Multnomah County NPDES MS4 Phase I Permit
Stormwater Management Program

Hydromodification Assessment

Submitted November 1, 2014

Road Services - Water Quality Program
Department of Community Services
Multnomah County

(This page left intentionally blank)

Contents

1. INTRODUCTION

What is hydromodification?

Hydromodification is a term which encompasses a range of physical responses of waterbodies to alterations in a watershed. US EPA's Office of Water defines hydromodification broadly as the "alteration of the hydrologic characteristics of coastal and non-coastal waters, which in turn could cause degradation of water resources." This includes activities in three categories:

1) *Channelization and channel modification*, which includes activities such as straightening, widening, deepening, and clearing channels of debris and sediment. This includes historic flood control techniques such bank armoring and clearing of instream debris.
2) *Dams*, defined as artificial barriers on waterbodies that impound or divert water, including large regulatory dams for hydropower, and small dams, such as farm ponds.
3) *Streambank and shoreline erosion* refers to the loss of soil and other material landward of the bank as a result of water flow overcoming the cohesive properties of soil and vegetation. This can include the erosion and re-deposition of sediment in the channel.

Streams are highly complex systems influenced by a number of variables, and, as is the case with most natural systems, if one variable is changed, it produces change in the others. In order to understand causes and impacts of hydromodification, the underlying functions and processes must be studied. The most important variables in natural stream function are:

- Flow – the volume and velocity of water delivered to the stream.
- Gradient - the slope of the streambed.
- Sediment load - the amount of natural sediment delivered to and transported by the river system.
- Channel shape - the physical structure and shape of the channel, its links with the floodplain and the degree of sinuosity.

Changes in any of these variables affect the balance of the river system and can produce degradation of downstream reaches. If changes are made in streams that affect the flow, gradient, sediment load, or channel shape, the downstream reaches will adjust to accommodate the volume of water available, the channel's characteristics, and the velocity necessary to transport the sediment load. The disruption of stream equilibrium leads to alterations to natural riffle and pool habitat diversity, accelerated bank failure and streambed erosion. Often,

downstream problems, like flooding, deepening of channels and head-cutting can be directly attributed to upstream degradation.

The causal relationship between hydromodification impacts and anthropogenic manipulation in the watershed must be considered to develop effective management plans. Watershed-based assessments tie stream stability to broad effects that directly alter habitat or lead to habitat change by altering natural variables of the stream. The following approach considers past and current practices, the extent of anthropogenic impacts, and the opportunities to enact change on the landscape to restore stream functions or mitigate further disturbance.

2. MANAGEMENT APPROACH

Hydromodification in the context of stormwater management has traditionally focused on addressing excessive erosion and deposition in channels and the resulting geomorphic changes. Such a view may define hydromodification in the narrow sense of "stream *hydro*graph-*modification*", or simply the increased runoff volume and duration associated with traditional urban development. These impacts are typically managed through the use of low impact development or instream restoration. While this narrow approach is sufficient to determine engineering solutions to decrease runoff from impervious areas, most urban watersheds in the County also have hydromodification impacts as a result of historic land use planning decisions, agricultural benefit, and other anthropogenic water quality degrading activities. A broad scope of hydromodification must be considered if multiple stressors exist in a watershed, and the management of a watershed by multiple entities is to be successful.

This initial assessment of hydromodification impacts in Multnomah County considers a watershed approach to hydromodification to assess the current condition of streams in the urban areas under the jurisdiction of the National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Phase I Permit (NPDES MS4 Phase I Permit, or Stormwater Permit). We examine the direct physical alterations of aquatic habitat, and those that encroach on the stream's riparian area. We also identify key landscape changes that lead to changes in stream variables, including flow, gradient, sediment load and channel shape. Many challenges to remedy impairments to the basic functions of a stream are insurmountable with the given resources over the short term. Thus, the long term nature of watershed management is the context for the strategies discussed in this report, including priorities for the County's transportation program, giving weight to stormwater management.

The intent of this report is to identify priorities for management, information gaps, and gaps in jurisdiction. Because many urban streams in the Portland Metropolitan area also have

agricultural impacts, significant wildlife, and a mix of public and private ownership, hydromodification impacts are varied in severity and area.

Watershed Approach to Hydromodification

In a natural system, streams provide four basic functions:

- Drainage of overland flow—headwater stream areas form the principal interface between land and water resources. They collect water runoff and deliver it downstream in a more concentrated pattern.
- Trapping of pollutants and sediments—in natural headwater streams, the near-stream areas and dispersed nature of flow allows for pollutants and sediments to be trapped in organic matters of the riparian areas. Nitrogen, phosphorus, and sediments laden with pesticides, heavy metals, or toxic hydrocarbons are among the key pollutants of concern.
- Water storage and slow release—headwater stream areas have a great capability to store water in their banks, beds, and floodplains and later release this water in a gradual manner, which serves to replenish groundwater and maintain base flows in streams.
- Basic energy supply—organic materials contributed by headwater stream areas form the basis for healthy aquatic life. Debris from wooded riparian corridors, filter strips and overland flow is delivered to the stream and forms the basic building blocks for the aquatic food web.

Healthy streams and watersheds provide ecological benefits by:

- Preventing pollutants and sediment from entering streams.
- Supplying organic material (branches and leaves) that form the base of the aquatic food chain.
- Providing diverse habitats for key aquatic species, including threatened salmonid species.
- Maintaining groundwater storage and reducing floodwaters.
- Recruitment of gravel for stream beds, particularly in riffle habitats that provide spawning areas for salmonids.
- Sorting fine sediments in pool habitat and dispersing sediment on floodplains.

Hydromodification activities adversely affect these functions.

While hydromodification activities likely occurred in Multnomah County streams before European settlement (e.g. fish traps, agricultural practices), the scale and intensity of hydromodification likely increased significantly as a result of modern agriculture and

development. Such activities included dredging of natural waterways, channel straightening and diking for flood control, and dams for irrigation on agricultural lands. In more recent years, use of drain tiles to improve the cultivation of agricultural lands and the development of urban centers and suburban areas significantly increased the amount of runoff from natural hydrologic conditions.

The losses of the ecological benefits are related to hydromodification impacts (Table 1). Watershed health depends on the repair of habitat and stream functions across the various pressures. While some functions are restorable with current best management practices, such as riparian habitat revegetation and the placement of large woody debris, other impacts such as channel straightening or flow regulation may be beyond the reach of jurisdiction's resources. Opportunities to improve watersheds must be pursued in partnership with other watershed jurisdictions and in coordination with private development wherever possible.

Table 1. The loss of ecological benefits from various types of hydromodification impacts.

Hydromodification impact	*Increases pollution input*	*Reduces organic matter input*	*Decreases habitat diversity*	*Reduces groundwater functions*	*Reduces gravels for spawning riffles*	*Reduces pools and floodplain connectivity*
Widening/deepening of channel			✖		✖	✖
Stream relocating		✖	✖	✖	✖	✖
Straightening channel length			✖		✖	✖
Headwater stream and wetland fills	✖	✖	✖	✖		✖
Bank stabilization			✖		✖	✖
Clearing instream debris		✖	✖		✖	✖
Riparian encroachment	✖	✖	✖	✖		
Flow regulation		✖	✖		✖	✖
Bridge construction	✖		✖			
Culverts			✖			✖
Draining and filling wetlands		✖	✖	✖		✖
Urban stormwater runoff	✖		✖	✖	✖	
Agricultural drainage	✖		✖	✖	✖	

3. WATERSHED AND STREAM CHARACTERIZATION

This section provides an overview of existing baseline conditions for watersheds within the geographic area of the County NPDES MS4 Phase I permit. The waterbodies in the permit area include the mainstem and tributaries of the Lower Willamette, Sandy, and Columbia Rivers, and tributaries of the Tualatin River (Table 1). The County jurisdiction within these watersheds is small relative to that of city jurisdictions. It varies from segments of road right of way within the cities of Troutdale, Fairview and Wood Village, to small pockets of urban residential area and a pocket of forested rural residential area within the City of Portland's Urban Services Area. The County also maintains several facilities in the urban area.

Table 1. Multnomah County streams and the associated NDPES permit area.

Watershed/Stream	*County NPDES Jurisdiction within Watershed*
Lower Willamette River	
• Johnson Creek	• 473 acres (0.74 mi^2); 3 Facilities
• Fairview Lake (Columbia Slough)	• 49 ac (0.08 mi^2) of residential area
o Fairview Creek, No Name Creek, Osborn Creek	• 109 ac (0.17 mi^2) of urban road right of way
• Tryon Creek	• 105 ac (0.17 mi^2) of residential area
Columbia River	
• Salmon Creek (Arata Creek)	• 125 ac (0.19 mi^2) of road right of way; 1 facility
Sandy River	
• Beaver Creek	• 35 ac (0.05 mi^2) of urban road right of way
• Sweetbriar Creek	• 6 ac (0.01 mi^2) of rural road right of way
Tualatin River	
• Fanno Creek	• 410 ac (0.64 mi^2) of residential area
• Cedar Mill Creek (Rock Creek)	• 362 acres (0.57 mi^2)

Stream and their channels are the result of the upslope and in-stream influences in the watershed, and of course the climate, geology and landform. This approach examines which natural and human-altered processes are influencing the stream's ability to maintain a natural channel. The following watershed characterization related to hydromodification includes:

- Jurisdictional area
- Soils
- Channel type (slope and confinement)
- Land use (zoning: agriculture, residential, commercial, industrial, open space)
- Hydrology and water use
- Channel modification
- Sediment source
- Fish and water quality

General characteristics of the Portland Basin

Multnomah County streams in the NPDES permit area lie in a geographic area known as the Portland Basin, which is bounded by the Tualatin Mountains to west, the Columbia River to the north, the foothills of the Cascade Range to the east, and the Clackamas River to the south. The topography is relatively flat along the floodplains of the major rivers, ranging from 11 to 50 feet. Deposits from the Missoula Floods created terraces above the floodplains, ranging from 50 to as high as 400 feet. Silt loam soils of varying thickness over unconsolidated volcanic and marine sedimentary rock are commonly found throughout the basin.

The climate in the Portland Basin is relatively mild. Annual precipitation at the Portland Airport averages 37.1 inches (30 year normal for 1971-2000), however precipitation in the basin varies and is generally greater. About 50% of the precipitation occurs during winter, with lesser amounts falling during spring and fall. Summers are typically dry and warm.

Precipitation over the Basin takes several pathways to groundwater and surface water drainage systems. In agricultural portions of the basin, rainfall transport is quickened by drain tiles and ditches, while in urban and suburban areas, runoff from roads and driveways are routed through pipes and manholes. In central areas of the basin, underground injection controls (drywells) recharge groundwater with runoff rather than contribute to peak flows in the streams.

Beaver Creek Watershed and Sweetbriar Creek (Sandy River)

Beaver Creek is the lowest tributary on the Sandy River, with the lower reaches located within the Metro Urban Growth Boundary in the Cities of Gresham and Troutdale. The watershed contains a mix of urban and rural development, as well as an abundance of commercial nurseries and other agricultural activities dominating in the upper watershed.

Within the 13.5 square mile watershed area, the cities of Troutdale and Gresham make up the majority of the NPDES permit area. The County has two significant road segments within the NDPES permit area: Troutdale Rd and Stark St (35 acre right-of-way area). The majority of the County's jurisdiction is in the rural upper watershed outside the NPDES permit area.

Sweetbriar Creek is a very steep and short tributary to the Sandy River that drains agricultural land east of Troutdale. This is not a fish bearing stream, and virtually no stream data exists.

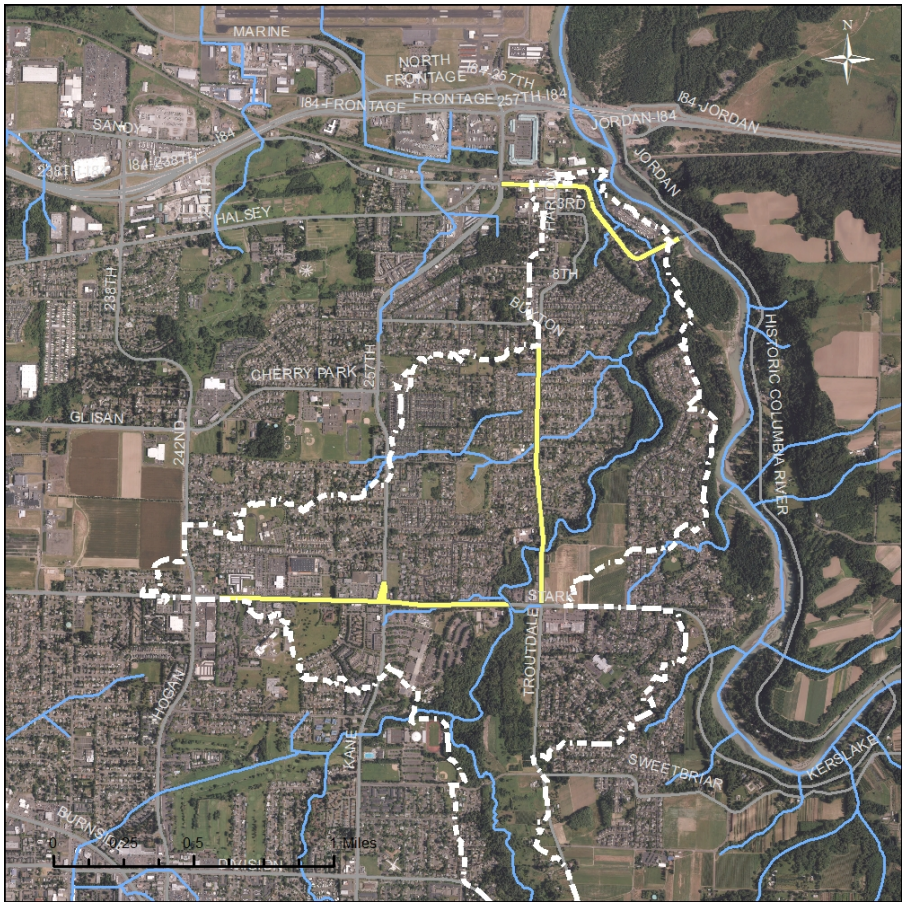

Figure 1. County right-of-way areas in the NPDES permit area in Beaver Creek are highlighted in yellow. Dashed line indicates the watershed boundary within the City of Troutdale.

Physical Characteristics	*Description*
Soils	Upper basin: Shallow poorly drained silt loam on broad terraces. Substratum is a silt loam fragipan. Lower terrace: Patches of poorly drained silt and alluvium and well drained gravelly and cobbly alluvium. Substratum is a gravelly sand. Lower canyon: very steep well drained silt loam, substratum contains gravel and cobbles.
Channel types	Upper basin: Low gradient moderately confined headwaters Lower terrace: Moderate gradient confined channel Lower canyon: Moderately steep narrow valley
Land use	Watershed area: Urban: 6.7 mi^2 (50%) Agriculture: 5.6 mi^2 (41%) Parks and open space: 1.2 mi^2 (9%)

Hydrology and water use: Mean summer stream flow ranges from 1 to 3 cfs, and the mean winter stream flow ranges from 32 to 60 cfs. Low summer baseflow is exacerbated by agricultural impoundments and irrigation. Winter peak flows range from 361 to 1,080 cfs. Drain tiles and lack of forest cover on much of the agricultural areas in the upper and middle reaches result in very flashy flows. Stormwater from Gresham and Troutdale urban areas, and County roadways contribute stormwater to the lower basin, however drywells infiltrate runoff in a portion of the watershed.

Channel modification: The steep lower canyon precluded much development beyond road crossings, and the riparian corridor is largely intact. Some minor stream alignment has occurred in portions of the upper watershed as part of agricultural practices; however farm ponds are a more significant alteration. Winter flows have scoured some reaches to bedrock in both low and high gradient reaches; however, gravel is recruited from the banks and good spawning habitat for salmonids remains. Beavers are active in the entire length of the stream. The stream suffers from a lack of large woody debris in much of the stream. Culverts at road crossings are numerous and act as grade controls at higher gradient reaches.

Sediment sources: Agricultural runoff is a significant source of sediment, particularly from farm roads. Cover vegetation has reduced overland rills and erosion, but some concerns remain. Stormwater runoff from

	portions of Gresham and Troutdale development and Multnomah County roads are also sources of sediment.
Fish and water quality:	Thirteen native fish species occur in Beaver Creek, including threatened coho, chum, and Chinook salmon, and rainbow (steelhead) trout. Beaver Creek does not meet water quality standards for temperature and bacteria. There is currently no pesticide data available for Beaver Creek, however there is reason to believe pesticides are an issue in the stream based on data from adjacent watersheds: Johnson Creek and the Clackamas River.

Fairview Creek (Fairview Lake, No Name Creek, Osborn Creek, Columbia Slough)

Fairview Creek is a 5-mile long urban creek, flowing from spring-fed wetlands on the northeast side of Grant Butte in Gresham. The creek drains approximately 7,000 acres (11 square miles) of urban watershed, flowing through the cities of Gresham and Fairview, and crossing several County roads. Approximately half of the watershed is within the City of Fairview (4523 acres). The creek receives flow from two tributaries, springs in a wetlands park, and runoff from paved surfaces before flowing into Fairview Lake and, eventually, the Columbia River via the Columbia Slough. Several County road segments discharge runoff to Fairview Creek (109 acres of right of way). Drainage from the Interlachen neighborhood on the north shore of Fairview Lake does not have hydromodification effects on the lake (49 acres).

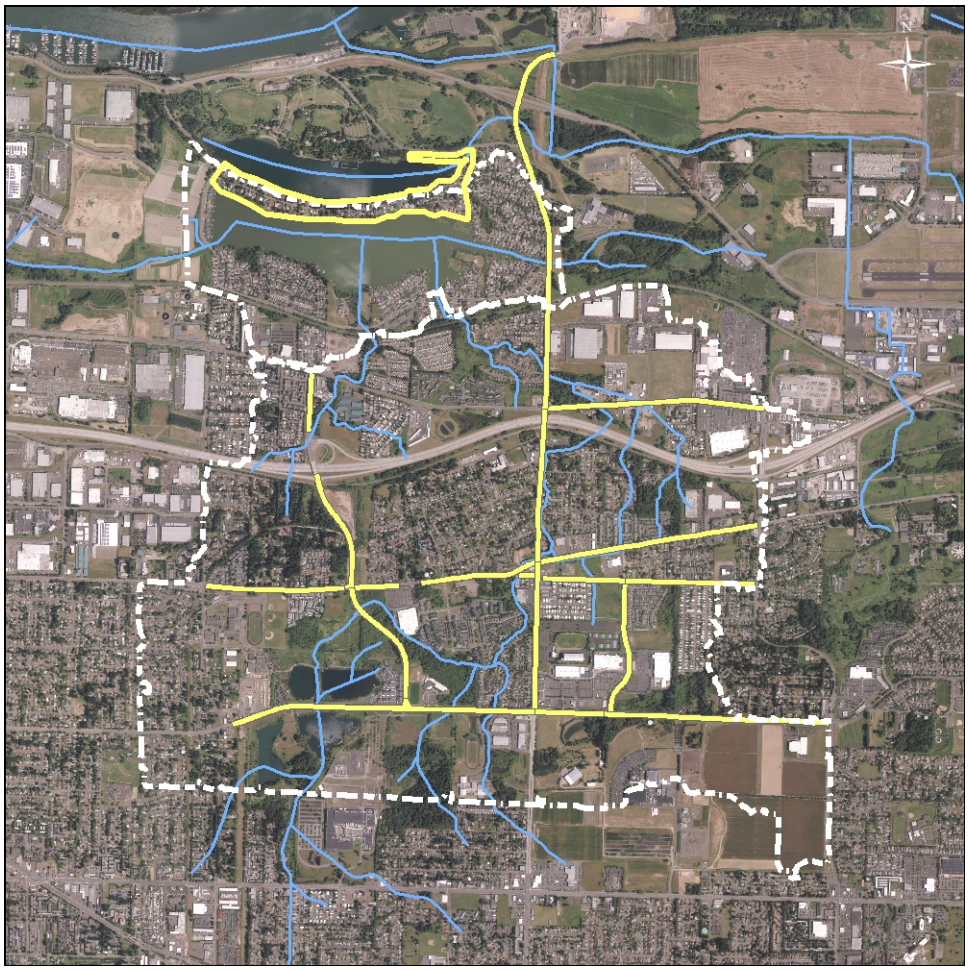

Figure 2. Fairview Creek right-of-way areas owned by Multnomah County highlighted in yellow. Interlachen neighborhood is outlined in yellow. Dashed line shows the watershed boundary within the City of Fairview.

Physical Characteristics	*Description*
Soils	Well drained silt loam formed in gravelly and cobbly alluvium. Substratum contains gravelly sand.
Channel types	Low gradient small floodplain channel Low gradient moderately confined channel Moderate gradient confined channel
Land use	Watershed area in the City of Fairview: Urban: 4416 ac (97.6 %) Agriculture: 107 ac (2.4 %)

Hydrology and water use: Historically, Columbia River freshets inundated much of the lower watershed, and with the construction of the levee and Bonneville Dam, connection to the river's effects were severed. The dominant hydrologic characteristics of the watershed are low summer flows (0.29 cfs min), high winter flows (71 cfs max) and flashiness and flooding during winter storm events. Stormwater is managed using drywell (underground injection controls) in parts of the watershed with well draining soils and high infiltration capacity.

Several water rights were issued when the watershed was predominantly agricultural, and it is unknown how many of these water rights are active. Effects of consumptive use on current flows are unknown.

Fairview Lake (and the Columbia Slough) have been physically altered and are managed for flow control and recreation by a system of weirs. The altered hydrology of the lake with high summer levels has led to sediment, erosion and water quality problems.

Channel modification: In addition to historic and current dikes and levees, the operation of gravel mines with settling ponds had a significant impact on the physical, chemical and biological health of the stream. Excess sediment and altered water flows caused historic fish kills. Channels were straightened for excavation operations. Stream armoring, loss of instream structure, and wetland and riparian area

loss are typical in residential and commercial parts of the watershed.

Fairview Lake outlet, which is the head of the Columbia Slough, is controlled by a weir system managed by the Multnomah Drainage District.

Sediment sources: Historic mining practices are said to have altered the substrate composition and sediment load in the stream. Historic inline settling ponds from mining operations act as sinks for sediment, while bank armoring contributes to a lack of substrate recruitment. Stormwater contributes fine sediment throughout the watershed.

Fish and water quality: Past mining practices led to flow diversion and massive sedimentation that caused kills of once healthy populations of cutthroat trout, freshwater mussels and macroinvertebrates that apparently have never recovered. Water control in the Columbia Slough and the Columbia River levee has eliminated all anadromous species.

Stormwater with associated nutrients, pollutants and sediment reduce the health of the streams, and especially Fairview Lake. There are Total Maximum Daily Load (TMDL) plans for metal, toxics, nutrients, temperature and bacteria in Fairview Creek, and the Columbia Slough system.

Johnson Creek (Lower Willamette)

Johnson Creek is a 26 mile tributary of the Lower Willamette River, with a watershed area of 54 square miles. Agriculture and urban development has significantly altered the hydrology and physical stream channel, however, much restoration is occurring in the watershed to improve habitat for ESA listed salmonids. Much of the County's jurisdiction is in the rural portion of the watershed, outside the NDPES permit area. However, pockets of unincorporated County (473 acres) adjacent to the City of Portland are within the Urban Services Boundary. These areas are urbanizing, but still rural residential. The County also maintains three facilities in the watershed: Gresham Probation Office, Gresham Library, and the County East Building.

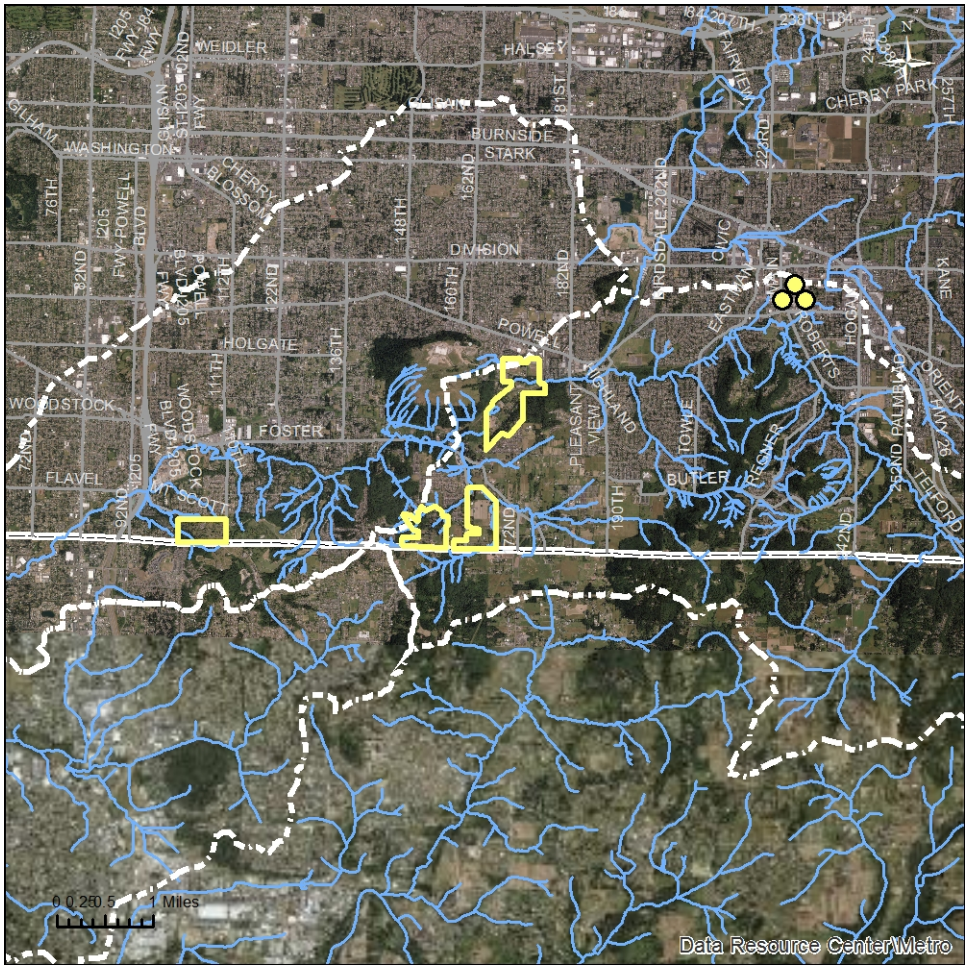

Figure 3. County facilities located in the Johnson Creek watershed identified by the yellow markers. Pockets of uncorporated County (rural residential and agriculture) are outlined in yellow.

Physical Characteristics	*Description*
Soils	Floodplain soils are poorly drained silt loam formed in recent alluvium. The substratum is a sandy clay loam.
Channel types	Low gradient small floodplain channel Low gradient moderately confined channel Moderate gradient confined channel
Land use	Watershed area: Urban: ~22,000 (65%); Rural: ~10,000 ac (30%); Open space: ~2000 ac (5%)

Hydrology and water use: Of the estimated 30 tributaries that existed historically, only a dozen remain. Most of the rain that falls in the north portion of the watershed is diverted to drywells for stormwater management. Johnson Creek flooding has been an issue since the conversion of forest to farmland in the early 20th century. The stream is characterized by low summer flows (<10 cfs) and flashy winter flows (>2,000 cfs). Groundwater discharge is important to maintain summer flows.

Channel modification: Lower Johnson Creek was channelized and armored for flood control in the 1930's. Channel straightening and farm ponds for agricultural use is common in the upper watershed. Many impassable culverts exist on the tributaries, and two abandoned weir structures exist on the mainstem.

Sediment sources: The potential for soil erosion is low in the lower watershed where the land is relatively flat. In the area near the Gresham Buttes, soil erosion risk is medium to high, as the soils are thin and sensitive to disturbance. Soils in the upper watershed are prone to erosion when vegetation is removed from agricultural practices.

Stormwater runoff from drain tiles and roadways can mobilize a significant amount of sediment. Irrigation practices and draining farm ponds are also a chronic source of sediment in the watershed.

Fish and water quality: Coho and Chinook salmon, steelhead and cutthroat, and several other native fishes inhabit Johnson Creek and its tributaries. Studies of Johnson Creek have shown elevated levels of DDT and Dieldrin, as well as metals and bacteria. Summer high temperature exceeds the water quality standards for over 100 days a year.

Tryon Creek

The Tryon Creek watershed in southwest Portland covers an area of approximately 4,142 acres, or 6.5 square miles. Approximately 105 acres (0.17 square miles) are within unincorporated Multnomah County. This area is composed entirely of residential land use. The two roads in this pocket do not have drainage systems and do not contribute runoff to the stream.

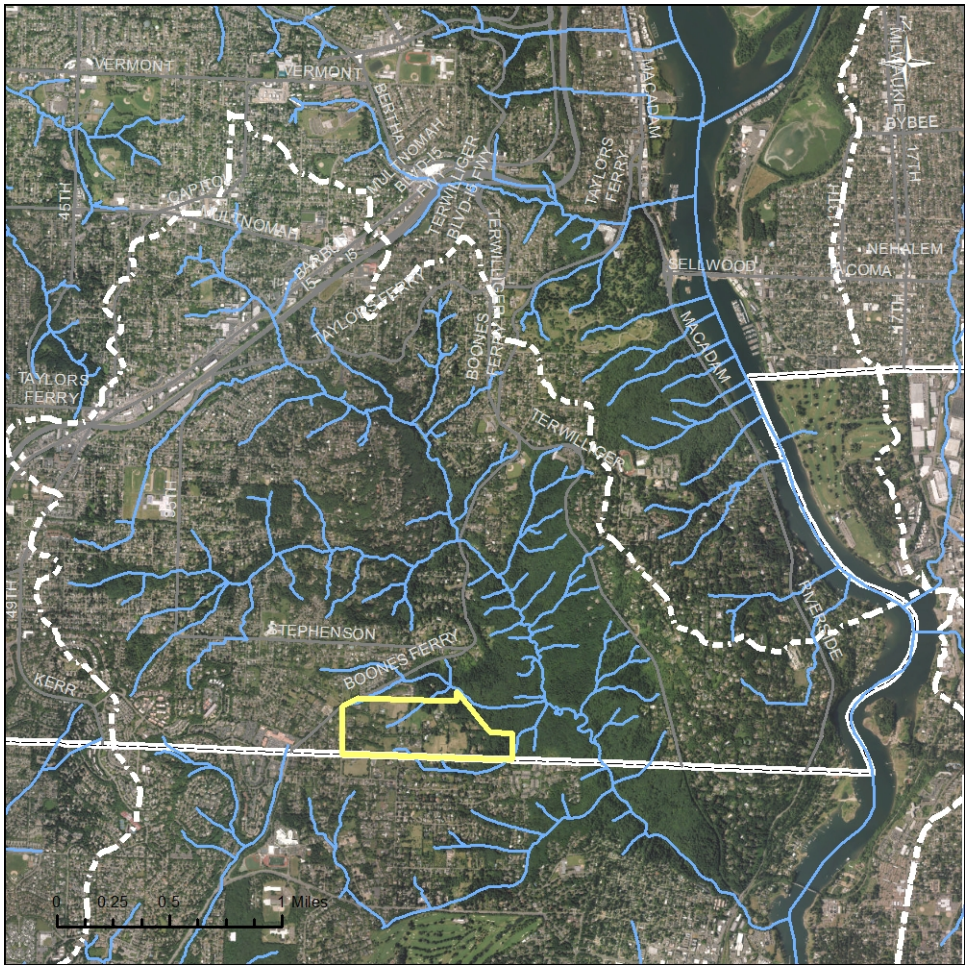

Figure 4. Area of unincorporated County in Tryon Creek Watershed is outlined in yellow.

Physical Characteristics	*Description*
Soils	Somewhat poorly drained silt loam on steep slopes with low permeability due to a substratum of silt loam fragipan. Perched water table in winter.
Channel types	Low gradient small floodplain channel Low gradient moderately confined channel Moderate gradient confined channel
Land use	Watershed area: • Residential: ~3,133 ac (76%) • Open space: ~867 ac (21%) • Commercial: ~130 ac (3%)

Hydrology and water use: Discharge is characterized by low summer flow with a minimum flow of 0.09 cfs, and flashy winter flows, with a maximum flow of 1,210 cfs. Average flow between 2002 and 2011 was 8.72 cfs. The total watershed impervious area is estimated at 24%, with the high impervious area concentrated at the headwaters and upper watershed.

Channel modification: Impervious area at the headwaters affects the hydrology throughout the stream. Most streams within the watershed have reaches that exhibit unstable streambanks, downcutting, and streambank erosion. Several culverts are present in the watershed.

Sediment sources: Two major stormwater outfalls in the Portland jurisdiction contribute about half the creek's total suspended solids and associated pollutants. Streambank erosion is prevalent in the tributaries and mainstem.

Fish and water quality: Coho, steelhead, and native cutthroat and other native fishes are present in the watershed. The stream temperature exceeds the state standards for periods in the summer.

Fanno Creek

Fanno Creek is a 15 mile tributary of the Tualatin River. Its watershed covers about 32 square miles in Multnomah, Washington, and Clackamas Counties. Approximately 7 square miles, or 4,529 acres, are within the Portland Urban Services Boundary (described in the table below). Within this area, a residential pocket of unincorporated Multnomah County area (approximately 458 ac or 0.17 square miles) is found at the headwaters of two Fanno Creek tributaries: Columbia Creek and Sylvan Creek.

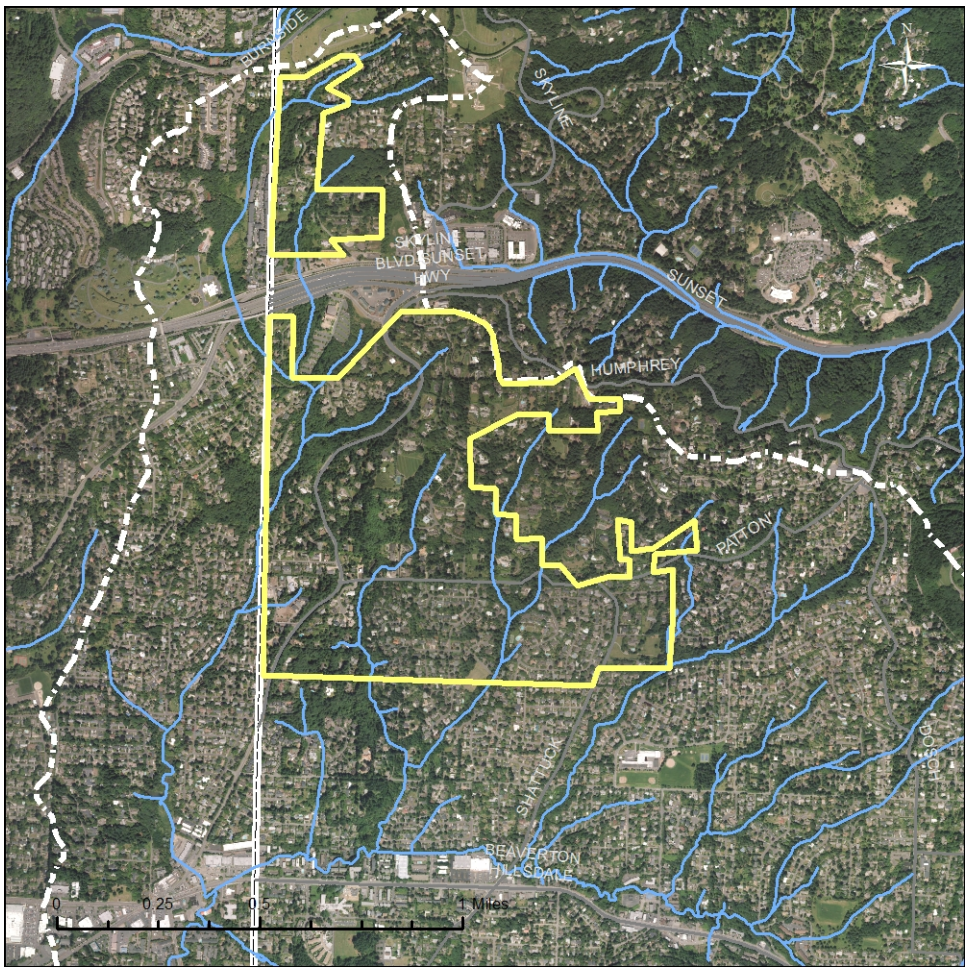

Figure 5. Areas of unincorporated County in the Fanno Creek Watershed are outlined in yellow.

Physical Characteristics	*Description*
Soils	Somewhat poorly drained silt loam on steep slopes with low permeability due to a substratum of silt loam fragipan. Perched water table in winter.
Channel types	Moderate gradient confined channel
Land use	Within Portland Urban Service Area: • Residential: 4095 ac (90%) • Open space: 261 ac (6%) • Commercial: 173 ac (4%) Within unincorporated County • Residential: 458 ac (100%) – approximately 80 ac of impervious area (18%)

Hydrology and water use: Discharge is characterized by low summer flows (1-3 cfs) and flashy winter storm flows (1,670 cfs max) with large contributions of stormwater. Portland Bureau of Environmental Services estimates that within their urban services area, which includes unincorporated Multnomah County, one third (33%) of the area has impervious cover.

Channel modification: Upper Fanno Creek tributaries in the unincorporated County pockets are fairly undisturbed give their steep and confined stream channels. Several culverts are found in the upper stream reaches.

Sediment sources: The slopes at the headwaters of Fanno Creek consist mainly of Columbia River Basalt exposed in ravines, but covered by up to 25 feet of wind-deposited silt. Silts and clays are the most common watershed soils, and significant erosion is common.

Fish and water quality: Fanno Creek supports resident cutthroat trout and other native and non-native species. Fanno Creek has poor water quality as a result of urban development, septic system failures and agriculture.

Salmon Creek (Arata Creek, Blue Lake)

Salmon Creek, and its major tributary Arata Creek, are among the most altered streams in Multnomah County. The streams originate from seeps and springs on the alluvial terrace of the Columbia River, and discharge to the Columbia River through a pump house at the Columbia River levee. The small watersheds, totaling 3.9 square miles in area, contain industrial, residential and remnant agricultural land uses. Nearly the entire length of both streams have been straightened, channelized or otherwise modified as a result of agriculture and urban development. Several County roads cross the streams in Troutdale and Wood Village (125 acres of right of way area).

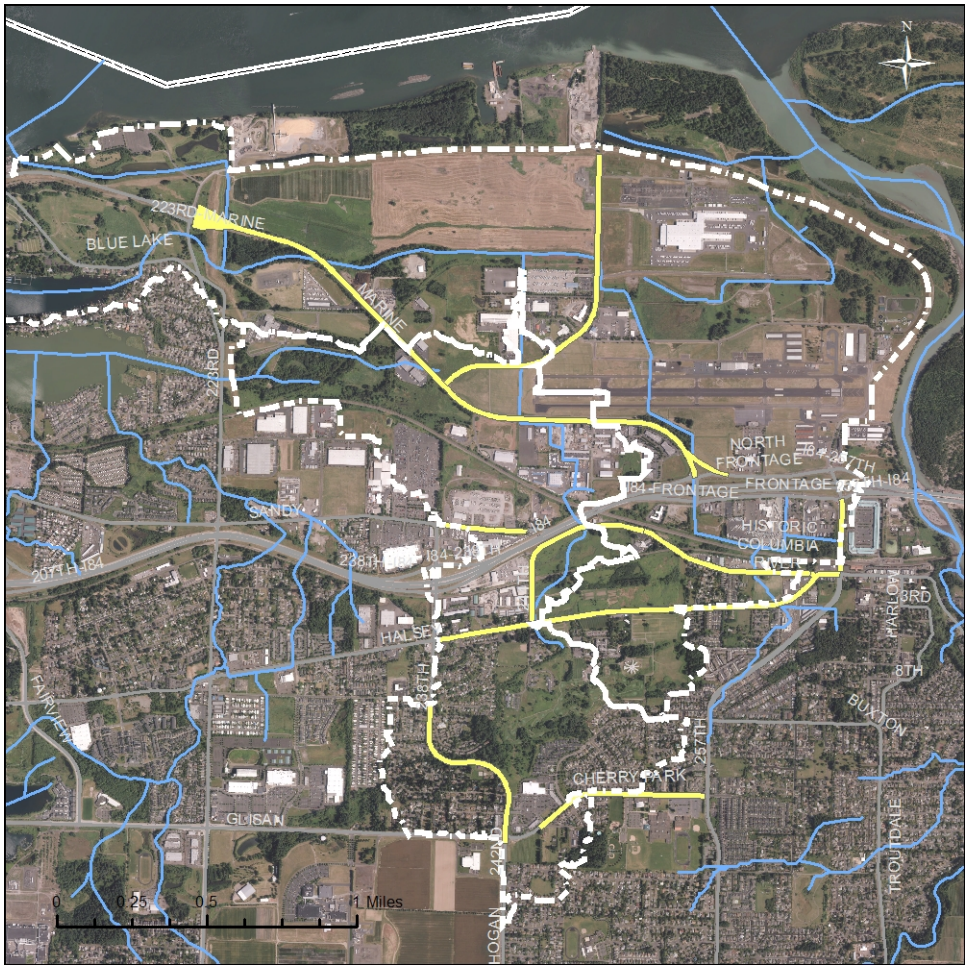

Figure 6. County right-of-way areas in the Salmon Creek watershed are highlighted in yellow. Watershed boundary is shown as a white dashed line.

Physical Characteristics	*Description*
Soils	Columbia floodplain: poorly drained silt loam over substratum of coarse sand. Terrace: well drained loamy alluvium.
Channel types	Low gradient floodplain Low gradient moderately confined Moderate gradient moderately confined
Land use	Watershed area: • Industrial: 2.1 mi^2 (53%) • Residential: 0.3 mi^2 (8%) • Agriculture: 0.3 mi^2 (8%) • Parks and open space: 1.2 mi^2 (31%)

Hydrology and water use: Outlet of Salmon Creek is controlled by a pump at the Columbia River levee. Blue Lake discharge joins Salmon Creek near the pump house. No flow data is available for Salmon and Arata Creeks.

Channel modification: Nearly all of Salmon Creek has been straightened and channelized as it flows between industrial development, including the I-84 freeway and the Troutdale Airport. Arata Creek is similarly channelized in the floodplain; however there are meandering reaches at the headwater as it passes through a condominium complex and city park. Segments of both streams are piped underground.

Sediment sources: Stormwater runoff contributes a significant amount of sediment.

Fish and water quality: No fish data found. No water quality data found.

Cedar Mill Tributary Headwaters (Rock Creek/Tualatin River)

A 362 acres pocket of rural unincorporated County area discharges to the headwaters of a Cedar Mill Creek tributary. Cedar Mill Creek is a tributary of Beaverton Creek, which drains to Rock Creek in the Tualatin River basin. This headwater area is largely forested with pockets of residential development. The urgban part of of this pocket is located in the Clean Water Services district which provide stormwater maintenance services. Land use is regulated by the City of Portland under an IGA with the County.

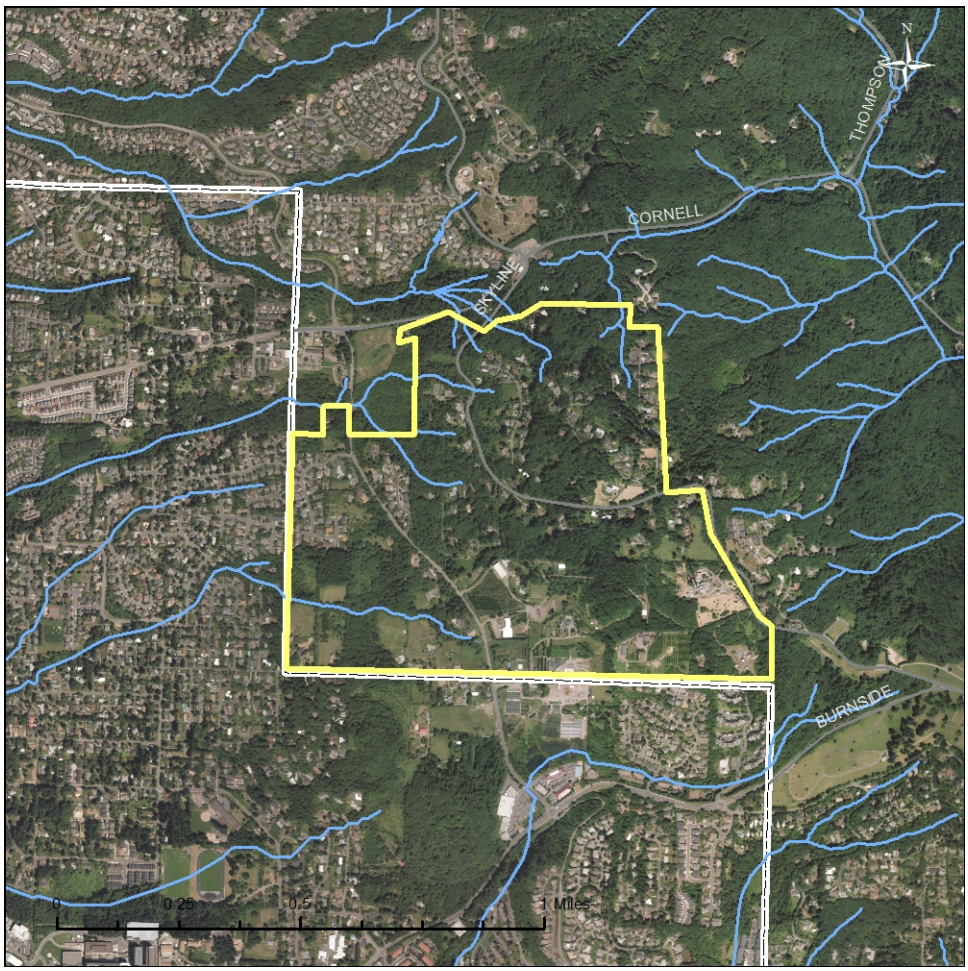

Figure 7. Area of unincorporated County in the Rock Creek watershed is outlined in yellow.

Physical Characteristics	*Description*
Soils	Poorly drained silt loam atop silt clay loam fragipan
Channel types	Moderate gradient moderately confined
Land use	• Residential development

Hydrology and water use: No data for Cedar Mill tributary

Channel modification: The upper watershed consists of steep forested ravines and development is nearly all outside of the riparian area. Very few road crossings exist, and a good riparian buffer exists downstream of the County area, despite heavy residential development.

Sediment sources: Erosion from ditches or conveyance of surrounding sediment through these ditches may occur. Stormwater runoff from residential development is likely.

Fish and water quality: No data for Cedar Mill tributary

3. SUMMARY OF HYDROMODIFICATION IMPACTS

Hydromodification impacts on streams within the County's NPDES area are the result of historic and more recent development practices. Stormwater runoff is among a wide range of impact types that occur, and while it is significant, the cumulative impacts are much more severe. In most cases, the extent of channel modification is irreversible, and returning a stream to natural or even near-natural conditions is beyond current resources for all but a few tributaries. Table 2 summarizes hydromodification impacts for key watersheds where the County has significant jurisdiction.

Table 2. Hydromodification impacts by watershed. Key: ● = major impact; ○ = minor impact; ▪ = not significant impact.

Hydromodification impact	*Beaver*	*Johnson*	*Fanno*	*Salmon*	*Fairview*
Widening/deepening of channel	●	●	●	●	●
Stream relocating	○	●	●	●	●
Straightening channel length	○	●	●	●	●
Headwater stream and wetland fills	●	○	●	●	○
Bank stabilization	○	●	●	●	●
Clearing instream debris	●	●	●	●	●
Riparian encroachment	○	●	●	●	●
Flow regulation	●	●	○	●	●
Bridge construction	●	●	●	▪	●
Culverts	●	●	●	●	●
Draining and filling wetlands	●	●	●	●	●
Urban stormwater runoff	●	●	●	●	●
Agricultural drainage	●	●	○	●	○

Note: Tryon and Cedar Mill Creeks are managed by the City of Portland and Clean Water Services, respectively, With little developed area in these watershed, these were not given priority in this plan.

4. MANAGEMENT STRATEGIES

Most of the problems associated with hydromodification stem from the fact that physical alterations upset the natural balance of streams and produce unintended, adverse downstream changes. While the County jurisdictional authority is limited, several plans and assessments have been completed to further information sharing with jurisdictional partners, and prioritize our own work.

The County is committed to practices that avoid and minimize impacts. Some general principles apply:

- Maintain natural flow volumes, velocities and delivery patterns.
- Avoid changing stream gradient.
- Control excess sediment and pollutant delivery to the stream.
- Maintain or restore natural channel shape.
- Avoid encroaching on the stream's riparian area.
- Restore instream habitat diversity.
- Avoid increasing entrenchment.

Existing County Programs

The County maintains several plans related to hydromodification. These can be found at the County Water Quality Program website: multco.us/roads/water-quality-program.

The *Road Maintenance and Operations Manual* describes how road crews perform maintenance duties on roadways by avoiding or minimizing impacts to streams. This plan was submitted to the National Marine Fisheries Services as part of a submittal for the Limit 10 Exemption of Take under the Endangered Species Act for Road Maintenance Activities.

The County also maintains a *Stormwater Management Plan* under the NPDES MS4 Phase I permit. This plan is a series of best management practices to reduce pollutants to the maximum extent practicable, including the development of stormwater treatment projects, and land use reviews to protect sensitive buffers.

The County had developed a *Stormwater Retrofit Strategy* as a requirement of the NPDES MS4 permit. This plan presents preferred alternatives and cost estimates for stormwater treatment for existing roadways in the NPDES permit area.

Total Maximum Daily Load (TMDL) Implementation Plan discusses actions the County takes for pollutant reduction on streams within the urban and rural County. While our direct influence is limited because of our jurisdictional authority, the County actively seeks opportunities to partner with agencies and participate in information sharing, monitoring, and outreach.

The County is committed to fish passage restoration for endangered fish species and other native fishes. *The County Fish Passage Assessment* describes the passability for fish using the Oregon fish passage rules, the condition of infrastructure, and a prioritization based on habitat gains.

Existing Partnerships

Under the Oregon Plan for Salmon and Watersheds, many watersheds have watershed restoration plans. These plans integrate stream health (chemical, physical, and biological measures), public and private partnerships, and urban and rural area restoration, including impacts from stormwater runoff. The County participates in several watershed coordination efforts, as time and resources allow.

Currently the County is involved in watershed coordination through the Fairview Creek Watershed Assessment, the Johnson Creek Watershed Council and Inter-Jurisdictional Committee of Johnson Creek, the Sandy River Basin Watershed Council, and the Beaver Creek Conservation Partnership. The TMDL Implementation Plan gives more detail on the relationship between these groups.

Salmon Creek has no watershed plan, but given the extremely modified condition of this short stream, and its permanent disconnection from the Columbia River, it is likely that this stream will be a low priority for restoration into the future. Other streams with existing populations of endangered fish species will take priority for County resources.

The City of Portland studies Fanno, Tryon and Balch Creek watersheds extensively, and also supports “Friends” groups, which are active. The County maintains relationships with City staff, however, direct County support has been limited given the small jurisdictional area and authority in these watersheds. The County maintains an intergovernmental agreement which transferred the stormwater maintenance to the City, as well as urban land use planning authority.

Significant Information gaps

While urban impervious area has received attention and study through the NPDES and TMDL regulatory processes, much less is known about the impacts of agriculture on watersheds.

Runoff from agriculture through ditch networks and drain tiles, chemical runoff and pesticide use, water withdrawals and impoundments are major determinants of water volume and quality. More data is needed to inform the voluntary and regulatory restoration efforts in area watersheds.

Further understanding of erosion thresholds can be gained through geomorphic characterization of stream channel and hydraulic and hydrologic modeling. Data on channel sinuosity, cross-sections, channel slopes, headcuts, bed material size, and field measured bankfull discharge are needed. The characterization of stream segments can provide the basis to assess stream bank and stream bed resilience and potentially predict catastrophic failure with bank collapse and channel incision. Historic changes and re-stabilization under the current conditions may be relevant to determine new goals for watershed health.

Conclusion

The County takes a broad perspective on hydromodification, with the overarching strategy of the hydromodification management approach to maintain and restore key watershed processes to meet both resource protection goals and regulatory requirements. This can only be accomplished by addressing all the changes in watershed functions and processes (physical, chemical, and biological). In this way, hydromodification management becomes a key component in protecting and restoring watershed functions and maintaining appropriate beneficial uses—and not just a tool to address stream-channel stability. Some physical alterations to stream channels and watersheds generally are irreversible and historic conditions cannot be restored. Working to understand where restoration can have significant impact is important to successfully coordinate action among responsible jurisdictions.

The County's urban footprint is relatively small in comparison to other cities in the area, and compared to agriculture, forestry and other land uses. However, efforts to provide stormwater treatment are important to reduce impacts, especially on water quality. The County's Stormwater Retrofit Strategy addresses opportunities for capital improvements within the road network. The County also participates in multi-jurisdictional watershed restoration efforts to create opportunities to share information, fill data gaps and coordinate restoration between jurisdictions. This hydromodification assessment serves as a basis for further study and project development in County watersheds in the NPDES permit area.

References

City of Portand Bureau of Environmental Services, 2005. Fanno and Tryon Creeks Watershed Management Plan. Portland, Oregon.

East Multnomah Soil and Water Conservation District, 2011. Beaver Creek – State of the Watershed: Spring 2011 fact sheet.

Fairview Creek Watershed Council, 2002. Fairview Creek Watershed Assessment.

Lee, K.K., and Snyder, D.T., 2009, Hydrology of the Johnson Creek basin, Oregon: U.S. Geological Survey Scientific Investigations Report 2009–5123, 56 p.

Oregon Watershed Enhancement Board. 1999. Oregon Watershed Assessment Manual. Salem, OR.

Snyder, D.T., 2008. Estimated depth to ground water and configuration of the water table in the Portland, Oregon area: U.S. Geological Survey Scientific Investigations Report 2008–5059, 40 p.

Wikipedia contributors. "Tryon Creek." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 1 Jul. 2014. Web. 12 Sep. 2014.

Wikipedia contributors. "Fanno Creek." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 1 Jul. 2014. Web. 12 Sep. 2014.