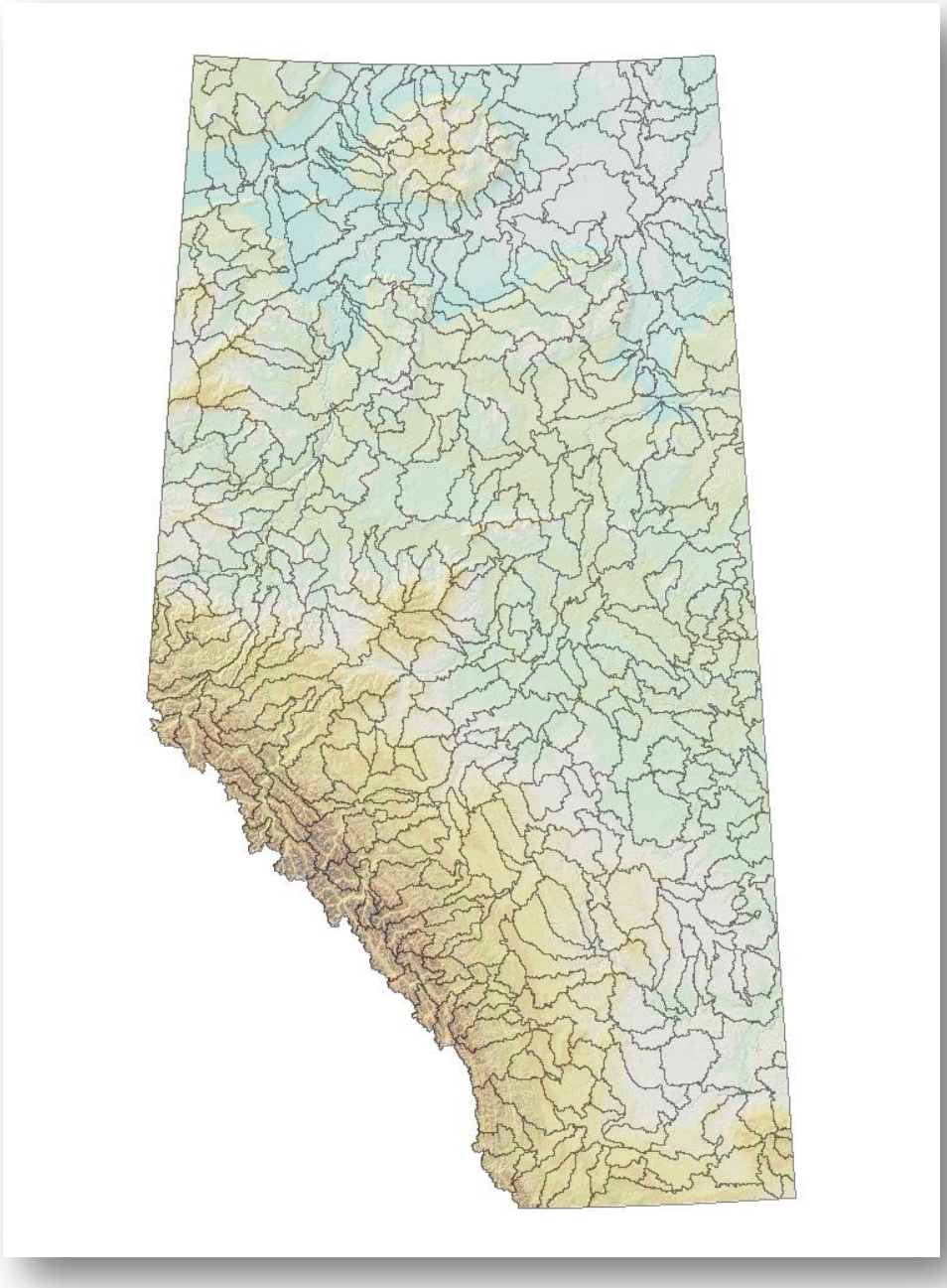
Hydrologic Unit Code (HUC) Watersheds of Alberta



Alberta Environment and Parks

The document explains the intended purpose, process of creation and use constraints of the Hydrologic Unit Code (HUC) Watersheds of Alberta.

These nesting watershed layers were created using ArcHydro Tools v.2.0 (EP) and are tied into a provincially comprehensive and aggregated collection of standard hydrologic units consistent with the coding system similar to USGS standards and procedures with accommodation to reflect pre-existing Canadian classification systems. The purpose of this dataset is to provide consistent and standardized GIS layer(s) that define hydrologic units that cover the province of Alberta. The HUC Watersheds of Alberta are successively smaller hydrologic units that nest within larger hydrologic units, creating a hydrologic watershed boundary dataset (Figure 1). Existing high resolution watersheds or catchment polygons are collated into larger watershed units to achieve a hierarchical, nested polygon data set. It should be noted that the HUC Watersheds of Alberta are not delineated to watersheds typically smaller than 500 km² (50,000 ha). Further delineation may be required for projects where program objectives require smaller, more refined watershed units; however, the HUC Watersheds of Alberta can be used as a surrogate until further work is completed, and where headwaters boundaries should spatially match, using ArcHydro Tools v2 data.

Although the detailed standards and procedures of hydrologic unit creation can be found in United States Geological Survey (USGS) publications (Seaber et al. 1994, USGS and USDA 2012) in general, the following principles should be applied when merging existing polygons to create watersheds:

- Hydrologic units should be created at a horizontal accuracy of 1:24 000 using the most recent Digital Elevation Model (DEM) (AgreeDEM, ArcHydro Tools v2 dataset).
- The location of boundaries at gauging stations, cities or other political or cultural points should be de-emphasized.
- The hydrologic units at any given level will be approximately the same size within a physiographic area for comparability and coordinating use and applications of hydrologic units. Further, hydrologic units will not be substantially different in size from the rest of the hydrologic units for a given level.
- All lower level units should nest within, and share common boundaries with, higher level hydrologic units.
- When non-standard areas such as remnant, non-contributing and diverted waters exist, they will be created according to USGS criteria.
- A hydrologic unit has a single flow outlet except in frontal, lake, braided-stream, or closed basin hydrologic units. The exceptions will be defined according to USGS standards and procedures (or other).
- Deciding where to place a watershed outflow can be highly subjective therefore the GIS technician will have to work very closely with area personnel with watershed expertise and local knowledge.

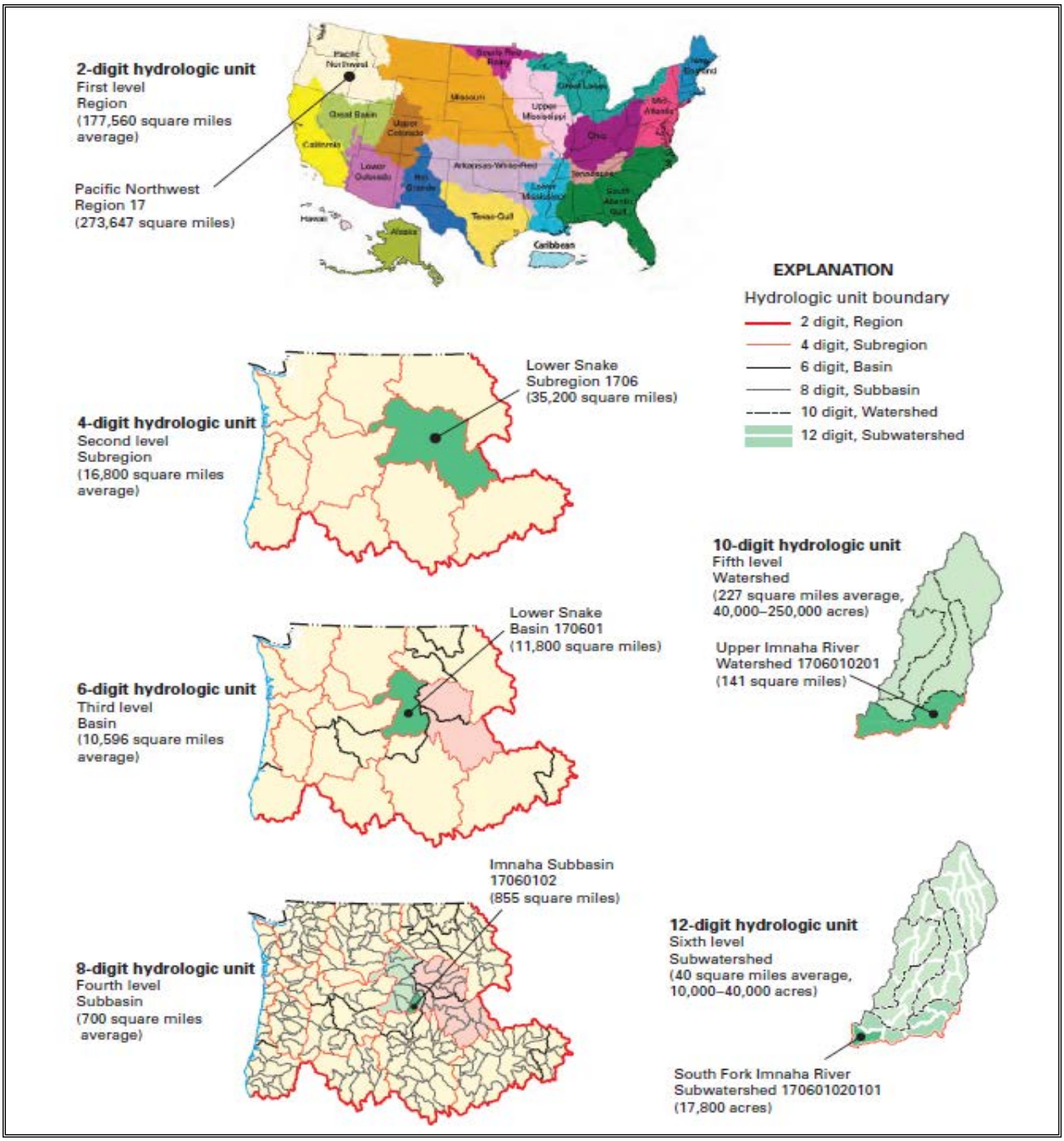


Figure 1. Basic principles used to create Hydrologic Unit Code Watersheds. Adopted from United States Geological Survey (USGS) publication (Seaber et al. 1994, USGS and USDA 2012).

HydrologicUnitCodeWatershedsofAlberta

This feature dataset contains Hydrologic Unit Code watersheds represented by the *HydrologicUnitCode2WatershedsOfAlberta, HydrologicUnitCode4WatershedsOfAlberta, HydrologicUnitCode6WatershedsOfAlberta, HydrologicUnitCode8WatershedsOfAlberta* and *HydrologicUnitCodeWatershedsOfAlbertaPourPoints* feature classes. These watersheds were

delineated using ArcHydro Tools v2. The HUC watersheds are a seamless provincial coverage. The final feature classes were given a 500 metre line smoothing between watersheds and basins. The smoothing process removed the grid-like pattern from the original data to generate a dataset that can be used for cartographic (mapping) purposes but further watershed unit delineation using ArcHydro Tools v2 or later versions will not match these boundaries. All 4 feature class elements were "clipped" to the Alberta Base Features Provincial Border.

The *HydrologicUnitCodeWatershedsOfAlbertaPourPoints* feature class represents the location of the start/end points for specific watershed units (stream confluences). By means of manual process, these points are collated together, and may or may not represent the watershed in the *HydrologicUnitCodeWatershedsOfAlberta* feature dataset. The points and the resulting watershed units were created on-the-fly. Only those watershed units that met the rule-set and criteria were chosen for final delineation.

Watershed Delineation Simplified Rule Set

All delineated watersheds described above follow the USGS Federal Guidelines, Requirements, and Procedures for the National Watershed Boundary Dataset. For more information, visit (http://water.usgs.gov/GIS/huc.html). Exceptions to watershed delineation are included below.

HydrologicUnitCode8WatershedsOfAlberta

- Seamless basin-wide coverage that falls completely within the 6-digit HUC watersheds.
- Strahler Stream order 4 or higher (named), where the confluence drains into the 6-digit HUC watersheds stream mainstem.
- Typically greater than 500km² (50,000 ha) total watershed area. Exceptions are stated below.
- Coding is 8-digit numeric coding. The last 2 digits in the code represents the unique ID for that particular 8-digit HUC (numbering upstream-downstream). The first 6 numbers represent the corresponding 6-digit watershed that the 8-digit watershed falls completely within (nesting).
- Field attributes included: HUC_8, HUC_6, HUC_4, HUC_2, WSC_CODE, Name, Basin, Shape Length and Shape Area.

HydrologicUnitCode6WatershedsOfAlberta

- Seamless basin-wide coverage that represents the general area and shape of the Watersheds of Alberta 2011 – Minor Sub-watersheds (Water Survey of Canada Regions) described below. Deemed necessary due to the wide application and use provincially.
- Coding is 6-digit numeric coding. The last 2 digits in the code represents the unique ID for that particular 6-digit HUC (numbering upstream-downstream). The first 4 numbers represent the corresponding 4-digit watershed the 6-digit watershed falls completely within (nesting).
- Coding does not typically follow the WSC coding system as the USGS federal guidelines do not account for basing watershed delineation (area) on existing watershed layers (i.e. WSC watersheds).

- Field attributes included: HUC_6, HUC_4, HUC_2, WSC_CODE, Name, Shape Length, and Shape Area.

HydrologicUnitCode4WatershedsOfAlberta

- Seamless basin-wide coverage which groups several 6-digit HUC Watersheds in relatively equally sized sub-basins.
- Does not follow particular hydrologic rules, but grouDrp's 6-digit HUC Watersheds together relative to geographic location. However, some resulting 4-digit areas do represent functional watershed areas (i.e. Smoky River, Wabasca River).
- Coding is 4-digit numeric coding. The last 2 digits in the code represents the unique ID for that particular 4-digit HUC (numbering upstream-downstream). The first 2 numbers represent the corresponding 2-digit watershed (basin) the 4-digit watershed fall completely within (nesting).
- Field attributes included: HUC_4, HUC_2, Name, Shape Length, and Shape Area.

HydrologicUnitCode2WatershedsOfAlberta

- Basin-wide coverage within the province of Alberta, representing general area and shape of the Drainage Basins of Alberta 2006 (superseded by the Watersheds of Alberta 2011) and the Watersheds of Alberta 2011 – Minor Sub-watersheds (Water Survey of Canada Regions)).
- Coding is 2-digit numeric coding. The 2 digits in the code represent the unique ID value that was added to the Drainage Basins of Alberta 2006: AB_1LHYDWASH-ID.

AB_1LHYDWASH_ID	BASIN	SUBBASIN
1	Milk River	Pakowki Lake
2	Milk River	Milk River
3	South Saskatchewan River	Oldman River
4	South Saskatchewan River	South Saskatchewan River
5	South Saskatchewan River	Bow River
6	South Saskatchewan River	South Saskatchewan River
7	North Saskatchewan River	Sounding Creek
8	South Saskatchewan River	Red Deer River
9	North Saskatchewan River	Battle River
10	Beaver River	Beaver River
11	North Saskatchewan River	North Saskatchewan River
12	Beaver River	Beaver River
13	Churchill River	Churchill River
14	Churchill River	Churchill River
15	Churchill River	Churchill River
16	Liard River	Fontas River
17	Slave River	Athabasca River
18	Slave River	Peace River
19	Great Slave Lake	Hay River
20	Liard River	Petitot River
21	Slave River	Lake Athabasca
22	Great Slave Lake	Kakisa River
23	Great Slave Lake	Buffalo River
24	Slave River	Slave River
25	Great Slave Lake	Taltson River

- Field attributes included: HUC_2, Name, Shape Length, and Shape Area.

HydrologicUnitCodeWatershedsOfAlbertaPourPoints

- Specific locations used to delineate a specific watershed unit using the "point

delineation" tool contained in ArcHydro Tools v2. Pour points represent the furthest downstream location a watershed, or catchment area begins or ends. Primary sources of determining the location or point delineation included where river confluences meet (following the above rule-set).

- These points are stored within the corresponding ESRI *.FGDB. The points can be used to delineate watersheds when necessary when and if updates to these layers is required.
- Data sources used to determine pour point location include the Alberta Base Features Single Line Network (SLNET) and its simplified version, available imagery and the Watersheds of Alberta 2011 – Minor Sub-watersheds (Water Survey of Canada Regions). Consistent delineation was applied in all basins and water courses in Alberta. However, it should be noted, ArcHydro Tools processing ultimately determined whether or not that pour point was to be "snapped" to a catchment polygon or not. A maximum snap threshold of 6 metres was applied.
- Field attributes included: None

Specific Modifications/Exceptions

1. Coding follows the USGS system, however a link to Water Survey of Canada (WSC) coding (as outlined by departmental EP Water Policy and Operations staff) is contained in the 6-digit and 8-digit HUC watersheds. To the degree possible, Water Survey of Canada sub-basins (00XX level) were approximated by the HUC 6 level of delineation, but some exceptions will be noted. Only the general polygon area contained by the WSC watersheds is represented in the HUC Watersheds of Alberta, coding follows basic principles of the USGS system.

2. There are no "Regions" or "Subregions", as outlined in the USGS federal guidelines. Therefore, the 2-digit HUC Watersheds start at the "Basin" level, and proceed to the "Subbasin" level (4-digit), to the "watershed" level (6-digit), and finally to the "subwatershed" level (8-digit).

3. Delineating watersheds solely based on size did not always make hydrologic sense. Best efforts to consistently break down units into smaller areas are applied (i.e. the size restriction of ~500 km² on 8-digit HUC Watersheds). Further delineation of smaller 8-digit HUC Watersheds (i.e. Strahler Stream Order 3 or less), or conversely, 10-digit HUC watersheds that fall completely within 8-digit HUC Watershed, was outside the scope of this project and delineation was not performed. This stage or phase would require additional or extended man-power needs. Small tributaries (Strahler Stream Order 3 or less) were included in the surrounding watershed area.

4. In most cases, on a provincial scale, arbitrarily splitting the mainstem channel flowing through a 6-digit HUC watershed to create, or split an 8-digit HUC watershed would not constitute natural hydrologic pattern or create a functional watershed area. (i.e. there is no known change in hydraulics between the middle reaches versus the lower reaches of the Chinchaga River, therefore, the mainstem was not split into 2 or more small watershed units). This is in violation of the USGS protocol, however, best efforts to use a consistent

approach to split watersheds further was applied. Mainstem channels were split if the resulting watershed area represented a change in hydraulics, and could be split into functional units such as the upper, middle, and lower reaches of a large river system. Regional hydrologists and biologists contributed opinions during the QA/QC stage to determine where natural breaks could occur, while following the general rule-set described above.

5. Watershed delineation included the basic principal of natural flow or hydrologic process (i.e. direction of water flow), and were created from confluences, upstream, applying the height of land (DEM). Watershed units containing dams, reservoirs, or other anthropogenic caused bodies of water (i.e. canals/weirs) were not typically split according to the location of a specific structure. However, exceptions exist where watersheds were split at one of these structures to apply a consistent approach to watershed size.

6. Naturally occurring lakes are included within the surrounding watershed area as most lakes typically contribute to lotic or riverine systems. 8-digit HUC watershed units were created up-stream of natural lakes, if it had a different name from the outflow river/stream, and was Strahler Order 4 or greater.

7. In some instances WSC Watersheds are very large, and may represent an entire basin within the province. Conversely, there are WSC Watersheds that represent very small contributing areas to a single basin. Therefore, To closely follow the USGS system of size and coding protocol, and applying consistent hydrologic principals, some watershed polygons are represented in the 2-digit, 4-digit, up to the 6-digit HUC watershed (identical contributing watershed area) level. When attempting to maintain relative 'size' rules to creating/grouping watersheds, some basins are treated 'special' due to their contributing watershed area with in the province of Alberta.

8. Some 6-digit HUC watersheds may also be included as an 8-digit HUC watershed (identical contributing watershed area). The watershed areas are nesting, however the code (HUC) itself is different, but matches its specific numeric code level (2, 4, 6, or 8, respectively). I.e. The 8-digit HUC for the Upper Bow River being 04020101 is also represented as 040201 in the 6-digit HUC watershed, and both watershed layers are also represented by an identical boundary to WSC Watershed 05BA. Other examples exist in the data set.

Other Data Sources

(Used to create/finalize the HUC Watersheds of Alberta):

- Provincial Boundary – BF_GEO_PROVINCIAL_POLYGON_V41. Compiled by Spatial Data Warehouse Ltd. (SDW), on behalf of the Government of Alberta, the ATS v4.1 Alberta Provincial Boundary polygon layer contains the polygon that represents the location of the boundaries of the Province of Alberta. This version of the Province of Alberta boundaries should be considered definitive for Government of Alberta use, and supersedes all previous versions.

- Base Features Single Line Network (SLNET) – BF_HYDRO_SLNET_ARC. Stream layer used in the creation of the ArcHydro Tools data set described above. SLNET contains all captured single line representations of hydrographic features. In addition, single line representations of polygonal features and single line arbitrary network connectors are in the file. SLNET layer was designed to provide users with a connected network of single line hydrography.
- Watersheds of Alberta 2011 – Minor Sub-watersheds (Water Survey of Canada Regions) – WSC_WATERSHEDS_2011 - Drainage basin boundaries were used to confirm and mimic the boundaries of the *HydrologicUnitCode6WatershedsOfAlberta* feature class due to the wide use across provincial government initiatives. Boundaries are not an exact match, and still follow hydrologic principal where deemed necessary. Subsequent nesting watershed unit boundaries and unit codes are affected by using WSC boundaries. These data are being used as input into a number of environmental and resource development initiatives, including (but not restricted to), water management, environmental impact assessment, integrated resource planning, wildlife habitat mapping and forest management. This type of information is intended for use in broad scale/reconnaissance level analyses only. The Watersheds of Alberta 2011 is a digital spatial database representing the major drainage basins for the province of Alberta as interpreted by Alberta Environment. The original basins were delineated using 1:50,000 topographic maps and some air photography of various scales. WSC line-work (boundary) was used to delineate HUC boundaries in areas of the province where DEM errors exist, typically areas where topographic relief is limited (i.e. Lower Peace, South Saskatchewan River basins).
- Base Features Derived Hydrocoded Simplified Linear Network - containing Strahler Stream Order. Line work was used to aid confirmation of a particular watershed start or end point (confluence), resulting in "pour points".
- Image Services (GoA) – Image Services displaying raster mosaics covering most, or all of Alberta. The majority of scenes making up a mosaic are captured in the year stated, but scenes from previous years may be used as needed. The latest available imagery was used to perform watershed point delineation to confirm where river confluence locations are.
- 1:1M Annotation – Used to populate the 'NAME' field in each feature class contained in *HydrologicUnitCode8WatershedsOfAlberta*. The largest stream (highest Strahler Stream Order) contained in the watershed unit was used to name individual watershed units. Where no named rivers existed, lakes and reservoirs contained by the polygon were used. Where no obvious body of water was named within the watershed unit an 'unknown' value was given.

Use Constraints and Limitations

Watershed boundaries will vary between existing watershed/basin GIS layers available within the Alberta Government repository. It should be noted, various data sets exist and the HUC Watersheds of Alberta data set is one, of many. The user takes full responsibility understanding the spatial and temporal limitations of the HUC Watersheds of Alberta. More information concerning data sources used can be found within the department using the 'keywords' listed

below. The underlying data used to create the HUC Watersheds of Alberta have use constraints with various degrees of accuracy. Where users identify watershed units that are required for a specific purpose, further delineation may be required outside the current HUC Watersheds of Alberta version. Updates to this dataset will not necessarily be performed upon further review of existing watershed units.

Quality Control/Quality Assurance

Provincial hydrologist and fisheries biologist staff from Environment and Parks directly contributed to the spatial adjustments within respective basins. Local working knowledge (by EP Corporate Geo-Administrative Area), was required to make adjustments to boundaries where the DEM could not process accurate watershed boundaries. Modifications to boundaries were incorporated into the final HUC Watersheds of Alberta feature class.

Keywords:

Watersheds of Alberta, Hydrologic Unit Code, HUC, 2-digit, 4-digit, 6-digit, 8-digit, Nesting Watershed Unit, Basin, SLNET, Hierarchical Code.

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