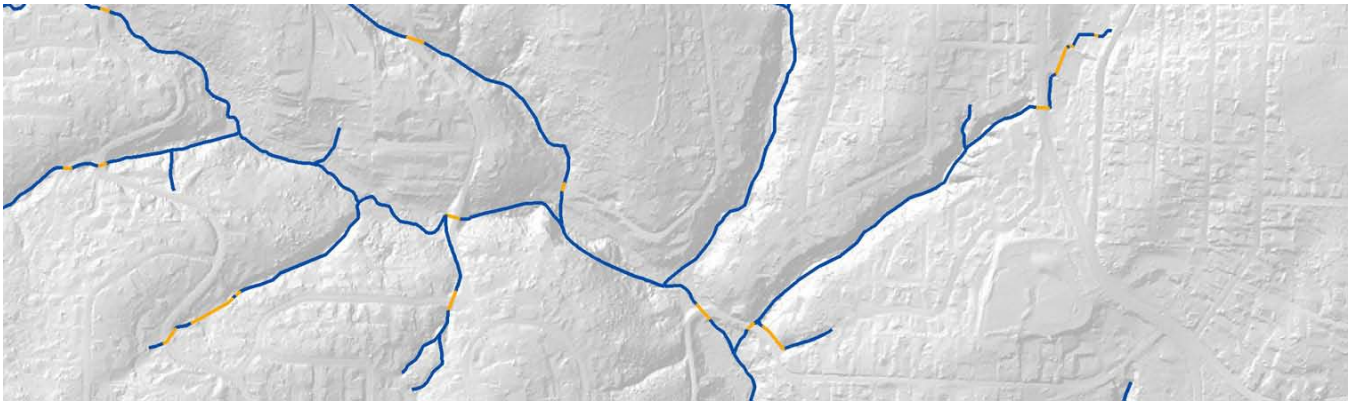
Natural Resource Inventory Update

stream and drainageway mapping project



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

project description

The stream and drainageway mapping project originated in 2003 as the Bureau of Planning, (now called and referred to in this report as the Bureau of Planning and Sustainability) was developing a new automated GIS model to map and rank landscape features that contribute to riparian resource values and functions. This map is used to update Portland's significant natural resource inventories.

Initially the model was developed and tested using Metro's regional stream map layer. However, during the model testing phase it became apparent that the Metro map was not accurate enough to support Portland's inventory update and resource protection program. A more detailed, precise map of streams and drainageways was necessary for analysis at the local scale.

The key goals of the re-mapping project were defined as:

› to refine the location of streams and drainageways previously mapped by Metro;

› to verify the existence and location of a number of stream and drainageway 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 and drainageway 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.

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

stream – An area where enough surface water flows to produce a channel, such as a river or creek, that carries flowing surface water during some portion of the year. Surface water flows may include stormwater runoff or groundwater discharge. Streams include:

- the water itself, including any vegetation, aquatic life or habitat;
- beds and banks below the ordinary high water level[1] which may contain water, whether or not water is actually present;
- the floodplain between the ordinary high water level of connected side channels;
- beaver ponds, oxbows, and side channels if they are connected by surface flow to the stream during a portion of the year;
- stream-associated wetlands;
- perennial stream (stream that flows throughout the year; permanent stream);

[1] *Ordinary high water* is the line on the bank established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

- intermittent stream (stream that flows only at certain times of the year, as when receiving water from springs or from surface sources; stream that does not flow continuously, as when water losses from evaporation or seepage exceed the available stream flow);
- ephemeral stream (stream or portion of stream that flows briefly in direct response to precipitation in the immediate vicinity, and with channels at all times above water table).

drainageway - An open linear depression, whether constructed or natural, which functions for the collection and drainage of surface water, subsurface flow or groundwater. It may be permanently or temporarily inundated. Drainageways may include sloughs[2]. Road-side ditches and similar facilities generally do not meet the definition of a drainageway unless the channel is a segment of an existing stream or redirected or relocated existing stream or stream segment.

The stream and drainageway mapping project focused on streams and drainageways 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 and drainageways have been relocated or reconfigured as part of or to accommodate development. In some situations, streams and drainageways have been created to supplement or even replace the natural hydrologic system. Relocated, reconfigured and some created streams and drainageways provide the critical watershed functions of the hydrologic system and were mapped as part of this project.

Beginning in April of 2003 the Bureau of Planning and Sustainability began revising stream and drainageway geometry based on information from reference data sources including 2' contours, aerial photos, and GPS surveys. New streams and drainageways were also added where previously unmapped surface flow was identified. All revised and newly mapped surface streams and drainageways were connected to the stormwater and combined sewer/stormwater pipes as mapped by the Bureau of Environmental Services.

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

[2] *Sloughs* are slow-moving, canal-like channels that are primarily formed by tidal influences, backwater from a larger river system, or groundwater. They may be permanently or temporarily inundated.

The stream and drainageway mapping project has been a collaborative effort involving Portland's Bureaus of Planning, Parks and Recreation, Environmental Services, and Corporate GIS. Metro and Clean Water Services also participated in the project. GIS staff from each of these agencies met at the beginning of the project to share the stream and drainageway centerline information used by each agency at that time. This information was combined into a single, regional stream and drainageway centerline dataset that served as a starting point for the mapping. The revised stream and drainageway centerlines are provided to all City bureaus for their use, and to Metro for regional distribution along with the Regional Land Information System (RLIS) "Natural Resource" GIS data.

The following report provides a brief description of the project status, the stream and drainageway mapping methodology, and the data sources used as reference for re-mapping and adding streams and drainageways. For a detailed description of the stream and drainageway 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.

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%

methodology

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

1) Stream and Drainageway Mapping Protocol

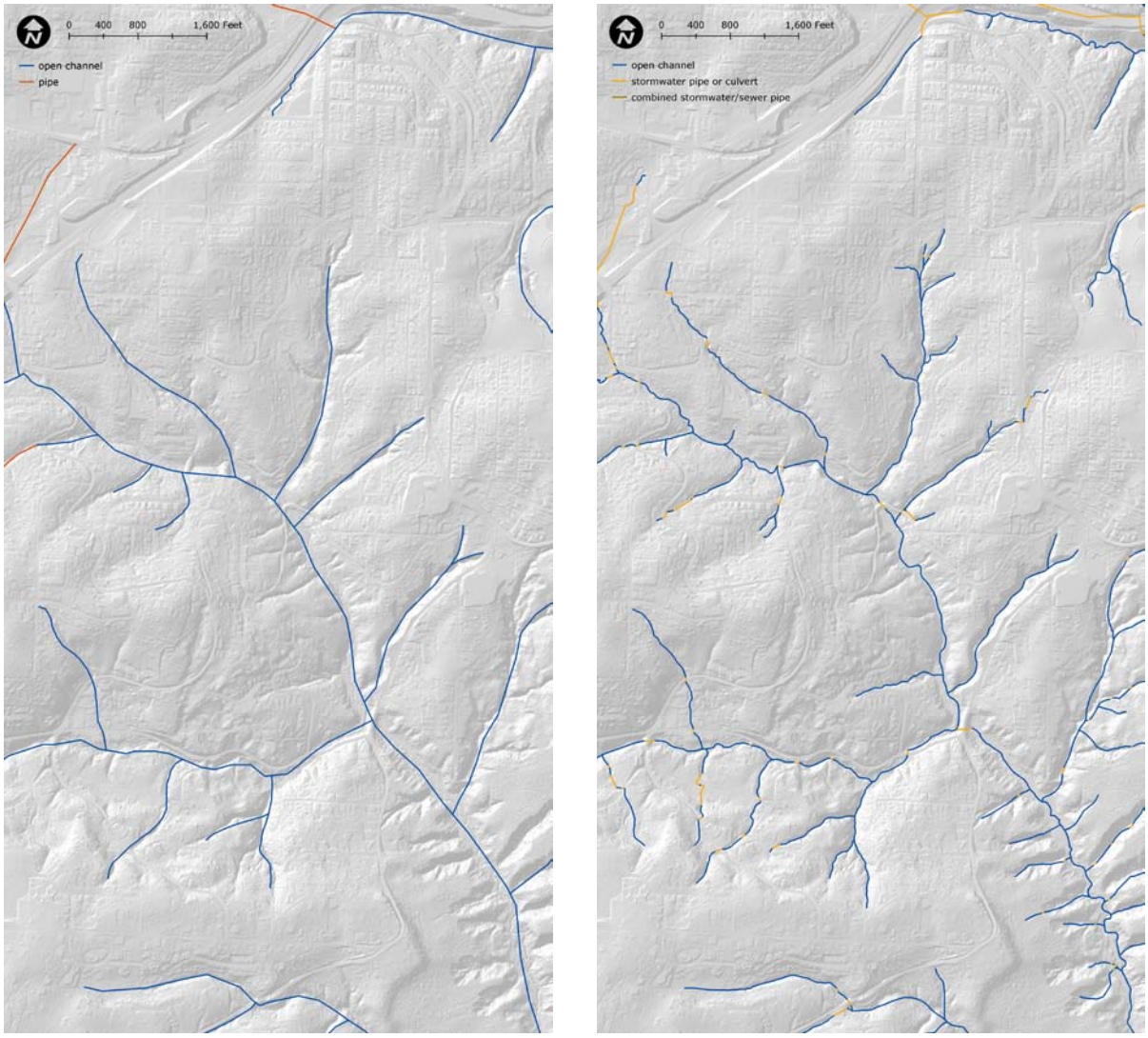
BES collection line GIS data, LiDAR-derived elevation models, photogrammetric data (2' contours), and aerial photos were among the data sources referenced by the Bureau of Planning and Sustainability when mapping the stream and drainageway centerlines.

Streams and drainageways 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 and drainageways were re-mapped to correspond with the new and more detailed reference data. Any new tributaries apparent in the reference data were added to the map as they were encountered during the revision process (Figure 1).

New streams and drainageways 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;
- 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 and drainageway data was originally based upon 1:24000 USGS quad topography. Stream and drainageway 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 1. Comparison of previously-mapped Metro streams and drainageways and remapped stream and drainageway centerlines .

Any stream or drainageway 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 or drainageway channel (e.g., topography indicates a channel and BES has mapped the channel), project staff deemed the stream or drainageway "substantiated" and required no further verification. The stream or drainageway was mapped based on the reference data.

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

The Bureau of Planning and Sustainability 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/drainageway 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 or drainageway centerlines were transferred to the new stream and drainageway centerlines. Additional information about the new and revised streams and drainageways was also captured, including the channel type, source of the geometry, and the date of the modification.

2) Field Verification Methodology

Project staff visited properties owned by the public 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 or drainageway segments flowing through properties where a larger percentage of property owners had given staff permission to enter and survey the stream or drainageway. Staff also focused on visiting streams and drainageways 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 or drainageway segment was made, a field crew visited the site and verified the presence and location of the stream or drainageway 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 or drainageway segment.

Stream and drainageway characteristics used to verify whether the channel met the stream/drainageway 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
- 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, drainageways, etc., and a map with 6"-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 or drainageway were also taken in most cases. All digital documentation and photos are available from the Bureau of Planning and Sustainability.

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 or drainageway channel. GPS points at each location on the stream/drainageway were differentially-corrected, averaged, and exported to GIS shapefile format. Stream and drainageway centerline segments were then digitized by manually "connecting" the field collected points in ArcInfo workstation. Digitized lines were "smoothed" to more realistically portray stream and drainageway 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 or drainageway. 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/drainageway 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 and drainageway 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 and drainageway re-mapping project are available in ESRI Shapefile format from the City of Portland, Bureau of Planning.

Stream and drainageways 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. Stream and drainageways located in this matter were assigned a "field date" in the stream and drainageway centerline GIS database. Not all stream and drainageways flagged for field verification were visited by project staff. To date, approximately 40% of flagged stream and drainageways have been visited. Any flagged stream and drainageways not visited are identified in the stream and drainageway centerline 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.

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:

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