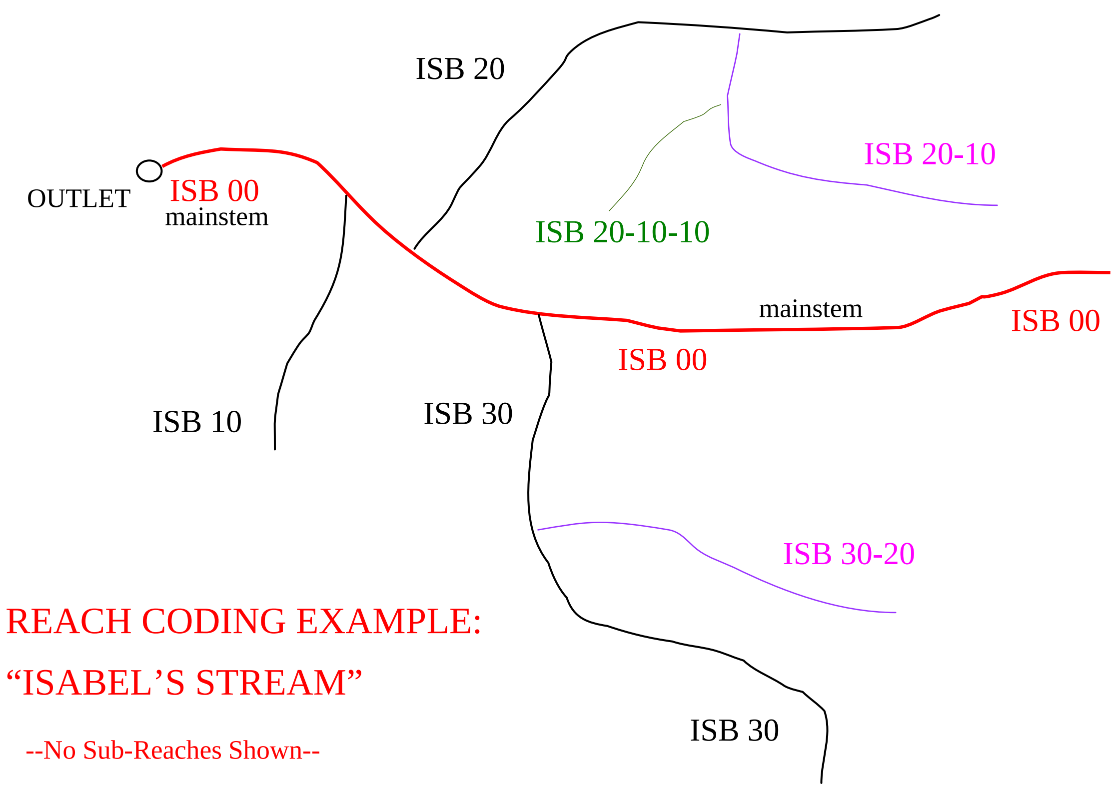
METADATA AND DOCUMENTATION

Characterization of the quality and nature of Municipal stream mapping data is crucial to the confident and correct application and integration of this information with other data sets, and for planning for future Municipal mapping. General guidance for the development of spatial metadata has been prepared by the Federal Geographic Data Committee (FGDC, June 8, 1994: "Content Standards for Digital Geospatial Metadata", Section 2.4, *.pdf file download @ http://www.fgdc.gov/standards/documents/standards/). To the extent feasible, or as required to meet other agency requirements, metadata prepared for Municipal stream mapping projects will conform to FGDC standards. However, for ease of use, the Municipality has developed additional descriptive metadata that provides practical information about the characteristics, attributes and digital representation of these features. These metadata are summarized in the document 'HGDB Data Dictionary', WMS document number WMP DBg09003

APPENDIX A

Municipality of Anchorage Stream Identification Coding

The Municipality has developed conventions for use in assignment of unique identification codes to discrete stream features. In general, all stream features within a stream catchment basin are assigned identification codes in relation to the main stem stream feature within that basin. The main stem is first assigned a three-letter mnemonic code (which reflects the commonly used name of the main stem or the principle branch) and a numeric code, -00, which signifies its identity as the main stem or a primary tributary (i.e., generally a higher order feature in the watershed). The main stem alpha code is then concatenated with a sequence of two-digit numeric codes to create unique identification codes for each tributary to the main stem. Finally, a four place decimal number (nn.nn indicating reach.sub-reach) is assigned to specify reach and sub-reach identities.



Stepwise guidance for applying stream coding is described in the following text:

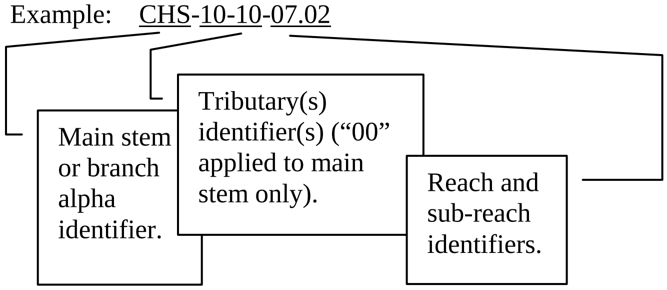
- USGS map comparability:

Compare Municipal mapping and any mapping and segmentation prepared under the U.S. Geological Survey’s Hydrographic Data Model (NHD) program. Identify principle NHD network points (tributary confluences) and codification (including NHD “watershed IDs”). Establish representational identities between Municipal features and NHD features. That is, identify the extent and approximate location of features apparently common to both data sets (Municipal locations are not likely to match exact NHD locations because of differences in mapping scale). Identify on the MOA streamline dataset the approximate location of the endpoints of NHD stream features. Code each discrete Municipal stream feature with appropriate NHD identification codes, including at minimum the NHD watershed ID.

- Basic stream codification:

Code all stream reaches with a combination of: (a) a *3-letter alpha string* representing the principle main stem or branch stream, (b) a *series of 2-digit codes* representing one or more tributaries related to the main stem or branch (concatenated with dashes in text form), and (c) a *4-digit code* identifying a reach and a sub-reach respectively (concatenated with a decimal point in text form, nn.nn, with the first two digits the reach and second two the sub-reach).

Example: CHS-10-10-07.02



- Alpha mnemonics conventions for known streams:

Use unique 3-letter mnemonics supplied by the Municipality and use the suffix -"00" with the alpha string to name all main stem or branch streams currently mapped as principal watersheds in the Municipal corporate map set.

> Examples: Chester Creek main stem reach identifications will all begin with CHS-00; North Fork Chester Creek main stem reaches will all begin with NCH-00. Note that the North Fork Chester Creek main stem is prefaced with NCH-00 (by Municipal caveat) even though it is a tributary to the main stem of Chester Creek.

- New main stem identifications:

Where a principal watershed includes a number of streams and tributaries (e.g., Little Campbell Creek), first select as the main stem ("-00" stream) that continuous stream thread that is currently named and generally understood (mapped) as the main stem. In identifying the extent of any unmapped streams and tributaries, select as the main stem that continuous stream thread that receives runoff from the largest contributing area.

- New alpha mnemonic assignments:

For un-mapped or un-named streams, assign new, unique 3-letter alpha prefixes only where the un-mapped stream flows directly into marine waters or into another un-mapped or unnamed stream. For un-mapped or unnamed streams that are tributaries to existing named streams, assign the same 3-letter mnemonic to the tributary as used for the existing named stream.

Assign short alpha names to higher order streams as shown on NPDES map sets, USGS maps, MOA maps or as generally and publicly known.

- Tributary coding conventions:

Assign odd decimal numeric identifiers to tributaries entering a main stem from the right side of the main stem (as determined looking up stream). Assign even decimal numeric identifiers to tributaries entering a main stem from the left side of the main stem (as determined looking up stream). Number those tributaries closer to the outlet of a main stem with lower decimal numerals and those tributaries closer to the source of a main stem with higher decimal numerals. The same numbering convention is applied to tributaries of tributaries.

For example, the first tributary entering a main stem from the left (looking upstream) will be identified as "–20". The first tributary entering a main stem from the right (looking upstream) will be identified as "–10". The second tributary entering a main stem from the right (looking upstream) will be identified as "–30", and so on. If the principal decimal numbers become exhausted, additional unit digits will be used to uniquely identify tributaries.

- Reach/Sub-reach coding conventions:

For each stream feature, assign reach numbers consecutively starting at the outlet of each discrete stream feature. A segmented Municipal stream feature has one (1) or more reaches. For each individual reach, assign sub-reaches consecutively, as necessary, beginning at the downstream end of each reach. Each Municipal stream reach has one (1) or more sub-reaches. The first reach of a stream or tributary is numbered "01". The first (or in cases where only one sub-reach is identified, the only) sub-reach of a reach is numbered "00".

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