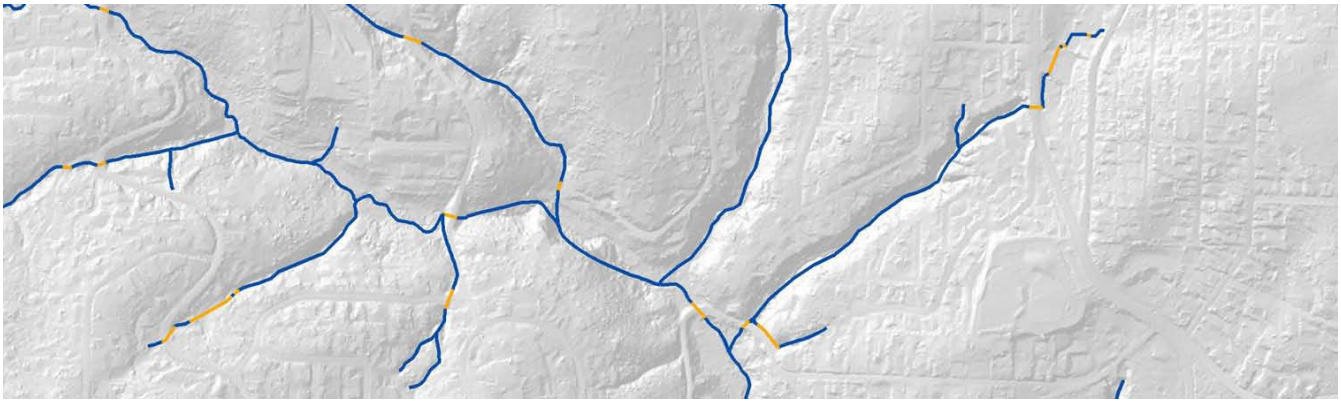
Natural Resource Inventory Update
stream remapping project



City of Portland Bureau of
Planning and Sustainability
Sam Adams, Mayor | Susan Anderson, Director

Natural Resource Inventory Update
stream remapping project

project description

The stream remapping project originated in 2003 as the Bureau of Planning and Sustainability (BPS) was developing a new automated GIS model to map and rank features that contribute to riparian resource values and functions. The data was used to produce the 2012 Natural Resources Inventory (NRI) that was adopted as part of the 2035 Comprehensive Plan. In 2018, BPS initiated a project to correct the location of the environmental overlay zone, the zoning tool Portland uses to protect significant natural resources, to better match river, streams, wetlands, flood areas, vegetation and wildlife habitat. As part of the Ezone Map Correction Project, BPS refined the stream mapping protocol and updated the city-wide stream data.

This report documents the 2003 methodology to remap all streams in Portland and 2018 methodology used to refine the data.

The key goals of the original remapping project were defined as:

- to refine the location of streams previously mapped by Metro;
- to verify the existence and location of a number of stream segments that were not previously mapped by Metro or included in the City's significant natural resource inventories;
- to refine the maps to address the location of piped stream segments and their connections to open channels, as there had never been a complete review of stream and drainageway location and surface water piping within the City.

The key goals of the 2018 refinement project were defined as:

- to clarify the definition of stream, drainageway, ditch, drainage and roadside ditch;
- to ensure that drainages and roadside ditches are not included in the stream data;
- to verify, via site visits, the presence and extent of streams on as many properties as possible; and
- to update the maps for the purposes of correcting the environmental overlay zone boundaries throughout the City.

The stream remapping project has been a collaborative effort involving Portland's Parks and Recreation, Bureau of Environmental Services, Corporate GIS and BES. Metro and Clean Water Services also participated in the project.

For the purposes of this project streams and drainageways are defined as follows:

stream – A stream is a channel that has a defined bed and banks and carries water continuously for a week or more during the wet season (October through April). Streams may be naturally occurring or may be a relocated, altered or created channel. Streams may contribute water into another waterbody or the water may flow into a pipe or culvert or may flow for some distance underground. Streams are also referred to as *drainageways* or *ditches* in City reports, codes and rules and by other agencies including Oregon Department of State Lands or US Army Corps of Engineers; the terms *stream*, *drainageway* and *ditch* are interchangeable for the purposes of this report and the Ezone Map Correction Project.

Streams include:

- the water itself, including any vegetation, aquatic life or habitat;
- channel, bed and banks, located between the top-of-bank[1]; the channel may contain water, whether or not water is actually present (see Figure 1);
- intermittent streams, which flow continuously for weeks or months during the wet season and normally cease flowing for weeks or months during dry season;
- sloughs, which are slow-moving, canal-like channels that are primarily formed by tidal influences, backwater from a larger river system, or groundwater;
- beaver ponds, oxbows, and side channels connected by surface flow to the stream during a portion of the year; and
- stream-associated wetlands.

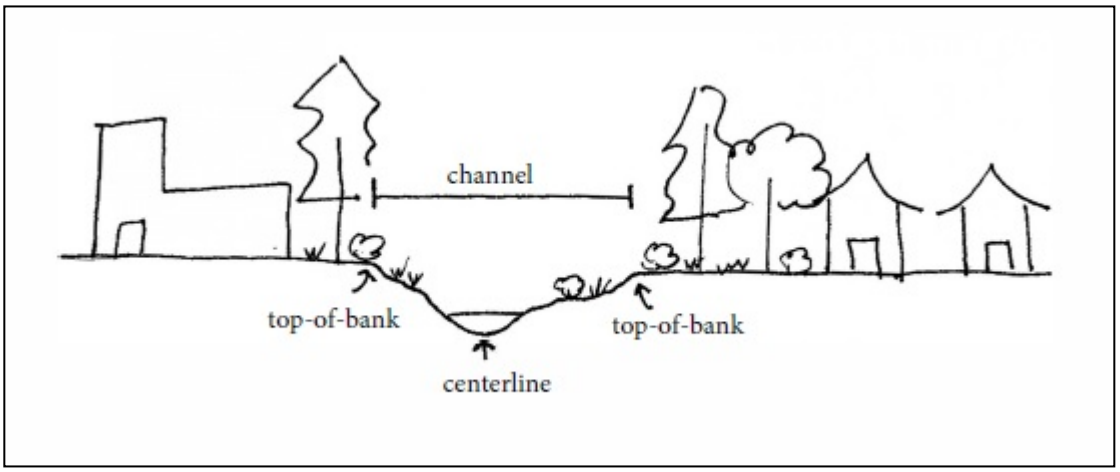


Figure 1: Stream Channel Cross Section

[1] *Top-of-bank* is where the stream bank levels off. It is created by seasonal high flows and frequent flood events that produce the channel. Water flows over the top-of-bank only during large flood events. In the Portland Zoning Code the *top-of-bank* is defined as the largest decrease in slope that is 10 percent or greater between the ordinary high water mark of a water body and a point 50 feet landward from the ordinary high water mark.

drainage – A drainage is an area on the land that conveys flowing water for only hours or days following a rainfall. If a drainage drains water from a wetland, pond or lake, even if it does not have a defined bed and bank, then it is classified as a stream. Ephemeral streams are considered drainages for the purposes of this report and the Ezone Map Correction Project.

roadside ditch – A roadside ditch is a constructed channel typically parallel to and in close proximity (approx. 15 feet) to a public road and is routinely cleaned (i.e., mechanically scoured or scraped of vegetation and debris) to maintain water conveyance capacity. Naturally occurring streams that have been relocated due to the construction of a road are not considered a roadside ditch.

Balch Creek

Columbia Slough

Crystal Springs

Roadside Ditch (not classified as a stream)

2003 stream remapping methodology

For a detailed description of the stream centerline GIS data, please refer to the online metadata at: http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52071&Db_type=sde&City_Only=False.

The 2003 stream remapping project focused on streams flowing through the City of Portland, as well as those located within unincorporated parts of Multnomah County where land use permitting is administered by the City of Portland.

There are areas of the city where streams have been relocated or reconfigured as part of or to accommodate development. In some situations, streams have been created to supplement or even replace the natural hydrologic system. Relocated, reconfigured and some created streams provide the critical watershed functions of the hydrologic system and were mapped as part of this project.

Beginning in April of 2003 the BPS began remapping stream geometry based on information from reference data sources including 2-foot contours, aerial photos, and GPS surveys. New streams were also where previously unmapped surface flow was identified. Bureau of Environmental Services (BES) mapped where surface streams were connected to the stormwater and combined sewer/stormwater pipes.

In addition, the BPS conducted an extensive field effort to confirm the existence and location of stream channels and piped segments. Field crews employed global positioning system (GPS) technology to verify the presence and location of streams where this information could not be derived from available sources of information. The field effort included streams on public and privately-owned land (with permission from property owners).

The starting point for the mapping project was the 2003 regional stream centerlines developed by Metro. More accurate stream centerline maps available for select areas around the City were also used as reference – including Columbia Slough centerlines created by BES and Powell Butte centerlines mapped by the Bureau of Parks and Recreation. All editing of stream data was done in ESRI's ArcGIS GIS software.

1) Stream and Drainageway Mapping Protocol

BES collection line GIS data, LiDAR-derived elevation models, photogrammetric data (2' contours), and aerial photos were among the data sources referenced by the BPS when mapping the stream centerlines.

Streams that were previously-mapped by Metro[3] were checked against all reference sources and re-mapped starting at the lowest confluence and moving up to the headwaters. Virtually all of the previously-mapped streams were re-mapped to correspond with the new and more detailed reference data. Any new streams apparent in the reference data were added to the map as they were encountered during the revision process (Figure 2).

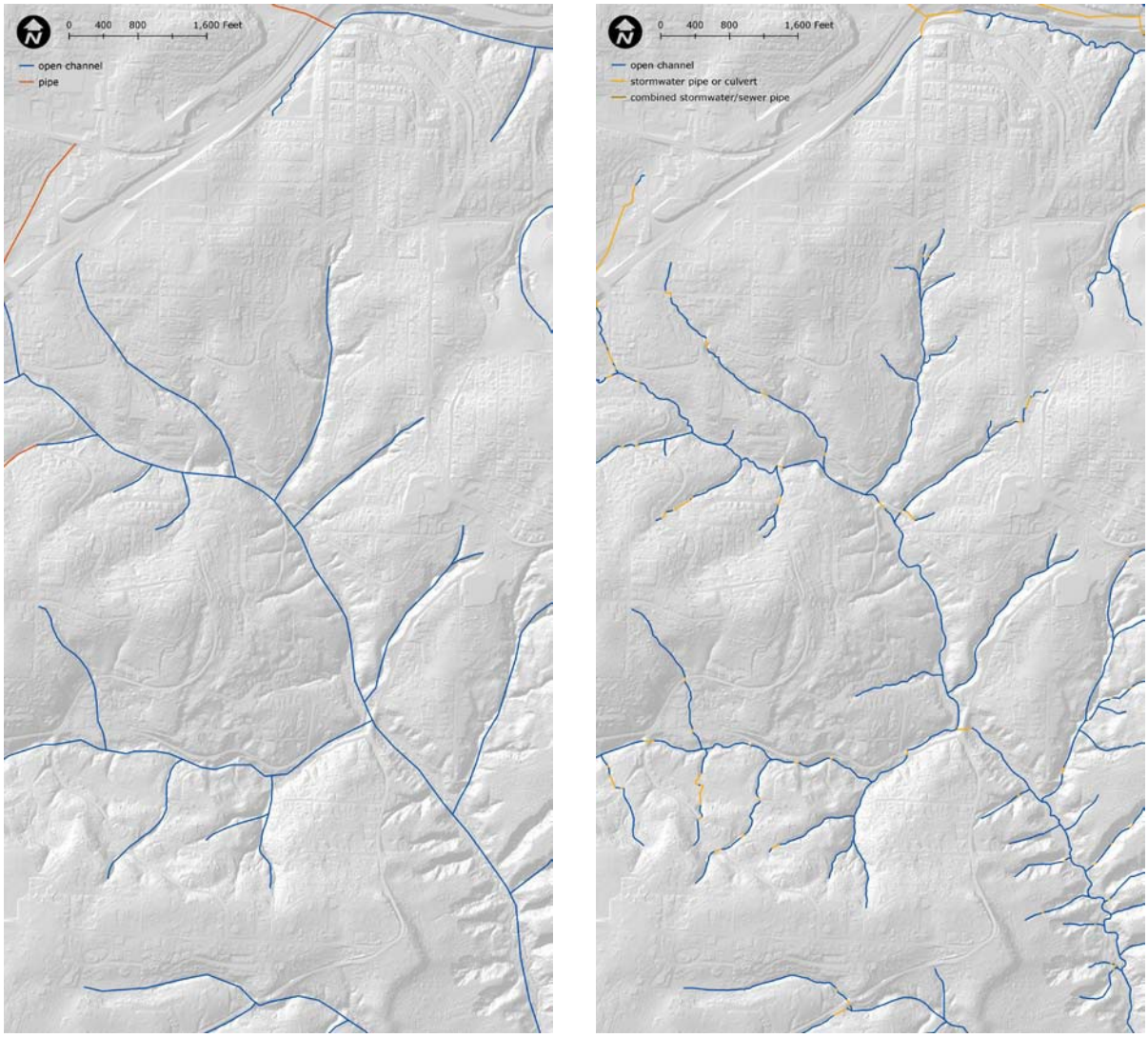
New streams were required to satisfy the following criteria in order to be added to the map:

- a channel exists and appears to be formed, at least in part, by water flowing through it - flow may be comprised of water from streams, surface flow, subsurface flow, groundwater, or stormwater discharge. Channels that emerge downstream of a pipe were mapped as beginning at the pipe outlet;

- the topographic information, aerial photo, BES collection line information or Multnomah County Drainage District information indicates that water on or upstream of the site drains to the channel; and

- the length of the stream or drainageway was greater than 50' (stream, drainageways and springs under 50' in total length were not mapped.)

[3] Metro's 2003 stream data was originally based upon 1:24000 USGS quad topography. Stream centerlines and banks were adjusted or digitized at approximately 1:10000 using the 1998 Spencer Gross 2'- resolution aerial photography.



Original Metro Centerlines

Remapped Centerlines

Figure 2. Comparison of previously-mapped Metro streams and drainageways and remapped stream and drainageway centerlines .

Any stream segments satisfying the mapping criteria above were further evaluated based on the following:

- If two or more reference sources affirmed the existence of a stream channel (e.g., topography indicates a channel and BES has mapped the channel), project staff deemed the stream "substantiated" and required no further verification. The stream was mapped based on the reference data.

- If a stream channel was supported by only one reference source (e.g., topography suggests a channel), project staff "flagged" the channel for field verification.

BPS compiled a list of all property owners whose tax lot contained a channel flagged for field verification. Property owners were sent a letter requesting permission for City staff to enter their property for on-site stream verification. The request included a self-addressed stamped return envelope for property owners to reply. Approximately 46% of property owners contacted granted access.

Database attributes from the old stream centerlines were transferred to the new stream centerlines. Additional information about the new and revised streams was also captured, including the channel type, source of the geometry, and the date of the modification.

2) Field Verification Methodology

Project staff visited both publicly- and privately-owned properties where the owner had given written permission allowing access.

Because of time and staff constraints, staff was not able to visit every property that was accessible. Priority for visitation was given to stream segments flowing through properties where a larger percentage of property owners had given staff permission to enter and survey the stream. Staff also focused on visiting streams that were relatively easy to access given topography (e.g., not steep vs. steep) and vegetation (e.g., penetrable vs. overgrown).

Once the decision to visit a particular stream segment was made, a field crew visited the site and verified the presence and location of the stream channel. Field crews used both visual assessment and, when GPS-satellite coverage was available, differentially-corrected GPS data collection. Field crews also took written notes on the location and description of the stream segment.

Stream characteristics used to verify whether the channel met the stream criteria, include one or more of the following:

- water flowing through the channel or evidence of periodic inundation;
- riparian-associated plants, including both native and non-native species;
- presence of amphibians, aquatic reptiles (e.g. turtles) or fish; including both native and non-native species; or
- evidence of wildlife use (e.g. beaver chews).

Field crews carried copies of a standard field visit form for notes and sketches, a map showing local topography, stream, etc., and a map with 6-inch-resolution aerial photographs of the property and surrounding area. All notes and maps for a particular field visit were scanned and stored in Acrobat PDF format. Digital photos of the stream were also taken in most cases. All digital documentation and photos are available from BPS.

Two survey-grade GPS receivers were used during the project – a Trimble Pathfinder Pro backpack system and a Trimble GeoXT handheld receiver. Both systems collected points and lines with an average horizontal error after differential correction of between 1 and 3 feet.[4] Two types of GPS data were collected – point features and line features.

Point features represented a minimum of 10 GPS points collected at 1-second intervals at multiple locations along a stream channel. GPS points at each location on the stream were differentially-corrected, averaged, and exported to GIS shapefile format. Stream centerline segments were then digitized by manually "connecting" the field collected points in ArcInfo workstation. Digitized lines were "smoothed" to more realistically portray stream geometry. Most GPS data was collected as point features.

Line features were created by collecting a series of points at 1-second intervals while physically walking the centerline of a stream. The collected points were each differentially-corrected and exported to GIS shapefile format as the vertices of a line feature. The advantage of this method was that it produced an actual centerline that could be directly incorporated into the stream dataset, rather than a series of points that had to be manually connected. However, because the points were not averaged at a single location over time, this method was slightly less accurate then the point feature collection method. In addition, it was only practical when the stream channel was open enough to allow relatively long – 50' or more – sections to be walked without obstruction.

[4] Differential correction is the process of correcting GPS data collected on a field unit with data collected simultaneously at a fixed base station. Because the base station it is at a known, surveyed location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the field collected data.

A summary of the specific GPS data collection parameters follows:

- Collection interval: 1 second
- Minimum number of points[5]: 10
- Maximum PDOP[6]: 6
- Minimum number of satellites: 4
- Elevation mask: 15º above the horizon

Points were differentially-corrected using the base station located at the U.S. Forest Service/Bureau of Land Management building in downtown Portland[7]. All GPS data was exported into the U.S. Stateplane coordinate system, in international feet, based on the NAD HARN/HPGN datum.[8] All GPS point and line features collected for the stream remapping project are available in ESRI Shapefile format from the City of Portland, Bureau of Planning.

Streams flagged for further verification and visited in the field were remapped to correspond with the visual assessment and/or GPS information collected for that segment. Streams located in this matter were assigned a "field date" in the stream centerline GIS database. Not all streams flagged for field verification were visited by project staff. Approximately 40% of flagged stream had been visited. Any flagged stream not visited were identified at the time in the GIS database.

[5] Though a minimum of 10 GPS points were required, field crews attempted to collect a minimum of 60 points (1 minute of data collection) whenever possible.
[6] The Position Dilution of Precision (PDOP) is a numerical value representing the quality of the satellite geometry and its impact on data collection accuracy.
[7] refer to http://www.fs.fed.us/database/gps/portland.htm for more information about the U.S. Forest Service base station.
[8] High Accuracy Reference Network (HARN) datum, a.k.a. High Precision GPS Network (HPGN), is a statewide upgrade to the NAD83 datum using Global Positioning System (GPS) observations.

stream refinement methodology

In 2007, BPS GIS staff used the newly-release LiDAR data to refine the stream centerline data. LiDAR is remote-sensing satellite data that maps the surface of the earth. It has a high degree of accuracy. Staff used GIS to … [short explanation of the methodology used].

In the spring of 2018, following adoption of the 2035 Comprehensive Plan, BPS staff launch a project to correct the location of the environmental overlay zone (ezone) boundaries to better match existing natural resource features including streams. The project began by using the adopted 2012 Natural Resources Inventory (NRI) which includes the results of the 2003 stream remapping project and the 2007 LiDAR refinements. It was assumed that all stream data had a high level of confidence.

All property owners, public and private, with existing ezones or where ezones boundaries were proposed to change on the property where sent a postcard notifying them of the project and providing a link to an online interactive map. The online map, Ezone Map, allowed property owners to look up their address and see the mapped natural resource features, including streams, existing ezones and draft corrected ezones. Through the Ezone Map, property owners could request a site visit to verify the location of natural resources on their site. Staff performed a site visit to every property that request one.

Staff also attend neighborhood association meetings and held drop-in hours at local libraries to inform the community about the project and encourage property owners to request a site visit.

During the site visits staff assessed the location of the natural resource features, except wetlands (see Wetland Mapping Protocol). Staff used detailed maps of topography (LiDAR-based), vegetation, streams and wetlands, aerial photography and field notes to verify the location of features.

project status

The initial mapping and classification of all known stream and drainageway centerlines within the City of Portland is complete. The data is updated regularly as new information becomes available. The following chart is a summary of stream and drainageway miles mapped at the completion of the initial mapping exercise (January, 2006). Ongoing modifications to the map since that time are not reflected in these numbers.

Stream and Drainageway Mapping Project Summary
Miles of streams and drainageways currently mapped in Portland and the Multnomah County pockets (as of January, 2006)

Re-mapping progress to date:	miles	%

Total miles of stream and drainageways previously-mapped by Metro:	180	
Miles of previously-mapped stream and drainageways revised:	180	100.0%
Miles of stream and drainageways added:	131	
Total stream and drainageway miles revised or added:	*311*	
Total number of surface stream and drainageway miles revised or added:	*260*	83.6%
Total number of piped stream and drainageway miles revised or added:	*51*	16.4%
Stream and drainageway verification to date:		
Stream and drainageway miles verified using existing sources:	250	80.4%
Stream and drainageway miles verified in the field:	24	7.7%
Total stream and drainageway miles verified to date:	*274*	*88.1%*
Remaining stream and drainageway miles to verify:	*37*	*11.9%*
Field work summary to date:		
Total number of property owners contacted:	670	
Number of property owners granting access:	304	45.4%
Number of properties visited:	163	24.3%

reference data sources

The following sources were used as reference for determining the presence and/or location of stream and drainageway centerlines:

Source:	**BES Collection Lines**
Created By:	City of Portland, Bureau of Environmental Services
Data Format:	GIS Shapefile
Date of Last Update:	11/26/2003
Description:	City of Portland regional sewer and drainage infrastructure. Includes sewer lines, stormwater pipes, combined sewer/stormwater pipes, culverts, and drainage ditches.
Notes:	Data is viewable for specific properties via www.portlandmaps.com
Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52073&Db_type=sde&City_Only=False

Source:	**LiDAR Data**
Created By:	Puget Sound LiDAR Consortium for Metro
Data Format:	ERDAS Imagine-format elevation models
Date of Acquisition:	March/April 2007, March 2005, & March 2004
Description:	3-foot resolution digital elevation model (DEM) of all Portland area bare-earth LiDAR point returns collected and processed to date (2004 through 2007). The DEM was used to generate hillshades and 2'/5'/ 10' contours that were used to map stream and drainageways.
Notes:	Data is the property of the Portland LiDAR Consortium.
Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52888&Db_type=sde&City_Only=False

Source:	**Photogrammetric Data (2' Contours)**
Created By:	City of Portland, Bureau of Environmental Services.
Data Format:	GIS Shapefile
Date of Acquisition:	1988 to 1994 (depending on location)
Description:	City of Portland 2' elevation contours. Contour lines derived from stereo analysis of aerial photos flown between 1987 and 1994. Created for the Bureau of Environmental Services.
Notes:	Data is viewable for specific properties via www.portlandmaps.com

Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52452&Db_type=sde&City_Only=False

Source:	**2008 Aerial Photos**
Created By:	Sanborn Map Company for Metro
Data Format:	Geo-referenced GEOTIFF images
Date of Acquisition:	June 19-29, 2008
Description:	Natural color (RGB) and color infrared (CIR) ortho-rectified digital imagery. Images are at six-inch resolution.
Notes:	Data is viewable for specific properties via www.portlandmaps.com. Other image years (1996 through 2007) were also used as reference.
Metadata Reference:	http://rlismetadata.oregonmetro.gov/display.cfm?Meta_layer_id=2302&Db_type=rlis

Source:	**5' Elevation Contours**
Created By:	Metro
Data Format:	GIS shapefile
Date of Acquisition:	July 2001
Description:	Five-foot elevation contours for urban areas of Multnomah, Clackamas, and Washington counties. Covers Portland metropolitan area.
Notes:	Copyright 2001 by Metro.
Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52453&Db_type=sde&City_Only=False

Source:	**BES Columbia Slough Centerlines**
Created By:	City of Portland, Bureau of Environmental Services
Data Format:	GIS Shapefile
Date of Last Update:	11/26/2003
Description:	Stream and drainageway centerlines mapped by the Bureau of Environmental Services Columbia Slough watershed team. Stream and drainageway locations not field verified.
Notes:	Shapefile data for the entire Columbia Slough watershed is available from BES.
Metadata Reference:	None currently available – contact Kevin Ramey in the City of Portland, Bureau of Environmental Services for more information.

project contacts

For more information about the City of Portland stream and drainageway mapping project, please contact the following Bureau of Planning & Sustainability staff:

Kevin Martin
GIS Analyst
503-823-7710
kmartin@portlandoregon.gov

Roberta Jortner
Supervising Planner
503-823-7855
rjortner@portlandoregon.gov

Mindy Brooks
City Planner
503-823-7831
mbrooks@portlandoregon.gov