Lower White River pH Total Maximum Daily Load – Implementation Plan

Published December 2022

Publication 22-10-011a

Publication and Contact Information

This document is available on the Department of Ecology's website at: https://apps.ecology.wa.gov/publications/SummaryPages/2210011.html

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Cover photo: The Lower White River at ~River Mile 25 taken by Nuri Mathieu.

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Lower White River pH
Total Maximum Daily Load

by

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Water Quality Program

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Acknowledgements

The authors of this report thank the following people for their contribution to this study:

- Nancy Rapin– Muckleshoot Indian Tribe
- Miranda Magdangal, Ben Cope, Laurie Mann (retired), Jill Nogi, and Gunnar Johnson – United States Environmental Protection Agency
- Joel Massmann – Keta Waters LLC
- Rick Reinlasoder, Jeanne Dorn, Cameron Chapman – King County
- Eric Palmer – City of Enumclaw

Implementation Plan

Introduction

This implementation plan was developed by Ecology, with input from Muckleshoot Indian Tribe (MIT) and the United States Environmental Protection Agency (EPA). As described later in the implementation plan, Ecology has already begun reaching out to other interested local stakeholders and cleanup partners (those organizations with jurisdiction, authority, or direct responsibility for cleanup) to kick start implementation actions on the ground. This plan describes what needs to be done to improve water quality. It explains the roles and authorities of cleanup partners, along with the programs or other means through which they will address these water quality issues. It prioritizes specific actions planned to improve water quality and achieve water quality standards. Total Maximum Daily Load (TMDL) reductions should be achieved within 10 years, or by 2032. If effectiveness monitoring shows this not to be the case, adaptive management procedures described in this plan will be triggered and the implementation plan revised with new milestones and a new load reduction completion deadline.

Point source wasteload allocations (WLAs) will be largely self-implementing through the administration of the National Pollutants Distribution Elimination System (NPDES) Program. However, the TMDL lead is tasked with working with permit managers to ensure that new TMDL related requirements become permit conditions when permits are renewed. Phosphorous nonpoint load reductions will be achieved primarily by reducing or eliminating sources associated with livestock agriculture and fertilizer application. Nonpoint implementation actions will be focused in three key sub-watersheds, namely: Boise, Pussyfoot and Second Creeks.

Ecology's authority to develop and implement TMDLs extends only to waters within its jurisdiction (i.e., state waters). The Lower White River pH TMDL ensures that the overall loading capacity will be met by making certain assumptions about the loading that includes a set-aside load ('reserve load' or 'MIT reserve') to account for the portion of the river that flows through the Muckleshoot Indian Tribe's Reservation. Therefore, implementation actions for point sources and nonpoint sources applicable to TMDL reaches within MIT waters, will be determined, coordinated, and regulated by the MIT and EPA.

Watershed characterization and land distribution

Land use

Additional notes on land use can be found in Appendix A. Land use determines the type, location, and relative severity of phosphorus pollution sources. The Lower White watershed can be roughly divided into three regions based on similarity of land uses (Figure 1) – lower, middle, and upper reaches:

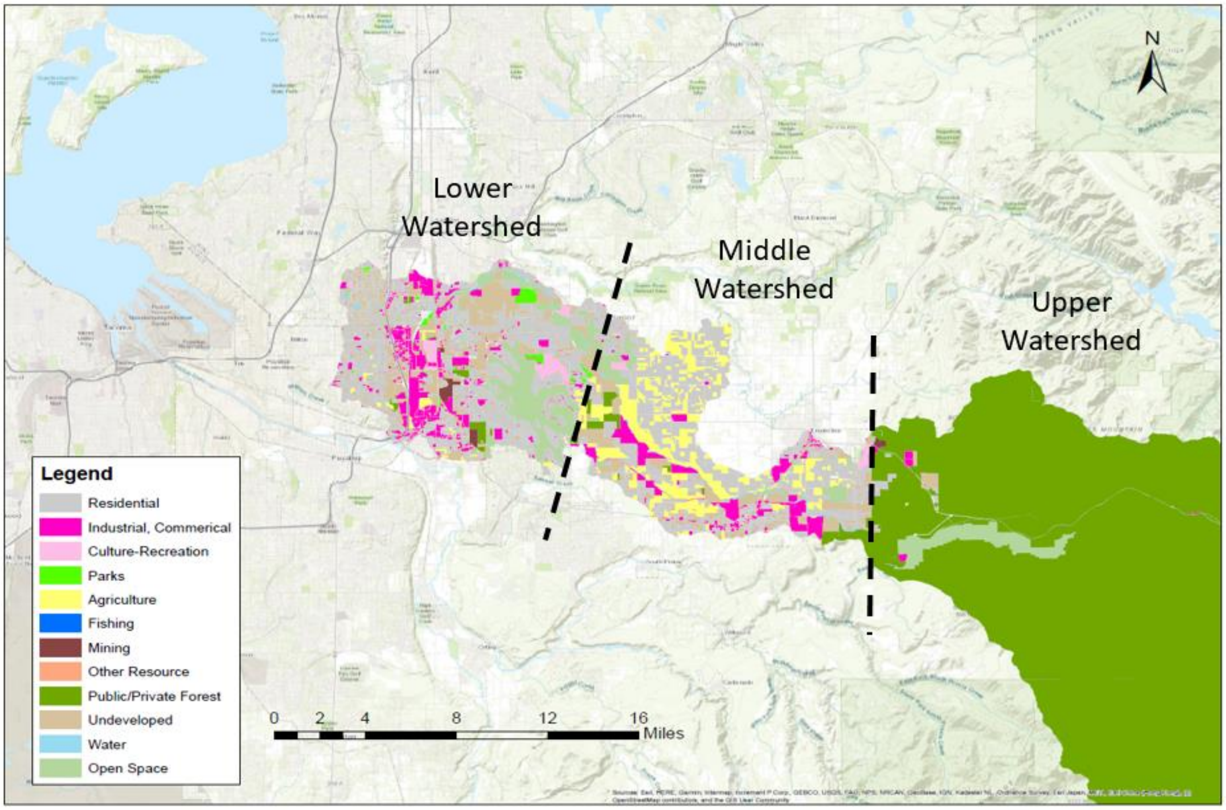

Figure 1. Land use in the White River watershed

Lower watershed - The lower watershed (from the White River mouth to roughly RM 14) near Sumner and Auburn is dominated by residential and commercial urban development, thus impervious surfaces and municipal stormwater pollution sources are of biggest concern. Point source requirements will be largely self-implementing by means of the NPDES permitting program. Thus, a robust implementation strategy is unnecessary here and this reach will not be the focus of this implementation plan. This reach includes a portion of the Muckleshoot Indian Tribe's Reservation and tribal waters.

Middle watershed - The middle reach (roughly RM 15 to RM 23) near the Enumclaw plateau is largely rural and includes a portion of the Muckleshoot Indian Tribe's Reservation (MIT Reservation) and tribal waters. With the exception of the MIT Reservation and the City of Enumclaw, which is relatively small geographically, this reach is dominated by nonpoint agricultural and onsite septic pollution sources (see Figures 2 and 3).

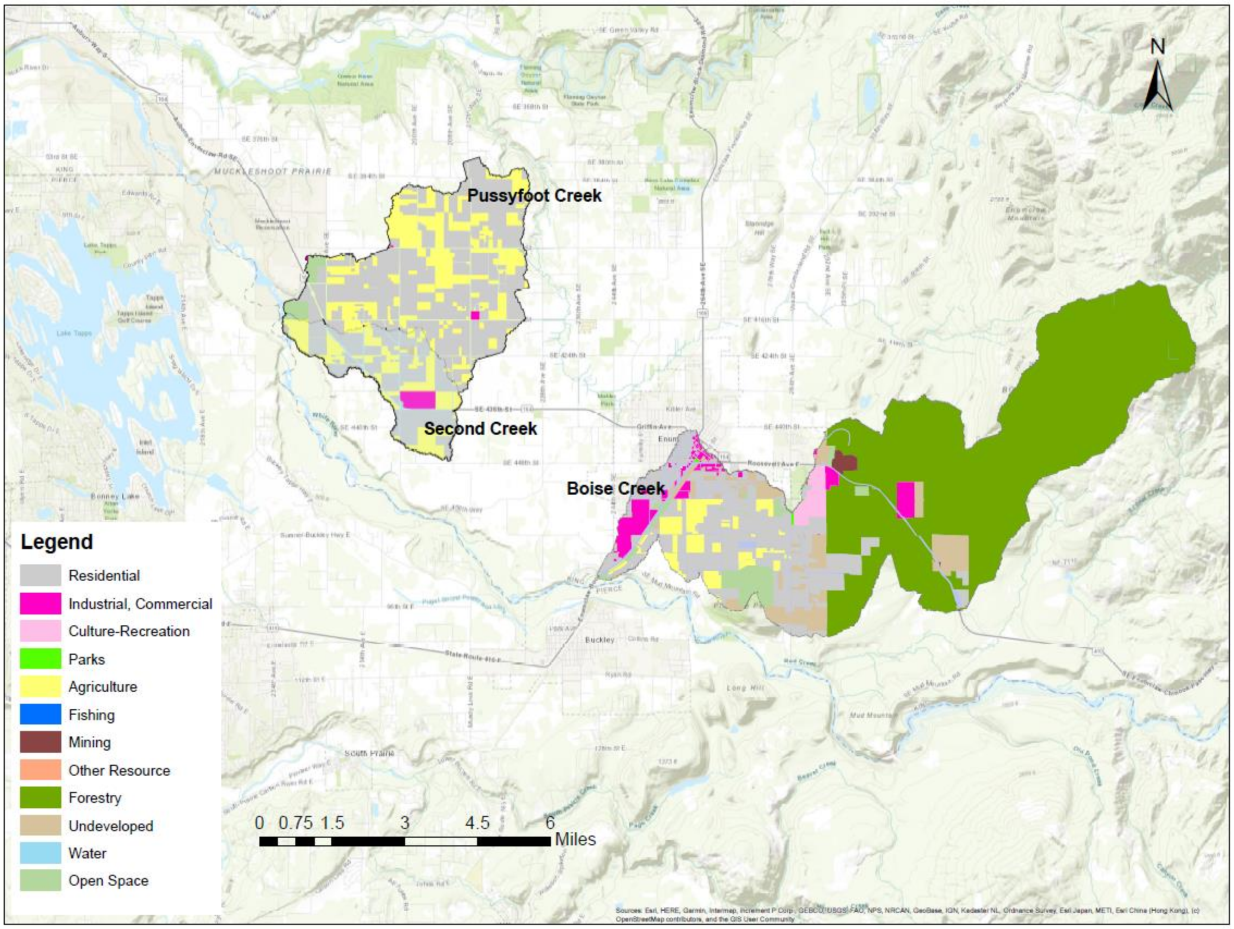

Figure 2. Boise, Second, and Pussyfoot Creek land uses

It is here that the biggest nonpoint load reductions are attainable as seen in the comparatively high anthropogenic nonpoint loading from the tributaries, Boise, Pussyfoot, and Second Creeks (Table 2). Three sub-watersheds in this middle reach, Boise, Pussyfoot, and Second Creeks (Figure 2) are the focus of the implementation plan that follows. Unless otherwise stated, the text that follows applies primarily to this middle reach, the Enumclaw plateau.

Upper watershed - The upper watershed (roughly RM 24 to RM 28) is largely wooded, with private and public commercial forestry operations dominating. Forestry lands fall under the administration of the state Forest Practices Rules. Therefore, this implementation plan will not propose additional actions here, but will rely on the implementation of these Forest Practices Rules to improve water quality on forestry lands.

Soils, topography, and hydrology

Other watershed characteristics, topography, soil types, natural and man-made hydrologic regimes are worth noting as these all likely affect phosphorus retention and transport to a degree and may impact the ease with which best management practices (BMPs) can be implemented. Additional notes on soils, topography, and hydrology use can be found in Appendix A.

The Natural Resources Conservation Service (NRCS) Soil Survey online shows soils of the Enumclaw plateau are composed primarily of poorly draining gravelly sandy and silt loams of the Alderwood and Buckley series. The NRCS describes these as generally being shallow, easily saturated, and associated with slow groundwater movement and surficial ponding. This likely results in reduced phosphorus transport via shallow groundwater and increased runoff from precipitation and irrigation.

The topography of the Enumclaw plateau is quite flat, with the exception of several isolated hills to the south and east of the City of Enumclaw. This likely exacerbates slow groundwater flow, soil saturation and surficial ponding typical of the local soils as described above. It can also complicate technical assistance and pollution source tracing efforts in that it can sometimes make it difficult to determine what direction water flows.

The Enumclaw plateau has seen significant man-made hydrologic change. Much of the Boise, Pussyfoot and Second Creek watersheds are altered – channelized, straightened, ditched, and incised in places. These changes often impede habitat recovery efforts (and associated natural processes). See Appendix C for more information concerning possible implementation challenges.

Short-term actions

For the purposes of implementation, this TMDL divides corrective measures into two categories: short-term and long-term actions. Short-term actions refer to those that can, at least in theory, be implemented immediately (i.e., within the 10-year implementation window of the TMDL), using existing regulations and resources. These often represent direct physical changes to land uses and/or the landscape. Long-term actions refer to those that are not immediately implementable. They indirectly facilitate implementation by creating the right conditions for later action. These usually include changes to land use planning and development ordinances and may require many years of preparation to enact.

Point sources of pollution

Point source requirements are detailed under the TMDL Allocations section. As stated previously, these requirements are expected to be largely self-implementing via the NPDES program. However, it will still be necessary for TMDL leads to monitor progress and permit renewal schedules to ensure WLAs are incorporated in future permits in a timely fashion. Current Washington State permit status is summarized in Table 1. Corresponding renewal deadlines are incorporated in the TMDL implementation timeline.

Table 1. Permit effective and expiration dates for Lower White River pH TMDL point sources

Permit Type	Effective Date	Expiration Date
Buckley STP	May 1, 2003	* April 29, 2008
Enumclaw STP	May 1, 2003	*April 29, 2008

Permit Type	Effective Date	Expiration Date
Municipal Stormwater (Phase I, Western WA)	August 1, 2019	July 31, 2024
Municipal Stormwater (Phase II, Western WA)	August 1, 2019	July 31, 2024
Construction Stormwater General	January 1, 2021	December 31, 2025
Industrial Stormwater General	January 1, 2020	December 31, 2024
Manke Lumber Industrial Stormwater Individual	October 20, 2020	September 30, 2025
Sand and Gravel General	April 1, 2021	March 31, 2026.

* Permit administratively extended

All permits are currently active. In general, permit renewal begins close to permit expiration, usually on a 5-year cycle. However, some permit renewals (typically individual permits) are delayed due to processing backlogs. In these instances, permits are administratively extended. For example, permits for the Buckley and Enumclaw WWTPs expired in 2008, but have been administratively extended. Per WAC 173-220-180(5) these extended permits are in effect and enforceable until the application has been denied or replacement permits issued. The Buckley WWTP permit was being renewed at the time of writing. The renewed permit is expected to become effective early, 2023. At the time of writing, it was unclear when the Enumclaw WWTP permit will be renewed. TMDL WLAs will be incorporated into permit at renewal or through a permit modification if renewal is delayed. TMDL requirements must be incorporated in all permits within 10 years of TMDL approval. And all permittees are expected to be in compliance within 10 years of TMDL approval. This is the same implementation timeframe set for nonpoint sources.

Permits for MIT lands will be administered by EPA. Ecology does not have jurisdiction or oversight over Tribal permit issuance or renewal, the White River Hatchery is currently covered under EPA's NPDES General Permit for federal aquaculture facilities and aquaculture facilities located in Indian Country in Washington (EPA's NPDES Aquaculture General Permit), while other MIT facilities have not yet been constructed (e.g., the Coal Creek Hatchery). Therefore, Tribal permits are not included in the above table. However, we recommend TMDL leads and/or implementation staff communicate with their counterparts at EPA to ensure, to the extent possible, that TMDL requirements are included in EPA permits in a timely fashion.

Nonpoint sources of pollution

Nonpoint sources are a significant element of the loading capacity and nonpoint load reductions will be essential to ensuring TMDL phosphorus (and pH) reduction goals are met. The highest nonpoint phosphorus loading originates from tributaries in the Enumclaw plateau area (Table 2). Therefore, these tributaries (Boise, Second, Pussyfoot Creeks) are the focus of this implementation plan. Pussyfoot and Second Creeks flows can be highly variable during much of the critical period, however our data suggest focusing nonpoint implementation in these drainages is warranted, regardless of seasonal flow patterns. The combined anthropogenic SRP loading from Pussyfoot and Second Creeks is over 15% of the total from all tributaries sampled during low flow conditions and nearly 11% in medium flow conditions. When combined with the loading from nearby Boise Creek, these three creeks represent just under half of the total anthropogenic nonpoint loading for the entire TMDL project area. Furthermore, TMDL analysis shows that the greatest likelihood of exceeding water quality standards is during low flow conditions at the start and end of the TMDL critical period (i.e., in May and October) when Pussyfoot and Second Creeks are more likely to be flowing.

The category ‘all other diffuse sources’ was developed based on the residual flow balance and SRP samples collected from gaining piezometers. While this is assumed to be primarily groundwater discharge, the allocation covers any small tributaries or seeps that may discharge to river during non-runoff conditions.

Red Creek was also found to be contributing relatively high nonpoint phosphorus loading to the White River. However, unlike the other tributaries mentioned, a review of land use and aerial imagery shows Red Creek has little, if any agriculture, and is instead dominated by forestry activities. Because we rely on the implementation of the forest practices program and its adaptive management program to address forestry activities and because loading analysis shows nonpoint reductions are possible without resorting to work in Red Creek (see Reasonable Assurance), this tributary is not addressed in this implementation plan.

The EPA recommends that watershed cleanup plans identify and address the following: pollution pathways, the types of pollution sources, the relative pollution contribution from these sources, restoration priorities, and target BMPs where they will be most effective. The next sub-sections attempt to follow this structure.

Source types

Additional notes on research related to the various source types described below are provided in Appendix D. A review of land uses (Figure 2), aerial imagery, and the results of informal watershed tours of the Enumclaw plateau show the most likely nonpoint sources of dissolved phosphorus in the Enumclaw plateau are as follows (in order of implementation importance):

Agriculture

The United States Environmental Protection Agency (EPA) has identified agricultural sources, including grazing and animal feeding operations to be probable key contributors of phosphorus (and nitrogen) to rivers and streams (see Appendix D).

Direct animal access to streams, manure or fertilizer overspray or runoff, runoff from pastures, grazing areas, and heavy use areas are significant potential sources of nutrients to Washington’s waters (see Appendix D). Given the land uses described earlier, livestock agriculture is thought to be the dominant nonpoint source of phosphorus in the Enumclaw plateau. While rainfall does occur in the summer TMDL critical period within the project area, most runoff is expected to occur in the wetter winter months.

Table 2. Nonpoint phosphorus loading and load reductions for Lower White River tributaries

Approx. River Mile	Model Reach	White River Tributary	Nonpoint Reduction	Existing SRP (ug/L)	SRP Conc. After Reduction (ug/L)	Total Existing SRP Load (lbs/day)	Natural SRP Load (lbs)	Approx. Anthropogenic Load (lbs)	Anthropogenic Load Reduction (lbs)	LA" Total Load after Reduction (lbs)
Low Flow	**Low Flow**	**Low Flow**	**Low Flow**	**Low Flow**	**Low Flow**	**Low Flow**	**Low Flow**	**Low Flow**	**Low Flow**	**Low Flow**
27	1	Red Creek	0%	26.45	26.45	0.116	0.057	0.059	0	0.116
23	5	Boise Creek	50%	17.6	15.3	0.72	0.526	0.194	0.097	0.623
15.7	13	Second Creek (aka Trib15.7)*	35%	229	153.4	0.024	0.001	0.023	0.008	0.016
15.6	14	Pussyfoot Creek (aka Trib15.6)*	35%	53.68	39.44	0.133	0.032	0.101	0.035	0.098
7.6	23	Bowman Creek	0%	7.54	7.54	0.03	0.030	0.000	0	0.03
5.4	25	Government Canal	0%	16.48	16.48	0.07	0.053	0.017	0	0.07
4.3	28	Tributary at RM4.3	0%	13.90	13.90	0.054	0.019	0.035	0	0.054
28 to 3.6	1 to 28	All other diffuse sources	0%	n/a	n/a	5.45	5.07	0.380	0	5.450
					Subtotal =	6.60	5.79	0.81	0.14	6.46
Med Flow	**Med Flow**	**Med Flow**	**Med Flow**	**Med Flow**	**Med Flow**	**Med Flow**	**Med Flow**	**Med Flow**	**Med Flow**	**Med Flow**
27	1	Red Creek	0%	26.45	26.45	0.230	0.113	0.117	0	0.230
23	5	Boise Creek	50%	19.28	16.14	1.574	1.06	0.514	0.257	1.317
15.7	13	Second Creek (aka Trib 15.7)*	35%	229	153.4	0.036	0.002	0.034	0.012	0.024
15.6	14	Pussyfoot Creek (aka Trib 15.6)*	35%	53.68	39.44	0.191	0.046	0.145	0.051	0.140
7.6	23	Bowman Creek	0%	9.6	9.6	0.055	0.055	0.000	0	0.055
5.4	25	Government Canal	0%	21.9	21.9	0.241	0.143	0.098	0	0.241
4.3	28	Tributary at RM4.3	0%	13.9	13.9	0.095	0.033	0.061	0	0.095
28 to 3.6	1 to 28	All other diffuse sources	0%	n/a	n/a	8.55	7.87	0.680	0	8.550
					Subtotal =	10.97	9.32	1.65	0.32	10.65

*Small portions of each Second Creek and Pussyfoot Creek are within MIT Tribal waters and therefore implementation actions applicable to these TMDL reaches within MIT waters will be determined and coordinated by the Muckleshoot Indian Tribe and the Environmental Protection Agency.

Manure may not reach surface water during the TMDL critical period as much as it does at other times of the year, but leachate and transport associated with manure during winter likely serves as a phosphorous source during the more biologically productive summer months. While surface runoff and erosion are important transport mechanisms on an annual basis, shallow groundwater may be an additional source of phosphorus loading during non-runoff conditions. The pollution transport pathway section provides a more detailed discussion of the potential influence of runoff and groundwater.

Onsite septic systems

In addition to livestock agriculture, failing or improperly constructed/sited onsite septic systems (OSS) are also thought to be a potentially important phosphorus source in the TMDL project area. Much of the Enumclaw plateau is serviced by OSS (Figure 3).

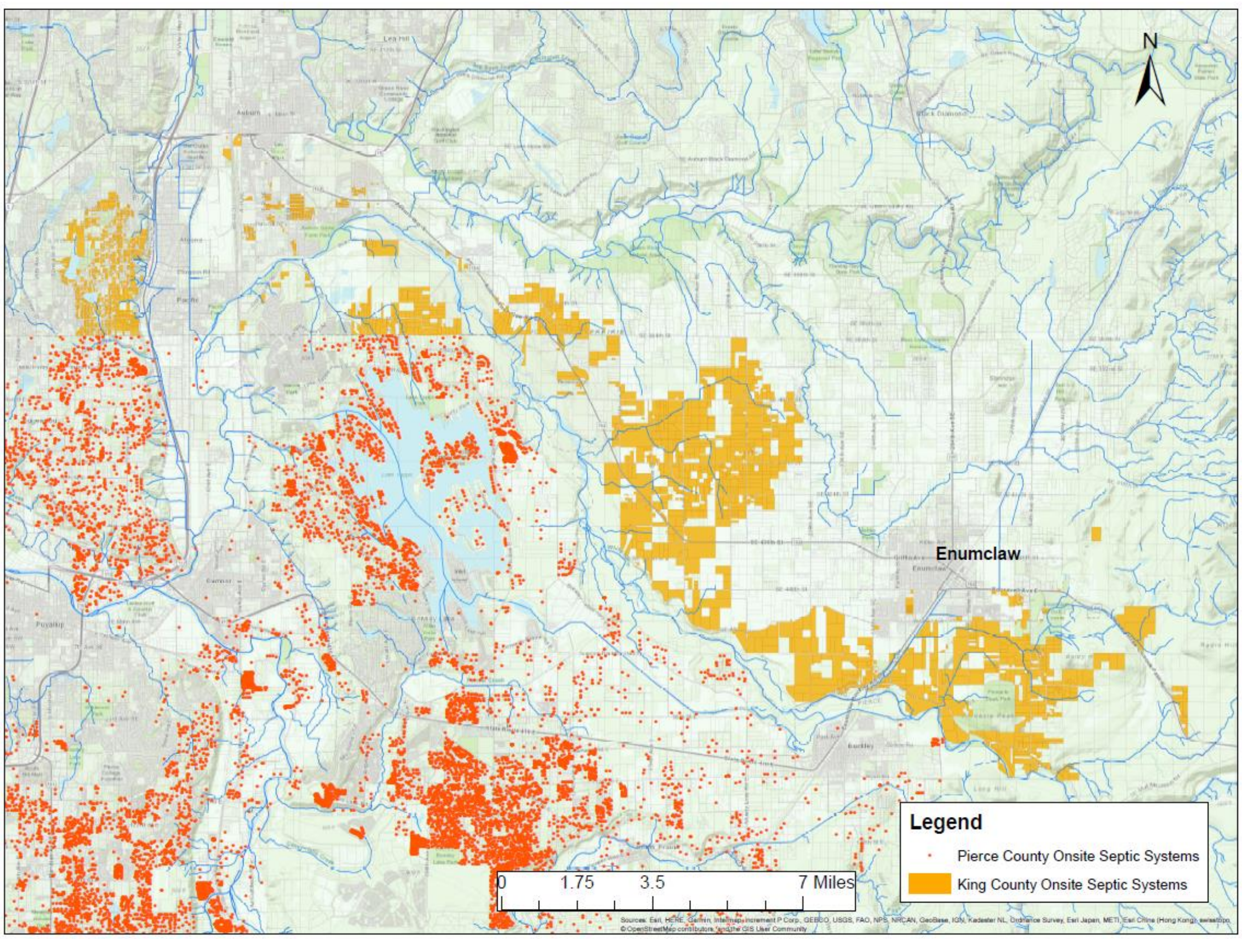

Figure 3. Onsite septic systems in the Lower White River drainage*

*The information included in Figure 3 has been compiled by County staff from a variety of sources and is subject to change without notice. Neither Ecology nor the Counties make representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a survey product. Neither Ecology nor the Counties shall be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. The information contained herein may not reflect current conditions.

Generally, septic systems are considered an effective means of wastewater treatment provided they are designed, sited and maintained correctly (see Appendix D). However, in areas with shallow groundwater or soils that become quickly saturated, as is the case in the Enumclaw plateau, treatment may not be as effective (see Appendix D). Also, several direct discharges of septic systems to surface waters have been found (and corrected) in the Boise Creek watershed (Jeanne Dorn, King County, personal communications, 2019) and it's possible more exist. Despite this, this TMDL considers onsite septic systems to be less important sources of phosphorus than agriculture in the Enumclaw plateau, primarily because shallow groundwater movement is usually not a significant phosphorus transport pathway, especially in waterlogged soils, and because analysis (see Reasonable Assurance) suggests loading from septic systems to be relatively low. Septic systems are thus a secondary focus of this TMDL implementation plan.

Forestry

As mentioned, commercial private and public forestry operations dominate the upper reaches of the Lower White river watershed (Figure 1). Forest practices that increase erosion (e.g., road construction), increase runoff (harvest of riparian vegetation) or increase nutrient availability (fertilization) could theoretically increase nutrient loading to adjacent streams. However, in the area this implementation plan focuses on, the Enumclaw plateau, agriculture is more significant. Of the three tributaries of primary concern in this TMDL (Boise, Second, Pussyfoot Creeks) only Boise Creek has any substantial forestry activity (Figure 2). However, nonpoint anthropogenic phosphorous loading from Boise Creek exceeds that of the other tributaries (Table 2). Furthermore, loading analysis (see Reasonable Assurance) suggests that this anthropogenic load cannot be adequately addressed in its entirety without considering upstream forestry practices.

However, research suggests (see Appendix D) the dissolved phosphorus related impacts of *current* harvest practices on some streams of western Washington are negligible. This TMDL suspects that current loading from the upper Boise watershed is due largely to the legacy impacts of less protective practices prior to the Forest Practices Rules coming into effect. Past forestry practices in upper Boise Creek emphasized resource extraction and were less protective than current practices. In addition, loading analysis (see Reasonable Assurance) suggests that if agricultural and OSS sources in Boise Creek are properly addressed downstream, relatively little additional load reductions will be required of forestry properties upstream. Therefore, this TMDL will rely on the more protective practices of the Forest Practices Rules and recovery via the natural attenuation of legacy sources to meet additional phosphorus reduction needs in Boise Creek.

Enumclaw golf course

The City of Enumclaw's golf course could potentially be an additional source of phosphorus, to Boise Creek specifically. It's a fairly large City owned property (approximately 433 acres) located between the flat agricultural plateau of middle Boise and the upper forested watershed. Boise Creek winds through the entire length of the golf course therefore there's substantial opportunity for management activities to contribute phosphorus loading. Ecology found that groundwater sampled between the Sumner Meadows Golf Course (now closed) and the White River at ~RM 4 contained the highest observed SRP concentrations in the 2012 study (427 ug/L). However, because the Enumclaw Golf Course represents only a small fraction of the total land use acreage in the watershed it's considered a lower priority than livestock agriculture and septic sources. Other managed turf grasses (e.g., parks, sports fields) are likely managed in a similar manner to golf course grasses, and thus could theoretically represent an additional phosphorus source. However, a review of aerial imagery shows that park/sport field lawns are not widespread in the Enumclaw plateau, being concentrated in or near the City of Enumclaw. And few of these are located directly adjacent to Boise Creek, instead discharging to the City of Enumclaw's municipal stormwater drainage system. As such, these potential sources fall under the jurisdiction of City's municipal stormwater permit. As with the golf course above, these other turf grass properties are thought to be relatively minor phosphorus sources in comparison to livestock agriculture and septic systems.

Pollution transport pathways

Runoff and Erosion

Research suggests that the chief phosphorus delivery pathways in agricultural areas are runoff and erosion (see Appendix D). Erosion is generally associated more with particulate phosphorus than dissolved phosphorus (see Appendix D) and thus, this TMDL prioritizes BMPs that address runoff. However, erosion is an important consideration in determining the bioavailability of P transported. Suspended sediment can rapidly sorb dissolved phosphorus and transformations of particulate to dissolved phosphorus do occur (See Appendix D). Therefore, erosion is still of relevance to this TMDL. During the drier summer months of concern in this TMDL, reduced surficial runoff from rainfall is likely supplemented by irrigation. During the driest periods of late summer, irrigation runoff may be as or more significant a transport vector as precipitation.

Although runoff and erosion typically provide the primary transport mechanism for phosphorus, phosphorus associated with runoff can also be deposited within the sediment layer of small streams. Sediments enriched with phosphorus from runoff can release phosphorus back into the water column during baseflow periods, particularly when the stream water is low in background phosphorus (see Appendix D). Figure 4 provides a conceptual example of this mechanism.

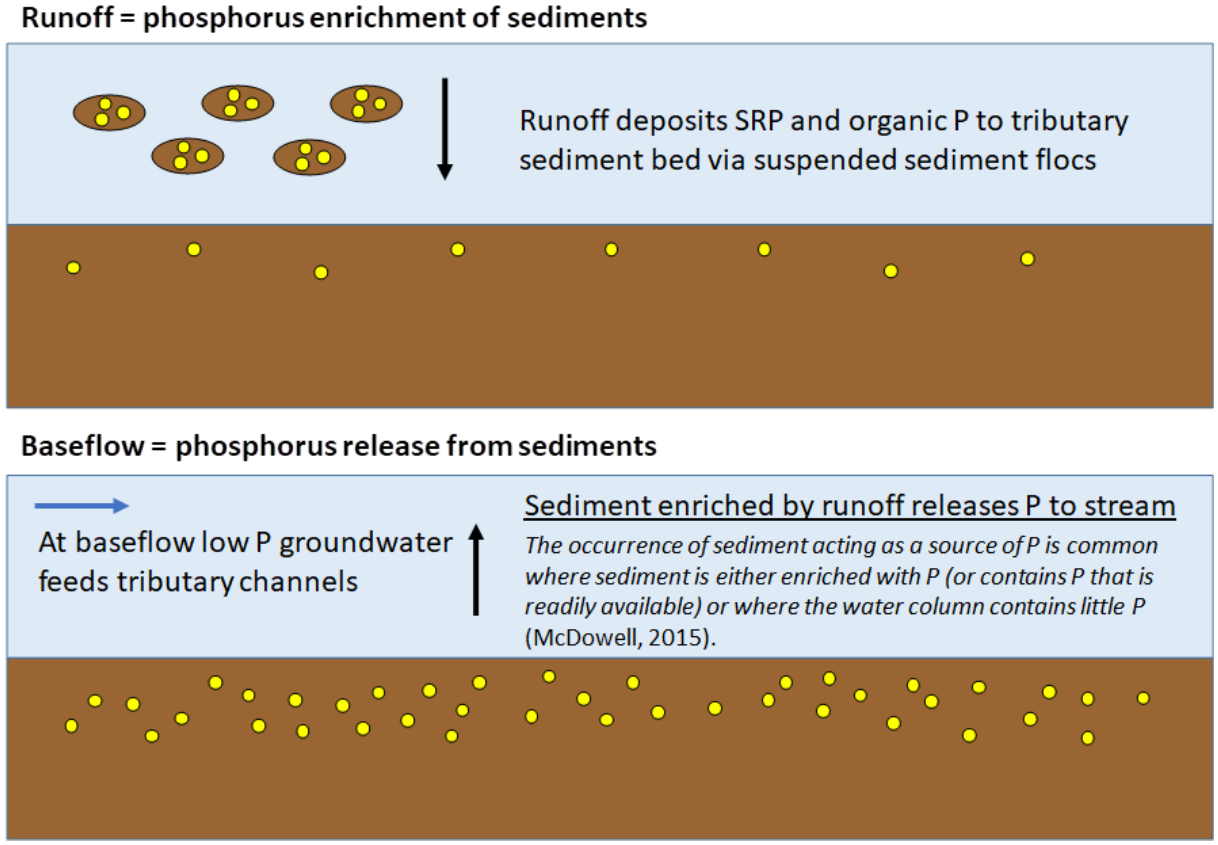

Figure 4. Phosphorus transport and release

Groundwater

See Appendix D for additional notes on groundwater. As stated, research suggests that runoff and erosion are typically the primary transport pathways for dissolved phosphorus to reach surface water. However, during the dry summer months of focus in this TMDL, groundwater transport may become comparatively more important. Lateral discharge appears to provide a source of baseflow to tributaries during non-runoff conditions. Ecology field staff confirmed these observations during the 2012 study. While shallow groundwater transport may become relatively more important in summer, it's unlikely that it surpasses runoff and erosion given the large body of scientific literature suggesting the contrary. Perhaps most important is not so much the quantity of phosphorus transported via groundwater relative to runoff/erosion, but the manner in which groundwater moisture and phosphorus content influence runoff/erosion transport.

Artificial Drainage

See Appendix D for additional notes on artificial drainage. Phosphorus transport via man-made drainage networks may well be highly significant and subsurface drainage may be even more important. Subsurface drainage systems, e.g., tile drains, are a common method of quickly drying agricultural soils prone to saturation. Artificial drainage systems are especially important because they can bypass many of the typical BMPs installed to address runoff and erosion transport, acting as direct conduits of phosphorous to waterways. Unfortunately, artificial drainage systems are often not easy to find because they're not flowing constantly, and subsurface drainage systems aren't usually visible. Similarly, eliminating these pathways may be challenging as removal of these structures may return soils to a semi-permanent waterlogged state, interfering with agricultural activities. Regardless it's important that TMDL implementers be on the lookout for drainage systems and attempt, as much as possible, to incorporate these sources into a holistic suite of solutions at problem sites.

Best Management Practices

This TMDL classifies nonpoint corrective measures into three broad categories, prioritized as follows:

1) Source control
2) Transport abatement
3) Nonpoint treatment

Research (see Appendix D) shows that practices reducing direct delivery of nutrients to surface runoff may yield the most rapid reductions in nutrient loading. Consistent with this the primary implementation focus of this TMDL is on implementing suites of best management practices (BMPs) that reduce or eliminate *sources* of dissolved phosphorus, specifically soluble reactive phosphorus (SRP). If nothing else, TMDL implementation should reduce or eliminate new, additional SRP loading. Phosphorus source control BMPs include practices such as proper manure storage and fertilizer application, livestock exclusion from riparian areas, riparian buffers, and regular onsite septic sewer inspection and repair.

This TMDL implementation plan also includes those BMPs that control or reduce phosphorous transport (runoff and erosion). These practices include riparian buffers, soil amendment, artificial drainage management, irrigation efficiency and conservation tillage practices.

Due to resource and site constraints (see Appendix D) this TMDL does not regard phosphorus removal structures as viable alternatives to source and transport control measures, and treatment is regarded the lowest implementation priority. However, treatment structures may have site-specific value, where source/transport control measures aren't sufficient (e.g., golf courses). Some source/transport control BMPs may indirectly provide additional treatment function.

BMPs are listed in Table 3 (1 = highest priority and 2 = priority). Natural Resource Conservation (NRCS) Field Office Technical Guide (FOTG) codes are also provided as a convenient reference.

Table 3. TMDL implementation BMP priorities

BMP Importance	Implementation Priority	NRCS FOTG	BMP	Source Control	Transport Abatement	Nonpoint Treatment
Needed	1	313	Proper manure storage	✓		
Needed	1	590	Proper fertilizer application, nutrient management plan	✓		
Needed	1	472	Livestock exclusion	✓		
Needed	1	391	Riparian buffers	✓	✓	✓
Needed	1	N/A	Onsite septic tank inspection, repair and maintenance (not NRCS funded)	✓		
Optional	2	333	Soil amendment		✓	
Optional	2	554	Tile drain, drainage water management		✓	
Optional	2	329, 345	Conservation tillage; no till, reduced till		✓	
Optional	2	449	Improved irrigation efficiency		✓	
Optional	2	N/A	Property acquisitions combined with restoration actions (not NRCS funded)	✓	✓	✓

Ecology recommends implementing suites of BMPs that are designed to comprehensively address pollution that can be generated by a land use. The first five BMPs listed in the table are considered compliance minimums, meaning these will need to be installed if TMDL nonpoint load reductions are to be achieved. 'Minimums' in the context of compliance with this TMDL means if sources are present, the expectation is that every source will be addressed using the appropriate BMPs listed. This does not imply that every site must have all five BMPs present at all times. For example, if no livestock are present, it would not be necessary to install livestock exclusion fencing. Brief guidance on the five priory BMPs is provided below, but implementers are encouraged to review the more detailed guidance given in Appendix D.

The remaining BMPs listed in (Table 3) are considered optional, they will help meet the TMDL load reductions, but considering the dominant land uses in the Enumclaw plateau and practical difficulties/constraints of implementation, TMDL implementers will need to employ them opportunistically. These BMPs likely cannot be relied upon as the primary tools to achieve TMDL compliance, but there may be situations where site-specific circumstances demand that these 'optional' BMPs are implemented. For example, if tile drains or ditches are present, drainage management may need to be made a priority because artificial drainage can bypass other BMPs. Similarly, depending on the results of effectiveness monitoring efforts, adaptive management could necessitate a long-term reorganization of priorities later, with increased emphasis placed on those BMPs. These BMPs are discussed in detail in Appendix D.

NRCS codes are provided so that, if need be, implementers can quickly access reference information regarding the engineering/design of the BMP. Referencing NRCS codes should in no way be interpreted to imply that the NRCS requirements supersede Ecology's water quality guidance. Where discrepancies exist between Ecology and NRCS guidance, implementation partners are highly encouraged to follow Ecology's recommendations as expressed in this TMDL, unless NRCS requirements are more stringent. Ecology staff will use this TMDL as the foundation for their work in the TMDL project area.

This TMDL's recommendation is that the practices listed be implemented in combination as a holistic system, because they support each other. The sum benefits are greater than the individual parts alone. Implementers should take note that the BMPs that follow describe the minimum needed to address phosphorus discharges only. They may not be sufficient to address other parameters of concern (e.g., temperature). Implementers should consider all parameters known to be of concern in project areas and scale BMPs to meet the most restrictive needs. Appendix D provides a detailed description of each individual BMP.

Manure storage

- Ensuring manure is covered so as to eliminate contact with rain.
- Ensure manure contact with soil is reduced or eliminated. Manure should preferably be stored on a concrete pad or contained in a water tight, leak free structure.
- Locate manure storage structures/manure piles away from surface waters, a minimum 50ft distance from surface waters is required for TMDL compliance purposes, but 100ft is strongly recommended.

Fertilizer application

- Applicators should avoid periods of intense rain and colder temperatures when biological activity is reduced. They should not use fertilizer in winter, and avoid application in the colder shoulder seasons and during summer rain storms.
- Specific attention should be paid to avoiding 'first flush' events, i.e., the first two rainfall events following a dry spell.
- A minimum 3-day window *between* application and the first runoff event is highly recommended.
- A minimum 50ft buffer between the fertilizer application area and surface waters is required as a minimum for TMDL compliance purposes, but a 100ft buffer is highly recommended.
- Landowners should apply manure at 'agronomic rates' using soil testing and following a nutrient management plan. Adjust nutrient applications when soil sampling demonstrates that crops are not utilizing applied nutrients.

Livestock exclusion

- Restricting access will help to prevent livestock from defecating in the riparian corridor and protect native riparian vegetation from grazing and trampling.
- Well-constructed, permanent fencing is usually the most effective livestock exclusion tool.
- Fencing and riparian buffers are typically implemented in combination.
- Fences should be located at minimum 50ft from perennial and seasonal streams for phosphorus control purposes only, but 100ft buffers are strongly recommended.

Riparian buffers

Consistent with the scientific literature reviewed related to dissolved phosphorus (see Appendix D), this TMDL Implementation Plan includes a 50ft as the minimum buffer width as necessary (on perennial and seasonal streams) to achieve assigned phosphorus reductions only (Table 4). This buffer width may not always be sufficient to achieve targeted reductions of phosphorus inputs to water; therefore, wider buffer widths are also recommended.

Depending on site conditions, wider buffer widths may be necessary for SRP phosphorus control along some stream segments. TMDL implementers are encouraged to evaluate site specific conditions that may apply to necessary buffer widths for SRP control for each location.

Table 4. Minimum buffer widths for SRP control and recommended buffer widths for broader water quality protection and funding eligibility purposes

Waterbody Type	Minimum Widths	Recommended Widths
Perennial streams	50ft	100ft
Seasonal, ephemeral and intermittent streams	50ft	50-100ft*
Artificial drainage and ditches**	20ft	35ft

*width dependent on the historic or current presence of anadromous fish.
**if located near a salmonid waterbody, a wider buffer may be necessary.

However, 100ft buffers are highly recommended to be protective of other water quality parameters (e.g., temperature) and to be consistent with Ecology's 319/Centennial funding eligibility criteria. Additional considerations are as follows:

- TMDL implementers should give thought to the species composition and structure of riparian buffers. Only native species are recommended for planting and a mix of grasses, forbs, shrubs and trees is recommended.
- Buffers must preferably be actively maintained (e.g., weeded, replanted) until the riparian forest becomes self-sufficient, typically 5-10 years after planting. Buffers must remain in place in perpetuity.
- Buffers may need to be combined with livestock exclusion fencing to ensure riparian vegetation is protected from disturbance.

Onsite septic tank inspection, repair and maintenance

- Home owners should regularly inspect and maintain septic systems. Gravity systems - every three years. Pressure distribution systems, proprietary systems, mound and sand filter systems - annually
- Pump septic tanks every 3-5 years. A general rule of thumb is the more people using the system, the more frequent pumping needs to be.

Implementers should consider referrals to their partners at Seattle & King County Public Health if they find the following:

- Bad odors around the drainfield area especially after heavy water use or rainfall
- Very wet spots with lush green grass growth over the drainfield or septic tank areas
- Standing water in the drainfield area
- Plumbing or septic tank back-ups
- Slow draining fixtures
- Gurgling sounds in the plumbing systems

Long-term actions

The nonpoint BMPs above will address immediate concerns associated with current pollution sources. However, long-term considerations, such as changes in zoning and land use regulations can have a significant impact on pollution loading as well. TMDL implementers may have little, if any, direct control over these processes, but they can help remind those that do of water quality considerations and advise actions most consistent with the TMDL. Implementers should therefore keep track of important dates in various planning processes and coordinate with leads to be able to provide input as appropriate. This TMDL deems the following to be the most important legislation for long-term implementation purposes:

- Growth Management Act (GMA)
- Shoreline Master Act (SMA)
- State Environmental Policy Act (SEPA)

These and other planning processes are discussed in detail in Appendix E. For the programs listed, implementers are expected to compare the BMP priorities listed under short-term actions above with existing land use/development and oversight regulations. If gaps exist, implementers must make recommendations via the appropriate planning processes to address the shortcomings. This TMDL does not attempt to do that analysis here as it’s too detailed for the scope of this document and adaptive management may necessitate future changes to BMP priorities. TMDL implementers should make that analysis on a case-by-case basis closer to the respective planning process renewal dates (below):

GMA – Per RCW 36.70A.130 on or before June 30, 2015, and every **eight** years thereafter, King, and Pierce counties and the cities within those counties are required to review and, if needed, revise their comprehensive plans and development regulations. For TMDL implementation purposes, this means that the next opportunity for TMDL implementers to participate in GMA process will be June 2023. It's recommended TMDL implementers begin their outreach focusing on local governments. If that proves unsuccessful, TMDL Implementers may need to shift focus to the state Department of Commerce.

Shoreline Management Act (SMA) – Per RCW 90.58.080 on or before June 30, 2019, and every **eight** years thereafter, King and Pierce counties and the cities within those counties are required to conduct a review of their master programs and associated documents for each local government per WAC 173-26-201(2)(f), at least once every eight years. If necessary, they revise their master programs to assure that the master program complies with applicable law and guidelines in effect at the time of the review, as well as assure consistency of the master program with the changes in local circumstance on the ground and in the comprehensive plan and development regulations. For TMDL implementation purposes, this means that the next opportunity for TMDL implementers to participate in SMA process will be June 2027. TMDL Implementers will need to work primarily with the Ecology SEA Program staff if TMDL related revisions are appropriate.

State Environmental Policy Act (SEPA) – Reviewers must consider TMDLs during SEPA and other local land use planning reviews. If the land use action under review is known to potentially impact pH and/or phosphorous as addressed by this TMDL, then the project may have a significant adverse environmental impact. SEPA lead agencies and reviewers are required to look at potentially significant environmental impacts and alternatives and to document that the necessary environmental analyses have been made. Land-use planners and project managers should consider the actions in this TMDL to help prevent new land uses from violating water quality standards. For example, to the extent possible, Shoreline Master Program (SMP) prescriptions should preferably be at least as stringent as the BMP recommendations given in this implementation plan. In addition, the TMDL should be considered in the issuance of land use permits by local authorities. Mitigation measures to avoid, minimize, and compensate impacts to pH and phosphorus loading consistent with this TMDL's BMP recommendations should be incorporated into projects. TMDL Implementers are expected to review and comment (if necessary) on SEPA proposals in the TMDL project area as part of their regular assigned duties.

Organizations that implement the TMDL

To implement the BMPs needed to achieve water quality standards, Ecology will need to work with partners in the watershed. Many organizations could potentially play a role in implementation. Appendix F discusses these organizations in detail, they are listed here:

- King Conservation District
- King County
- Stormwater Services Section
- Permitting Division, within the Local Services Department
- Livestock Program

- Farmland Preservation Program
- Public Health Seattle – King County
- City of Enumclaw
- City of Buckley
- Muckleshoot Indian Tribe
- Washington State Department of Transportation (WSDOT)
- Washington State Department of Agriculture (WSDA)
- Natural Resource Conservation Service (NRCS)
- Washington Cattleman's Association (WCA)
- Washington State University (WSU) extension
- The Washington Farm Bureau
- Pierce County Public Works and Utilities, Surface Water Management Division
- Pierce Conservation District (PCD)
- King CD Stream Steward Program and the Pierce Stream Team
- Puyallup Tribe of Indians
- Tacoma Pierce Health Department (TPCHD)

Of these, five are critical to TMDL implementation success in the focus area in the Enumclaw plateau. These include King County, Seattle-King County Public Health, King Conservation District, City of Enumclaw, and the Muckleshoot Indian Tribe. Ecology has already begun outreach to these core groups (see Outreach section) and currently enjoys good collaborative working relations with them. Ecology hopes to further deepen these ties and leverage these relationships over the next 10 years to implement the actions described. While no nonpoint work is currently planned in Pierce County, it's possible that future adaptive management efforts necessitate additional work there. Therefore, potential Pierce County partners are also listed above.

Priorities

Implementation resources and staff are limited, and it's not possible to fix all problems everywhere at once. So, it's important to focus those resources on priority areas where they can have the biggest impact. Several studies have underscored the importance of concentrating implementation resources on sensitive source areas within a watershed, rather than implementing general strategies over a broad area (see Appendix G). Prioritization is a key component to any successful implementation strategy. This TMDL attempts to prioritize implementation systematically, at increasingly finer scales, starting at the watershed level, then narrowing focus to sub-watersheds or tributaries, finally ending at the individual parcel level. The goal is to provide implementers a clear roadmap to take the information presented previously and apply it at the site level in a way that addresses the most significant sources in the most effective and efficient manner possible.

Watershed scale

This TMDL focuses implementation efforts in tributaries of the Enumclaw plateau where agricultural land uses are most prevalent, specifically Boise, Pussyfoot and Second Creeks. This TMDL recommends implementers further prioritize their work according to the total anthropogenic loading from each tributary. For tributaries with proactive implementation, Table 5 shows tributary implementation priorities, based on data from Table 2. Implementation on the remaining tributaries should occur on an opportunistic basis, so they are not prioritized.

Table 5. Tributary SRP Anthropogenic Loading and Associated Implementation Priorities

Implementation Status	Tributary	Anthropogenic SRP Load (lbs)	Anthropogenic SRP Load (lbs)	Priority (1 = highest)
		Medium Flow (April – June)	Low Flow (July – October)	
Proactive	Boise Creek	0.514	0.194	1
Proactive	Pussyfoot Creek	0.145	0.101	2
Proactive	Second Creek	0.034	0.023	3
Opportunistic	Red Creek	0.117	0.059	n/a
Opportunistic	Government Canal	0.098	0.017	n/a
Opportunistic	Bowman Creek	0.000	0.000	n/a
Opportunistic	Other diffuse sources	0.680	0.380	n/a

Watershed scale priorities are further discussed in Appendix G.

Sub-watershed scale

This section attempts to prioritize reaches within the three priority tributaries. This TMDL did not sample the tributaries upstream of the mouths, so no SRP data are available to directly inform reach prioritization. However, given the probable sources cited previously, it seems reasonable to use fecal coliform (FC) bacteria as an indirect prioritization tool. Reaches are assigned high, medium, and low priorities based on Ecology FC source assessments (see Appendix G. Figure 5 shows bacteria reductions needs, taken from the Puyallup Fecal Coliform TMDL.

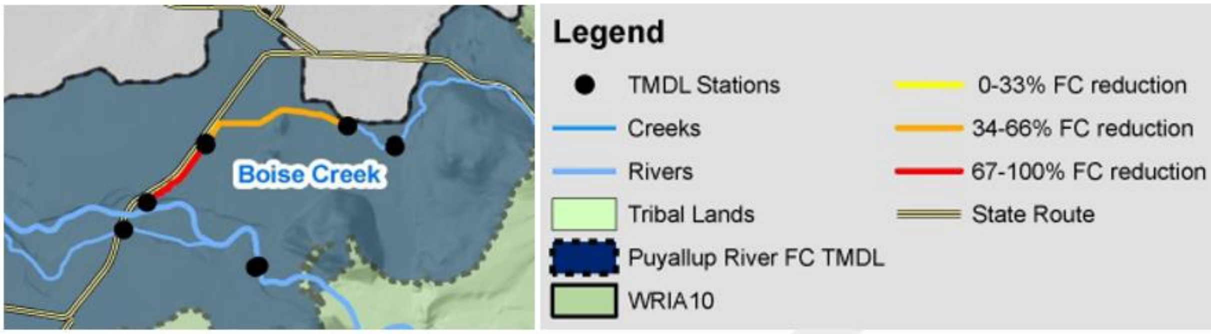

Figure 5. Boise Creek Dry Season (July – October) FC reductions (from Puyallup Fecal Coliform TMDL)

This TMDL adopts these reduction priorities for SRP load reduction purposes, i.e., the lower reach (from the mouth to 252nd St.) is highest priority for implementation work, while the upper reach is a moderate priority. The upper watershed is forested and not an implementation priority as previously discussed. Results from Ecology's FC source assessment study of Pussyfoot and Second Creeks (Appendix G) were used to establish reach priorities shown in Figure 6.

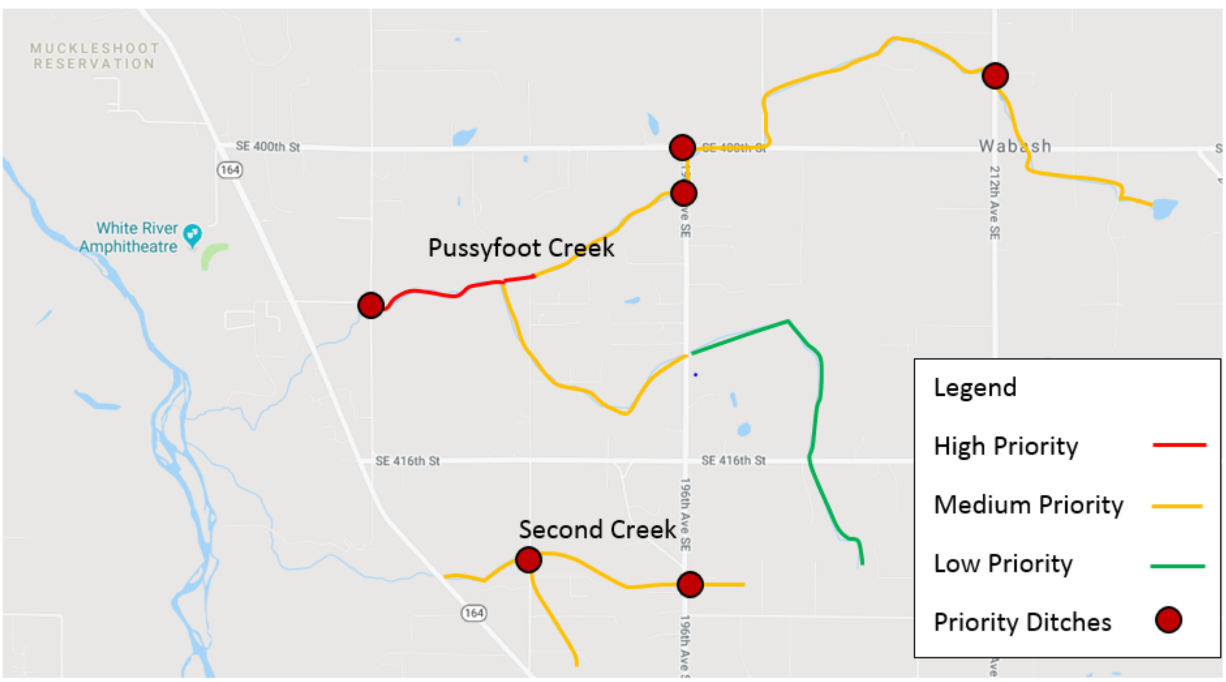

Figure 6. TMDL Implementation Priority Reaches, Pussyfoot and Second Creeks

Reach scale

Areas within each reach are further prioritized based on proximity to surface water. Parcels within 100ft of surface water are considered a priority for implementation purposes (Figure 7). Parcels further from surface water are unlikely to be significant contributors of dissolved phosphorus, unless artificial drainage serves as a direct conduit.

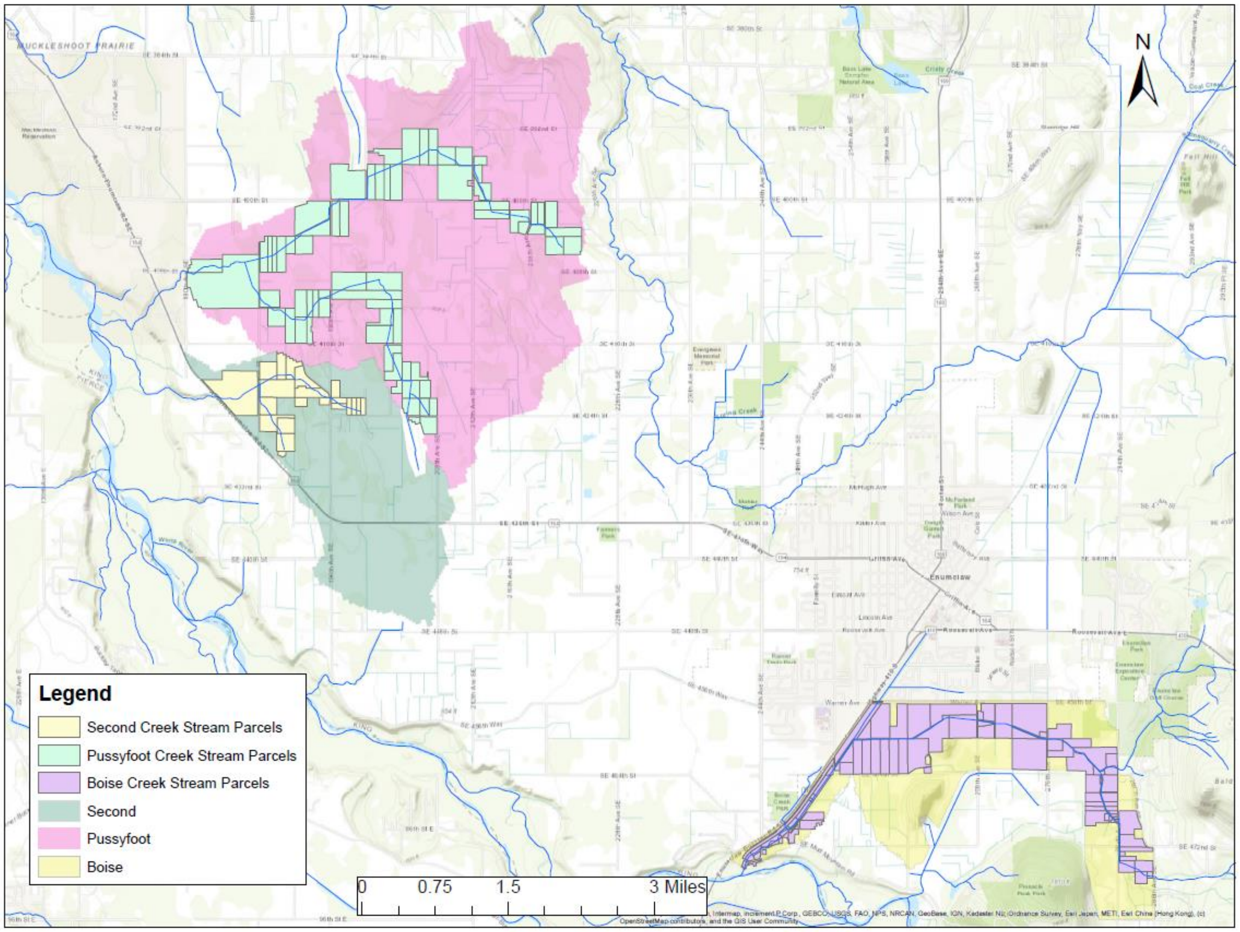

Figure 7. Boise, Pussyfoot, and Second Creek Implementation Priority Parcels

As discussed, failing onsite septic systems (Figure 8) are thought to be an additional potential source of phosphorus loading. While livestock sources are deemed more significant, septic systems should not be ignored. See Appendix G for further information.

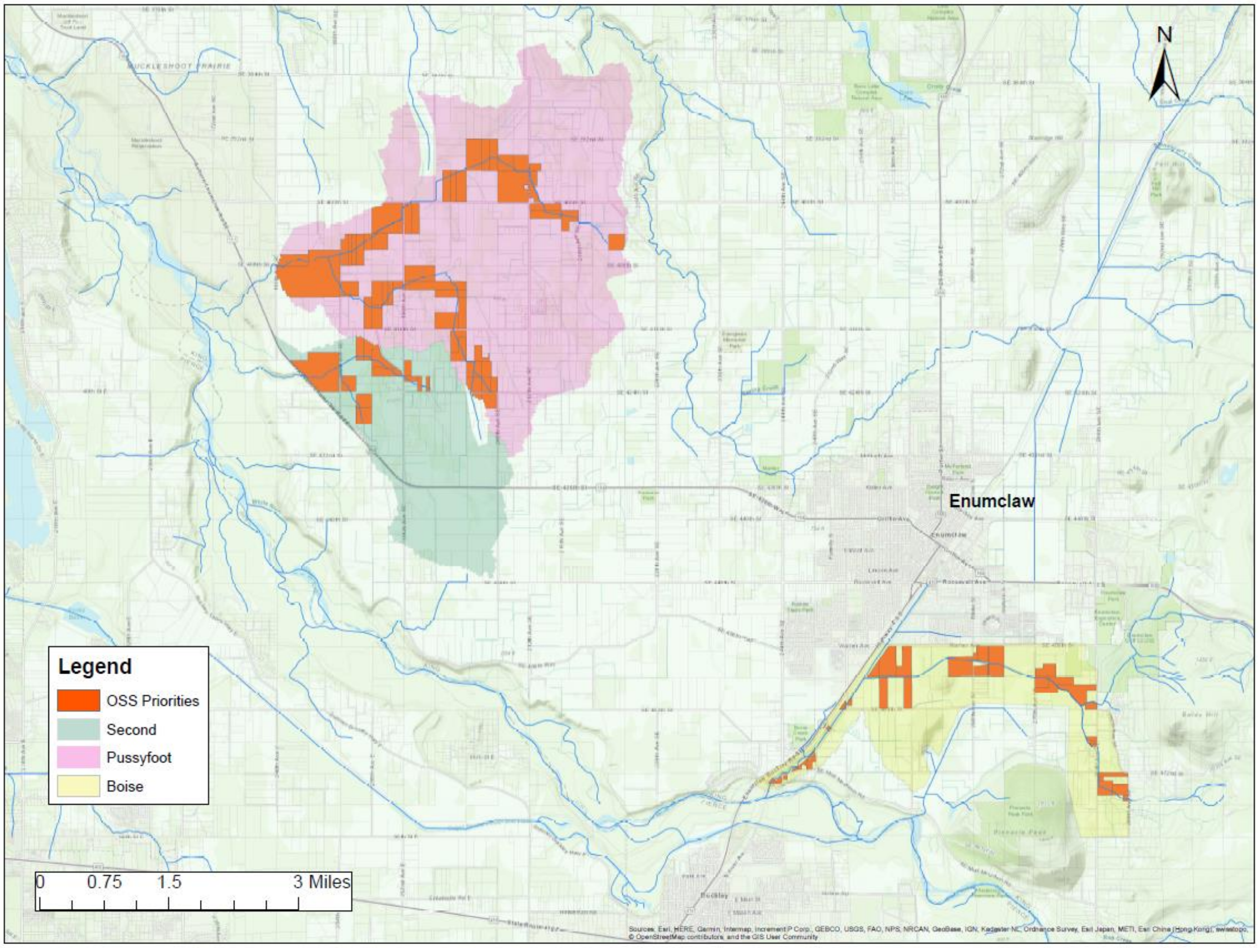

Figure 8. Onsite Septic System (OSS) inspection priorities in Boise, Pussyfoot and Second Creek Watersheds*

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King County monitoring data collected 2011 and 2012 (see Appendix G) suggest that Enumclaw stormwater conveyances between Warner Road and highway 410 (Figure 9) are conduits for bacteria. This TMDL recommends that implementers investigate further and work with implementing partners to find resolution.

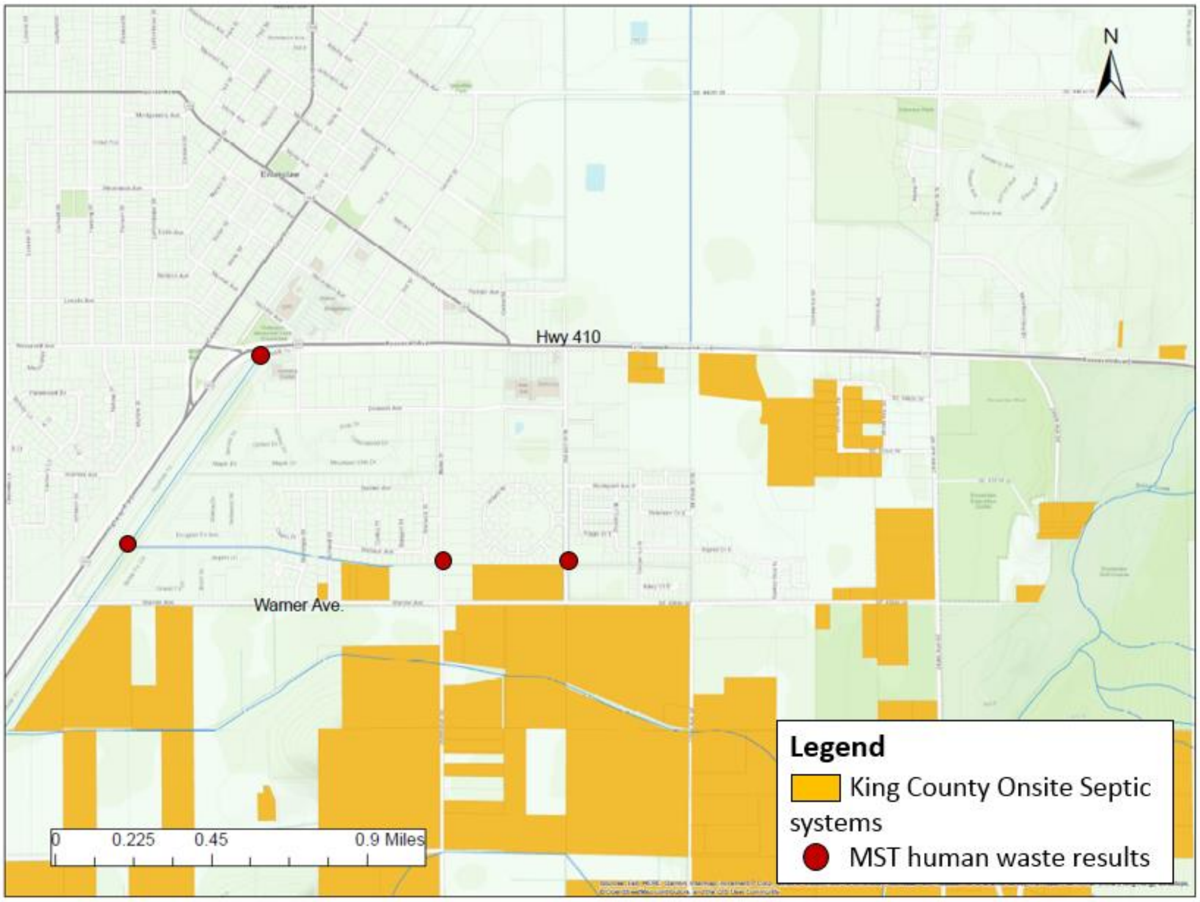

Figure 9. Septic Systems in and near Enumclaw in Relation to MST Results Suggestive of Human Waste*

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It may be necessary later to expand focus to include septic systems in other sub-watersheds, e.g., Government Canal and Red Creek. The above may not represent all parcels worthy of inspectors' attention. In addition, the above in no way implies that all systems near surface water are a problem. This information is provided solely for implementation prioritization purposes. Furthermore, direct connections to ditches and/or failing systems near artificial drainages may provide a conduit to surface waters, facilitating phosphorus transport, even when much further away than 100ft.

Parcel scale

Further information on parcel scale priorities is provided in Appendix G. Once parcels potentially contributing phosphorus loading to surface water have been identified, it will be necessary to identify and prioritize BMPs at each site. The five TMDL compliance minimum BMPs listed in Table 3 must be installed to the extent practicable if phosphorus loading is to be fully addressed. Preferably, these will all be implemented as a holistic suite of practices that support each other (Figure 10).

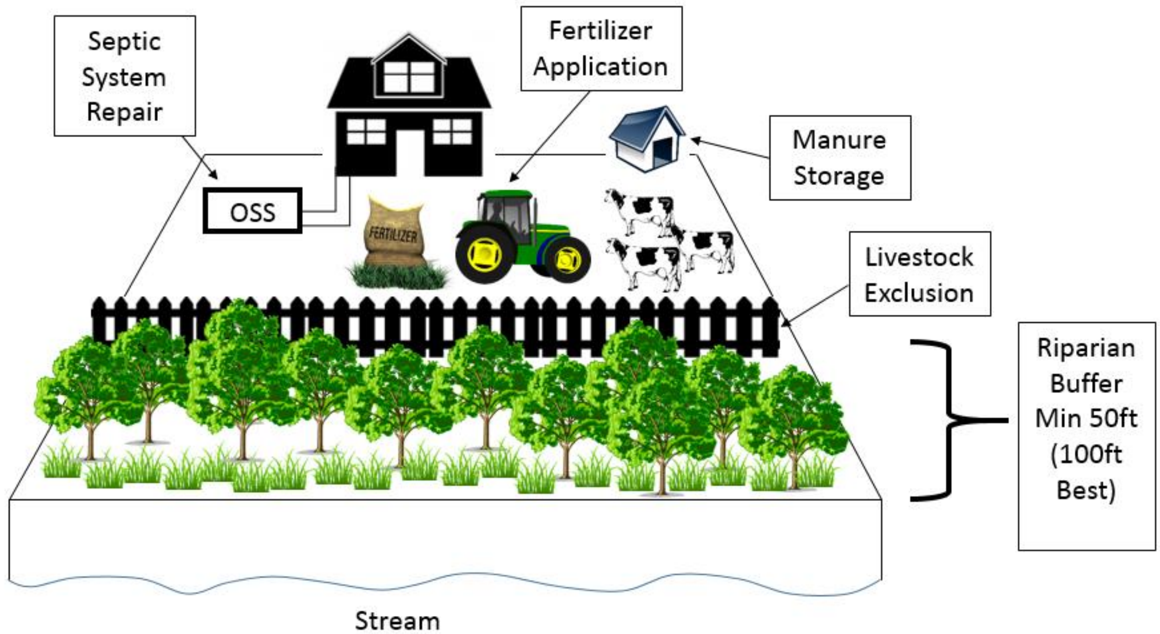

Figure 10. Holistic Application of Priority BMPs

In order to assure nonpoint load allocations are met, implementers will need to eliminate or substantially reduce all sources and pathways within 50ft of surface waters (see Reasonable Assurance). Under normal circumstances, BMP installation should be prioritized as listed in Table 3, but implementers may need to use best professional judgement to reprioritize BMPs based on site conditions.

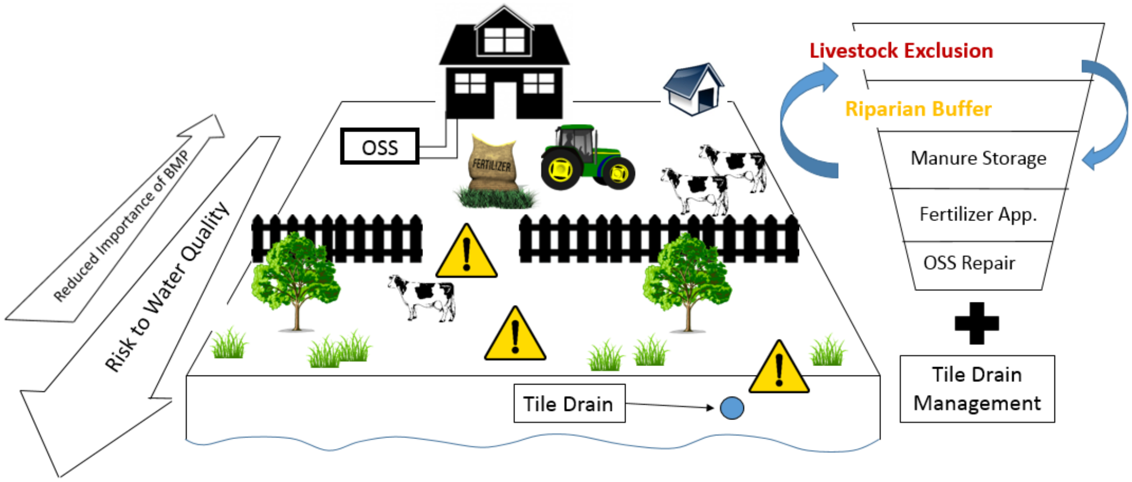

Figure 11. Reordering of implementation priorities based on BMP functionality and proximity to surface water

Figure 11 shows a hypothetical example of the reordering of BMP priorities based on site-specific conditions. Here manure storage and fertilizer application are conducted appropriately and located some distance from surface water, but the livestock exclusion fence is inadequate, and the riparian buffer is in poor condition. In this example, implementers would need to prioritize fence repair and buffer restoration. In addition, implementers should be on the lookout for direct conduits like tile drains that can bypass typical BMPs and may need immediate attention.

Timeline

This plan is designed to see TMDL implementation and attainment of water quality standards within ten years. Assuming this TMDL is approved/adopted in 2022 that would set TMDL implementation to be completed by 2032. If monitoring data shows that water quality standards have not been attained by 2032, this implementation plan should be revised, and a new implementation timeline established (see Adaptive Management section). This TMDL proposes an annual implementation schedule based on the TMDL BMP compliance actions and priority reaches established earlier. For the purposes of implementation scheduling (Table 6), priority reaches in Boise, Pussyfoot and Second Creeks were assigned lettering (Figure 12). In some instances, reaches were deemed too long to be effectively addressed within a calendar year, so these reaches were split.

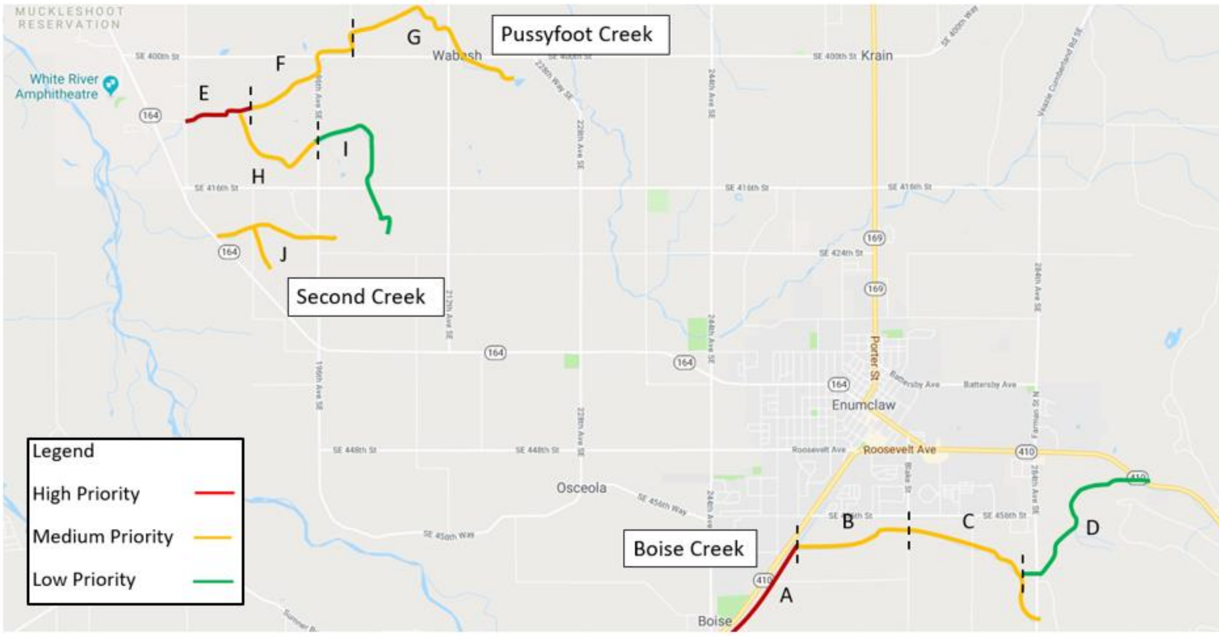

Figure 12. TMDL implementation priority reaches and lettering for scheduling purposes

Actions were assigned to each year in order of priority, starting with the highest priority reaches, then medium priority reaches in Boise and Pussyfoot Creeks. This was followed by the Second Creek reach and ended with low priority reaches in Boise and Pussyfoot Creeks. The upper forested reaches of Boise Creek are not included as no additional implementation actions are recommended for this part of the watershed. The purpose of basing annual assignments on priority reaches is to ensure work begins where it is most needed, i.e., addressing the largest number and/or most significant sources. This should facilitate the most rapid load reduction progress possible. Permit renewal and GMA/SMA process reminders from previous sections are also incorporated into the schedule (Table 6).

Table 6. TMDL Implementation Annual Schedule

Year	Action	Implementer*	Priority Reach
1 (2023)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY** (nonpoint), KC, KCD, MITFD***	A
1 (2023)	Ensure WLAs incorporated in new Buckley and Enumclaw STP permits.	ECY (TMDL lead and permit manager)	n/a
1 (2023)	Ensure WLA incorporated in new Manke Lumber Industrial Stormwater Individual permit.	ECY (TMDL lead and permit manager)	n/a
1 (2023)	Ensure WLA incorporated in new Industrial Stormwater General permit.	ECY (TMDL lead and permit manager)	n/a
1 (2023)	Ensure WLA incorporated in new Construction Stormwater General permit.	ECY (TMDL lead and permit manager)	n/a

Year	Action	Implementer*	Priority Reach
2 (2024)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	E
2 (2024)	Ensure WLA incorporated in new Sand and Gravel General permit.	ECY (TMDL lead and permit manager)	n/a
3 (2024)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	B
4 (2026)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	F
4 (2026)	Participate in GMA comprehensive plan and development regulation revision for King and Pierce Counties.	ECY (TMDL lead), KC	n/a
5 (2027)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	C
5 (2027)	Ensure WLAs incorporated in new Municipal Stormwater Phase 1 and 2 General permit.	ECY (TMDL lead and permit manager)	n/a
6 (2028)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	G
7 (2029)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	H
8 (2030)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	J
8 (2030)	Participate in GMA comprehensive plan and development regulation revision for King and Pierce Counties.	ECY (TMDL lead), KC	n/a
9 (2031)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	D
10 (2032)	Implement all BMP compliance minimums, optional BMPs as appropriate.	ECY, KC, KCD, MITFD	I

* Inclusion of implementation stakeholders is for Ecology planning purposes only. It is not meant to imply Ecology's authority over these organizations or assume their commitment to implement the TMDL.

**ECY = Department of Ecology, KC = King County, KCD = King Conservation District, MITFD = Muckleshoot Indian Tribe Fisheries Division

***Inclusion of MITFD in this table is for planning purposes only. It is not meant to imply Ecology has jurisdiction over activities on MIT property or discharges to Tribal waters.

Ecology hopes that implementation partners will collaborate with Ecology in the implementation of this TMDL. However, because Ecology does not have authority over these partners Ecology does not assume that partners will always want to or be able to implement the actions described in this TMDL. Ecology also recognizes that it has no jurisdiction over activities on MIT property and/or discharges to Tribal waters. MIT is under no obligation to implement the previously described nonpoint BMPs on Tribal property. Tribal property was intentionally excluded from load reduction estimates shown in the Reasonable Assurance section and hence the attainment of TMDL load allocations is not dependent on implementation on Tribal property. However, Ecology believes that its water quality improvement efforts are closely aligned with partners' priorities and is therefore optimistic regarding collaborative implementation of this TMDL.

Each year's assigned BMP implementation should be interpreted as start dates. It's unlikely that all work within a given reach will be identified, outreach completed and BMPs fully installed within one calendar year. This is especially true of the highest priority reaches with the largest number and severity of problems. In reality, the following years will see not only the start of work in another priority reach but also continued work in proceeding priority reaches (Figure 13). This will result in a gradual increase in implementation workload, but this should be mitigated somewhat by the fact that implementers will become progressively more experienced and thus efficient at their work, and work in lower priority reaches should be easier and faster to complete. Years 6 and 7 will likely see the highest workload with a gradual tapering towards project close.

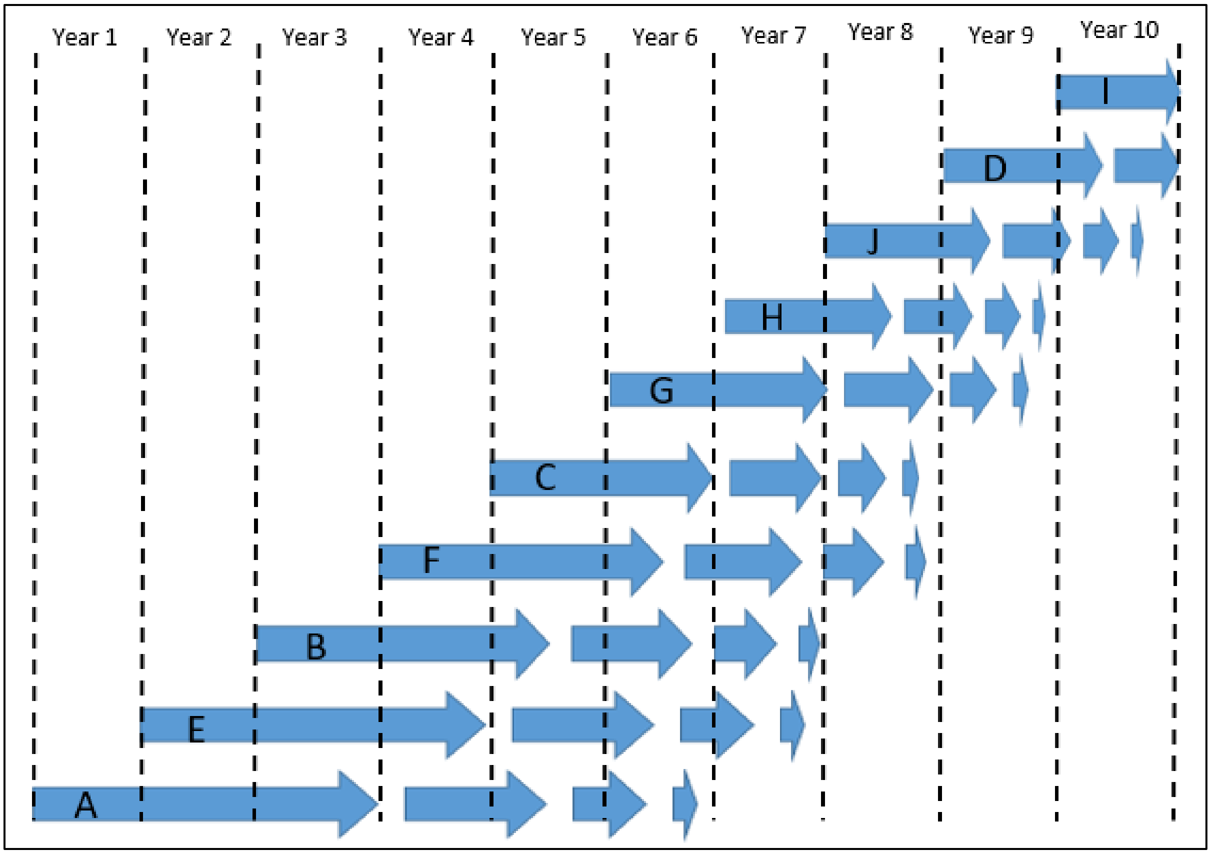

Figure 13. Conceptual model showing work start in priority reaches and increasing implementation workload

The schedule provided in Table 6 is meant to serve as a guide to aid implementers as to how to direct their efforts to ensure the most effective and efficient load reductions possible. The authors recognize that practical considerations (e.g., complaint response, landowner readiness) may necessitate adjusting the schedule. Implementers are free to do so as necessary but are encouraged to adhere to the above schedule as far as possible. A drastic reorganization of the schedule could disrupt the ramping up of implementation effort and/or undermine efforts to see priority sources addressed as quickly as possible.

Technical feasibility

Prior to drafting this TMDL, Ecology put a lot of effort into reaching out to point source stakeholders and permit managers (See Outreach section) to ensure the proposed WLAs and associated implementation actions were reasonable and feasible to the extent possible. Both the cities of Enumclaw and Buckley have communicated that the WLAs and associated treatment optimization and alum addition are workable with current plant design, and they should not constitute an unmanageable financial burden to local ratepayers (City of Enumclaw. personal communication. June 19, 2018). Similarly, multiple discussions with staff from the Muckleshoot Indian Tribe Fisheries Division (MITFD) led to the development of a hatchery WLA and MIT reserve allocation that are protective of the White River, but also allow the Tribe to increase fish production to meet salmonid harvest and recovery goals. Most stormwater permittees should not be discharging during non-runoff conditions and thus most should have no additional TMDL compliance requirements. In addition, monitoring requirements are straightforward, so these should not represent a heavy lift for permittees. While some of the optional nonpoint BMPs described (e.g., Soil Amendment) described previously are relatively new and untested (at least in Washington State), all the 5 TMDL compliance minimum BMPs on which this TMDL relies are well established practices with a track record of years of successful implementation in the State. These practices are all known to be practical and technically simple to install. In short, this TMDL deems all the compliance minimum BMPs in Table 3 to be feasible and implementable.

While the point source controls and nonpoint BMPs described in this TMDL may all be feasible, some will likely be more difficult to install than others. This is useful information for outreach and implementation planning purposes. Therefore, this TMDL attempts to assess the relative difficulty of implementing the various BMPs (Table 7 and 8).

Table 7. Point source implementation challenge

Source Type	Treatment Upgrade	Phosphorus Reduction Benefit	Cost	Local Support	Technological Complexity	Implementation Challenge
Point Source Controls	Enumclaw WWTP	1	Moderate	High	High	Moderate
Point Source Controls	Buckley WWTP	2	Moderate	High	High	Moderate
Point Source Controls	Whiter River Hatchery	3	Moderate	High	High	Moderate
Point Source Controls	Coal Creek Fish Facility	4	Moderate	High	High	Moderate

The cost of implementation actions was ranked as follows: ≤ $499,000 = ‘low’; $500,000 - $999,000 = ‘moderate’, ≥ $1,000,000 = ‘high’. The cost estimates are conservative. ‘Local support’ is a subjective assessment based on correspondence with stakeholders (point sources), anecdotal discussions with partners, and prior implementation experience in other watersheds. ‘Technological complexity’ is a subjective assessment of the relative need for specialized engineering design and/or construction expertise. The ‘implementation challenge’ represents the relative difficulty of successfully completing the implementation action and is the average of the cost, local support, and technological complexity rankings.

Table 8. Nonpoint source implementation challenge

Source Type	BMP	Phosphorus Reduction Benefit	Cost	Local Support	Technological Complexity	Implementation Challenge
Nonpoint Source Controls	Manure Storage	1	High	High	Moderate	Moderate
Nonpoint Source Controls	Nutrient Management Planning	2	Low	High	Moderate	Moderate
Nonpoint Source Controls	Livestock Exclusion	3	Moderate	Moderate	Low	Low
Nonpoint Source Controls	Off-stream Watering	4	Low	Moderate	Low	Low
Nonpoint Source Controls	Riparian Buffers	5	Moderate	Low	Moderate	Moderate
Nonpoint Source Controls	OSS Repair/Replacement	6	Moderate	Moderate	High	High

It is important to underscore the limitations of this exercise. The reader is reminded that the rankings are qualitative, based on compounding subjective assessments and as such have limited reliability. And the rankings are useful only as far as they facilitate comparisons between implementation actions, i.e., they are not absolutes, and a low rank does not mean a task will be objectively 'easy' to implement. For example, the high OSS implementation challenge ranking should not be interpreted to mean there's next to no chance of proactive OSS repair efforts being successful. The OSS ranking has meaning only in relation to those for other BMPs, in other words, of those actions assessed, OSS repair may be the most challenging to implement. Finally, as previously stated, this TMDL deems all the actions described to be feasible and implementable for the reasons mentioned.

Costs

It is important to understand the costs associated with implementation because:

- It gives a sense of how realistic load reduction goals are (see Technical Feasibility section below).
- It helps implementers develop sound budgets, prioritize spending and/or ensures that funding requests are accounted for.
- It may help prioritize grant funding resources in future.

What follows is an attempt to provide cost estimates for the actions described previously. The numbers provided are not meant to be the basis for sophisticated economic analysis. They serve primarily to provide a simple, brief overview of *relative* implementation effort, prioritize implementation tasks, and speak to general feasibility. However, implementers should note that there are inherent assumptions, compounding estimates, and unknowns associated with this work that prohibit a highly accurate analysis. While this TMDL has tried to approach this exercise with rigor, implementers are advised to use what follows with caution and use additional information as available. As this TMDL did not attempt to provide detailed analysis or recommendations regarding long-term actions, cost estimates are developed only for short-term actions.

Point sources

Cost estimates (Table 9) for the Enumclaw and Buckley WWTP upgrades were taken from technical memoranda produced by Esvelt Environmental Engineering for the cities (see Appendix D and E of TMDL Technical Analysis document). These costs assume optimization of the cities' current secondary treatment facilities and chemical polishing (alum) will be sufficient to comply with their WLAs. These estimates include operational and maintenance costs. Cost estimates for MIT's White River Hatchery (from an MIT technical summary) are based on a new screening facility to accommodate increased hatchery production and meet WLAs and/or reserve allocations. The summary gives a cost range of $250,000 to $270,000 for the upgrade. This includes a Class 5 conceptual cost estimate of capital costs only, with operational costs potentially adding a substantial amount to the total cost. This estimate is a Class 5 conceptual cost with an accuracy range of - 50% to +100%. No cost estimate was available for the future Coal Creek facility; therefore, the same estimate for the White River facility was used. Costs associated with stormwater compliance monitoring or associated infrastructure improvements were also excluded. Most stormwater permittees should not be discharging during critical period non-runoff conditions and costs associated with outfall inspection and sampling (if necessary) should be minor. It's not possible to predict those rare instances where stormwater infrastructure upgrades will be necessary, therefore these costs could not be estimated.

Table 9. Point Source TMDL Implementation Cost Estimates

Point Sources	Cost per unit	Unit	Total
Enumclaw WWTP	N/A	N/A	$870,000*
Buckley WWTP	N/A	N/A	$390,000*
Coal Creek Fish Facility	N/A	N/A	$270,000**
Whiter River Hatchery	N/A	N/A	$270,000**
		Total	**$1,800,000**

***** Costs estimates were accurate at the time of TMDL drafting several years ago. However, now at the time of TMDL finalization, cost estimates are higher.

**This includes an estimate of capital costs only, with operational costs potentially adding a substantial amount to the total cost. This estimate is a Class 5 conceptual cost with an accuracy range of - 50% to +100%.

Nonpoint sources

Nonpoint estimated cost ranges are summarized in Table 10. The 'Upper Estimate' assumes all BMPs will be needed at all sites and is likely a large overestimate, but represents the most conservative, upper expenditure limit. The 'Lower Estimate' assumes that not all BMPs will be needed everywhere (with the exception of riparian buffers) and is roughly half the 'Upper Estimate' cost. The 'Lower Estimate' is likely closer to reality. Organizational operating costs (e.g., salaries, travel costs) and supporting resources costs (e.g., effectiveness monitoring) were not included in the estimates unless otherwise stated.

Table 10. Nonpoint TMDL Implementation Cost Estimates

Nonpoint BMPs	Cost per unit	Type of Unit	Units (low estimate)	Units (high estimate)	Lower Estimate	Upper Estimate
Manure Storage Structure	$17,500	Per parcel	91	182	$1,592,500	$3,185,000
Off-stream, Watering	$11,250	Per miles of fenced stream length	16.8	33.6	$189,077	$378,153
Nutrient Management Planning	$28.73	Per acre	743	1486	$21,346	$42,693
Livestock Exclusion Fencing	$5.00	Per foot	88740	177480	$443,700	$887,400
Riparian Buffers	$3,779.56	Per Acre	203	203	$767,251	$767,251
				Total	**$3,013,874**	**$5,260,497**

Nonpoint BMP cost estimates were calculated using a combination of NRCS Environmental Quality Incentives Program (EQIP) fiscal year 2019 rates and Ecology's Financial Management Program's (FMS) and Water Quality Policy program's rough estimates. The five 'optional' BMPs listed in Table 3 were not costed as they will only be implemented sporadically. Costs for BMPs are often provided in ranges, and in these cases the median value was used for costing calculations. Stream feet, parcel numbers, OSS numbers and acreage data were derived from GIS analysis. The BMP costs are for work in Boise, Pussyfoot and Second Creeks only. Here follows a summary of input data:

- Manure storage structures
    - $17,500 per structure (WQ Policy)
    - One structure per parcel

    - 182 parcels within 100ft of streams
- Nutrient Management Planning
    - $7.33-$50.13 per acre (NRCS EQIP)
    - 182 parcels = 1,486 total acres

- Livestock Exclusion Fence
    - $5 per foot (FMS/WQ Policy)
    - Assumed entire length of streams must be fenced
    - Stream length includes mainstems only, no agricultural or road side ditches
    - 27,048 meters = 88,740 feet of stream (low estimate)
    - Fence length multiplied by 2 as both sides of stream must be fenced (high estimate)
- Off-stream Watering
    - $11,250 per mile stream fenced (FMS/WQ Policy)
    - Feet of stream fenced (above) converted to miles
    - The reimbursement rate is an estimation of the component costs necessary to provide off-stream watering e.g., pipeline, pumps, hydrants, water tanks
- Riparian Buffers
    - $1287.04-$6272.08 per acre (NRCS EQIP)
    - Acreage assumes minimum 50ft buffers along entire mainstem
    - Acreage = stream feet (above) X 100ft (50ft per stream side)
- OSS repair/replacement
    - $7-$30k (FMS)
    - Assumes one tank/system per parcel
    - King County OSS GIS layer used to identify parcels with septic systems
    - Only parcels within 100ft of streams included

The caveats mentioned above aside, the costing exercise shows nonpoint implementation costs to be higher than for point sources. It may give the false impression that nonpoint BMPs aren't cost effective. It's important to remember that, unlike the point source controls, the nonpoint BMPs will address not only dissolved phosphorus loading, but a variety of other parameters (e.g., sediment, temperature, dissolved oxygen, and bacteria). Therefore, in a sense, nonpoint implementation costs can only be properly appreciated in the context of implementing a collection of already existing, approved TMDLs, and possible future TMDLs.

In this light, nonpoint actions may actually be quite cost effective. For added perspective, it's useful to consider the value of the ecosystem services Boise, Pussyfoot, Second Creeks and the larger White River watershed provide. The authors were not able to find environmental economic analysis data for the three tributaries or the White River specifically. However, in an ecological economic estimation of the Puyallup watershed, Earth Economics established that, if treated like an asset with a lifespan of 100 years, the present value of ecosystem services provided is between $13 billion and $120 billion.[1] As the White River represents a large portion of the total flow volume and acreage of the Puyallup drainage, its value can be expected to represent a similarly large portion of that cited value. Meaning the long-term value of the services the White River provides likely far exceed the costs of implementing this TMDL. In this context, total implementation costs are fairly low.

Funding sources

There are multiple sources of funding for the BMPs available in the TMDL implementation area. Federal, state, local, and private funding opportunities may be available. A detailed description of the possible available funding sources thought to be most significant in TMDL project area is given in Appendix H, a brief list is provided here:

- Federal Cost-Share and Rental Payment Programs
- USDA Farm Service Agency
- Conservation Reserve Enhancement Program (CREP)
- Conservation Reserve Program (CRP)
- Continuous Conservation Reserve Program (Continuous CRP)
- Emergency Conservation Program
- Farmable Wetlands Program
- USDA Natural Resource Conservation Services
- Environmental Quality Incentive Program (EQIP)
- Agricultural Conservation Easement Program (ACEP)
- Conservation Stewardship Program (CSP)
- Regional Conservation Partnership Program (RCPP)
- Agricultural Management Assistance
- USDA Rural Development
- Single Family Housing Guaranteed Loan Program
- Single Family Housing Repair Loans & Grants
- US Fish and Wildlife
- Partners for Fish and Wildlife Program
- State
- Recreation and Conservation Office
- Salmon Recovery Grants

[1] Batker, D., Schmidt, R., Harrison-Cox, J., and Christin Z. 2011. The Puyallup River Watershed: An Ecological Economic Characterization. Earth Economics.

- Farmland Preservation Grants
- Aquatic Lands Enhancement Account (ALEA)
- Washington Wildlife and Recreation Program (WWRP)
- Department of Natural Resources
- Community Forestry Assistance and Environmental Justice Grants
- Tree City USA Tree Planting and Maintenance Grants
- Department of Ecology
- Water Quality Combined Funding
- Centennial Clean Water Program
- Section 319
- Clean Water State Revolving Fund (SRF)
- Direct Implementation Funds (DIF)
- Coastal Protection Fund - Terry Husseman Account
- Floodplain by Designs
- Streamflow Restoration
- State Conservation Commission
- Local Government
- Clean Water Loans

Outreach

TMDL implementation necessitates outreach to interested and effected parties and because the reach of TMDLs is so broad, a comprehensive and coherent outreach strategy is needed. This TMDL will not attempt to provide a detailed outreach and communications plan. That should be developed post TMDL approval/adoption in concert with key implementation stakeholders. In addition to the typical internal and external administrative coordination and collaboration procedures (see Appendix I), this TMDL recommends the following as a general outreach approach to landowners:

- Ecology staff should coordinate with key stakeholders on developing collaborative, detailed education/outreach strategy
    - Key stakeholders include KCD, KC, MITFD, City of Enumclaw, City of Buckley and state public health districts
    - Be sure to include staff with communication/outreach training/expertise
- Identify target audience
    - Landowners with property adjacent surface water, especially those with septic systems
- Identify geographic areas to focus outreach efforts

    - Focus on implementation priorities, working through ranked reach priorities sequentially
- Anticipate problems and develop solutions
    - Identify barriers to implementation
    - Brainstorm potential solutions to overcome barriers and facilitate behavior change
- Develop messaging
    - Concentrate on the 5 TMDL minimum compliance BMPs
    - Emphasize funding assistance opportunities
    - Incorporate solutions to barriers (above)
- Ensure messaging consistency
    - To the extent possible make sure messaging is consistent amongst partners/stakeholders and across various media and events
- Produce educational materials to support messaging
    - E.g., flyers, brochures, pamphlets, post cards, door hangers
    - Restoration project and creek signage (especially in Pussyfoot and Second Creeks where it appears residents are least familiar with water quality issues)
- Use social media/mass media
    - E.g., Facebook, Twitter, Instagram, Nextdoor
    - Messages should be short, targeted to audience
    - This is a good way to spread the word about local programs and advertising upcoming workshops or other education events (below)
    - Make use of local TV and newspapers to spread messaging. May necessitate creation of short video or written articles
- Use education events and tools
    - Develop new public events or make use of existing education events to present messaging and answer questions
    - E.g., King County Fair (annually in Enumclaw), King CD's 'mud and manure' workshops
    - Use Ecology's 'Enviroscape'[2] model to teach basic riparian ecology and BMP function
    - Promote King Conservation District's 'Stream Team' citizen science monitoring efforts and incorporate messaging (above) into training as far as possible
    - Consider partnering with local schools to further spread messaging

Tracking progress

This TMDL proposes implementation progress be assessed annually. The TMDL lead, with input from nonpoint and permit staff, will be primarily responsible for writing an annual report each November summarizing the past year's activities, successes and failures, and proposed actions for the following year (see Adaptive Management section below). The primary focus of this

[2] https://www.enviroscapes.com/

annual assessment will be comparing BMP implementation actions with scheduled activities to ensure progress remains on track but should also document permittees' progress towards meeting their WLAs (and associated permit limits). Monitoring data (see Effectiveness Monitoring section) will be used to identify and trace pollution sources. Permittees' discharge monitoring reports (DMRs) may also be reviewed at this time to assess progress towards compliance. This TMDL recommends that key implementers (Ecology, KC, KCD, MITFD, City of Enumclaw) meet once, towards the end of each calendar year (i.e., December or January) to review the annual report, to problem solve and form consensus on the following year's work.

Further progress toward meeting the implementation objectives identified in this plan will be evaluated at milestone years 3 (2025) and 7 (2029). Progress will measure by comparing BMP implementation per the schedule and status and trends monitoring data collected to date (see Effectiveness Monitoring section). Detailed BMP installation progress milestones are shown in Table 11.

Table 11. TMDL progress BMP installation and pollutant load reduction milestones

Year 3 (2025)	Year 3 (2025)	Year 7 (2029)	Year 7 (2029)
Implementation Progress Milestones	**Implementation Progress Milestones**	**Implementation Progress Milestones**	**Implementation Progress Milestones**
Priority Reach	**BMPs Installed***	**Priority Reach**	**BMPs Installed**
A	≈ 60 %	A,E,B	≈ 100 %
E	≈ 40 %	F,C	≈ 80 %
B	≈ 20 %	G	≈ 40 %
Load Reduction Milestone	**Load Reduction Milestone**	**Load Reduction Milestone**	**Load Reduction Milestone**
Boise, Pussyfoot, Second Creek mouths**	≈ 33 % SRP nonpoint load reduced	Boise, Pussyfoot, Second Creek mouths	≈ 66 % SRP nonpoint load reduced
Boise, Pussyfoot, Second Creek mouths**	≈ 33 % SRP nonpoint load reduced	Boise, Pussyfoot, Second Creek mouths	≈ 66 % SRP nonpoint load reduced

* BMP Installed = % of total problem properties in that reach where all necessary TMDL minimum compliance BMPs have been installed. **SRP load calculated from orthophosphate monitoring data collected at 'status and trends' monitoring sites at tributary mouths (see Effectiveness Monitoring section).

At year 3, implementers should expect to see completion of all necessary BMP actions within priority reaches scheduled for installation by 2025 (assuming TMDL approval in 2022) per Table 23 and a 33% decline in pollution loading. At year 7, implementers should see completion of all necessary BMP actions within priority reaches scheduled for installation by 2029 per Table 6 and a 66% reduction in pollution loading. If implementers choose to deviate from the implementation schedule proposed in Table 6, implementation progress goal at year 3 will be installation of all BMPs on 33% of all deficient properties' watershed wide, and at year 7 installation of all BMPs on 66% of all deficient property's watershed wide. The efficacy of the percentage of BMPs installed as a reliable progress measure depends heavily on an accurate and comprehensive baseline assessment of problem properties and needed BMPs. As discussed under Reasonable Assurance, this TMDL strongly suggests that implementers not rely solely on Ecology's standard practice of documenting what is observable from public right-of-ways. Those observations should be supplemented with analysis of the most recent publicly available satellite imagery, and/or observations from fixed wing aircraft and boats to the extent practical.

At the end of the 10-year implementation period, phosphorus load reductions should be achieved, and pH water quality standards met. If this proves not the case, adaptive management will be triggered (see Adaptive Management section below), the implementation plan will be revised, and a new set of implementation actions, reach priorities, and progress targets will be established.

Effectiveness monitoring

Effectiveness monitoring (EM) is a critical component to successful TMDL implementation, and without it there would be no way to determine project outcomes. This TMDL proposes a three-pronged approach to EM: 1) implementation monitoring (which has already begun), 2) mid-project data analysis/assessment, and 3) a one- or two-year post-implementation (i.e., 'traditional') EM effort. See Appendix T for more detail.

Implementation monitoring

As stated, this TMDL will employ enhanced effectiveness monitoring **during** implementation to track trends and identify additional sources. This aspect of the EM program is focused in the three tributaries of concern in this implementation plan, namely Boise, Pussyfoot and Second Creeks. The EM program began July 2019 and will continue throughout the implementation period (i.e., for 10 years). The main goals of this EM study are to:

1. Track general water quality trends in each of the tributaries.
2. Provide the information feedback needed for adaptive management purposes.
3. Trace sources of bacteria pollution and identify likely causes.

Effectiveness monitoring locations are shown in Appendix J. While the focus of implementation monitoring is to track progress in the Enumclaw Plateau specifically, there is still an ongoing need to characterize broader nutrient and pH changes. For this reason, this TMDL also recommends additional 'opportunistic' data collection, staff, budget, and time allowing (see Appendix J). Ideally, 'opportunistic' monitoring should occur at least once before or at the interim 3-year milestone assessment and again before or at the 7-year milestone assessment.

Interim 5-year data assessment

At the project implementation halfway point, (i.e., at year 5) implementers must collate and summarize all data gathered to date:

- Conduct a data quality assessment and analyze all USGS, Ecology, MIT, and other pH/nutrient/water quality data collected in the Lower White River.

- Summarize findings/recommendations in a report, made available to TMDL implementers/stakeholders and Lower White River TMDL Workgroup members.
- Contingent on available staff and resources.
- Conducted by Ecology Southwest Regional Office (SWRO) monitoring staff if available.

Continuous pH monitoring

Within 3 years after the TMDL is approved by EPA, if resources allow, begin conducting continuous monitoring of pH for 1 to 2 weeks during critical periods at locations described in Appendix J. The ability to conduct monitoring in a given year will be dependent on available staff and equipment resources. The work may be conducted by Memorandum of Agreement (MOA) agency staff, local watershed partners, or under contract (USGS, consultant) and may be sponsored by agency, grant, or other sources of funding. Ecology has many competing monitoring priorities and limited staff and financial resources with which to do this work. Unfortunately, Ecology can therefore provide no assurances that it will be able to do this continuous pH monitoring regularly, if at all.

Post implementation monitoring

This TMDL recommends that monitoring staff integrate pH synoptic surveys into the traditional EM protocol to ensure that not only phosphorus is characterized, but the impact on pH is understood such that the conclusions of the TMDL model can be tested. The primary purpose of this monitoring is to assess the efficacy of implementation efforts more broadly throughout the Lower White River watershed. Therefore, unlike the narrow focus of the Implementation Monitoring, this monitoring should preferably assess the entire TMDL project area. After 10 years of TMDL implementation, a traditional one-year EM study may be conducted to assess overall success at project closure. Whether this occurs precisely at year 10 or slightly after (e.g., year 12) depends on the degree to which all necessary BMPs have been installed at this time, and the EM results collected during TMDL implementation (see Adaptive Management). See Appendix J for further details.

Soil/sediment sampling

Monitoring staff should consider sediment/soil phosphorus sampling in future. If BMPs have been successfully installed and most/all phosphorus sources controlled as directed in this TMDL but phosphorus loading to surface water remains high or unchanged, it may suggest continued inputs from legacy phosphorus sinks (see Adaptive Management section). This is perhaps beyond the scope of traditional post project EM, but soil/sediment sampling would be invaluable in identifying phosphorus hotspots for future adaptive management control purposes and is thus highly recommended. Areas where phosphorus is likely to accumulate should be a high priority for sampling. These locations may include riparian buffers, vegetated strips, and instream benthic sediments, particularly areas of slower flow and higher retention times like pools, eddies, dead zones, and channel margins. To reduce costs and staff time, this TMDL recommends that soil/sediment sampling be restricted to the three watersheds in the Enumclaw Plateau of primary interest in this implementation strategy (Pussyfoot, Second and Boise Creeks).

Lag time in water quality response and monitoring

Lag time represents the amount of time elapsed between installation or adoption of nonpoint management measures and measurable improvement in water quality. Sometimes lag time can be substantial to the point where even 'long-term' monitoring efforts may fail to show definitive results. The elements of and reasons for lag time are discussed in more detail in the Adaptive Management section and Appendix J. Despite attempts to accurately assess and track water quality response through the robust effectiveness monitoring strategy described above and in Appendix J, lag time will likely hamper to some degree this effort. While this TMDL contends that compliance is achievable in 10 years, allowances must be made for possible longer implementation periods. It may be necessary to extend or adjust implementation efforts after the first 10 years of implementation (see Adaptive Management below). If so, it's likely that effectiveness monitoring efforts will also need to be extended or adjusted.

Adaptive management

Natural systems are complex and dynamic. There's a degree of uncertainty involved in predicting the way an ecosystem will respond to management activities and can only be described as probabilities or possibilities. In this context, trial and error (i.e., adaptive management) is a critical tool in ensuring project objectives are met. Adaptive management involves testing, monitoring, evaluating applied strategies, and incorporating new knowledge into management approaches that are based on field observation and scientific findings. In the case of TMDL projects, Ecology uses adaptive management to assess whether the actions identified as necessary to solve the identified pollution problems are working. As we implement these actions, the system will respond and change. Adaptive management allows us to fine-tune our actions to make them more effective, and to try new strategies if we have evidence suggesting that a new approach could help us to achieve compliance.

As already stated, TMDL reductions should be achievable by 2032. Several implementation actions for other completed, approved TMDLs are already currently underway in Boise, Pussyfoot and Second Creeks which overlap with BMPs prescribed in this document. Ecology has already reached out to key implementation stakeholders and developed collaborative relationships with them. And as stated above, EM efforts, key to providing the necessary feedback data for adaptive management purposes, have already started.

Process steps

Ecology will use adaptive management when BMPs are not being installed as planned, when water monitoring data show that the TMDL project targets are not being met or implementation activities are not otherwise producing the desired result. Adaptive management is a circular, iterative process consisting of four basic steps which feed into one another (Figure 14).

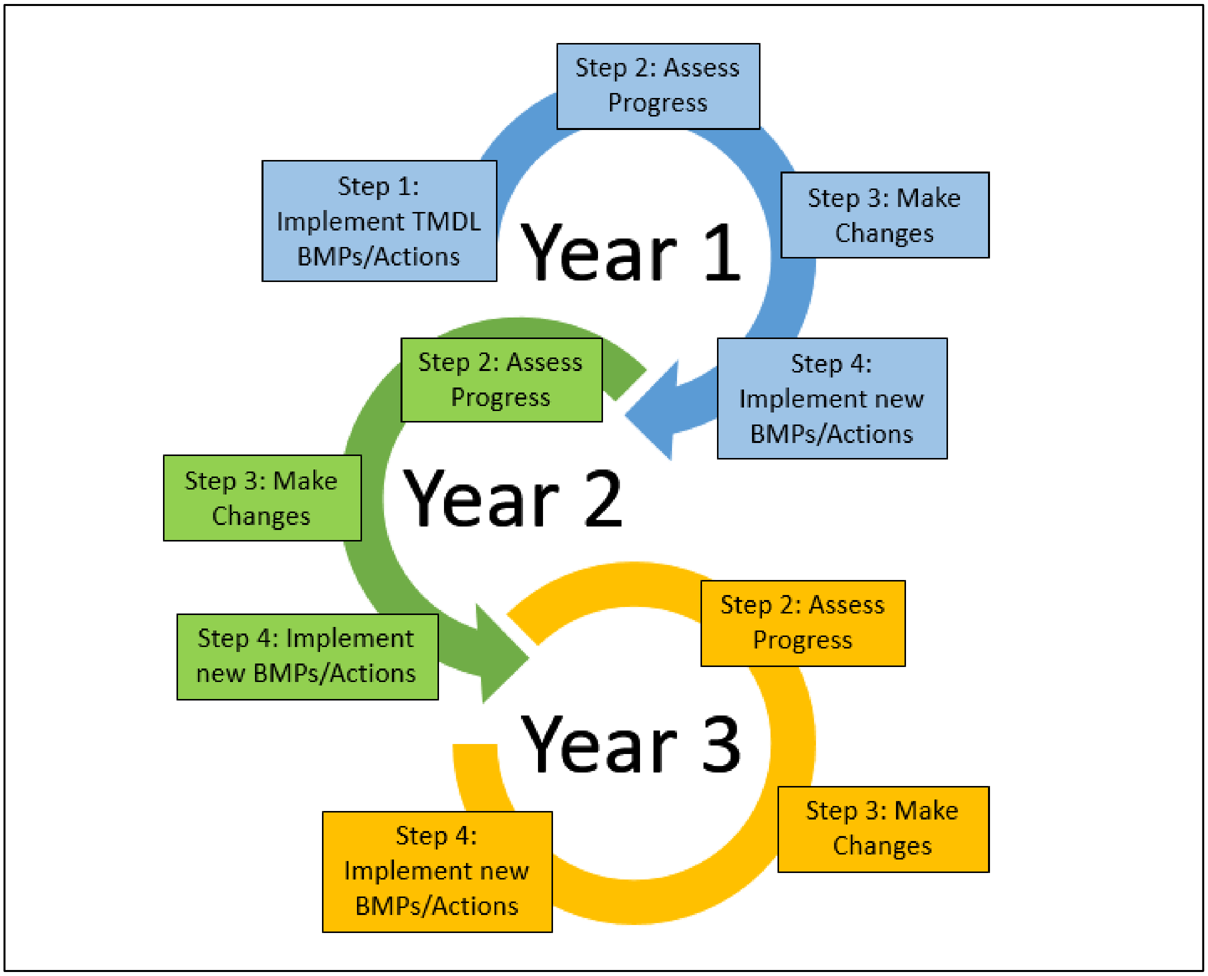

Figure 14. Conceptual model of TMDL adaptive management

Adaptive management process steps are described in detail in Appendix K. As described previously, implementation milestones are proposed for Years 3 and 7. Not only should the progress of BMP installation and other TMDL actions be assessed, but these milestone years should also include an analysis of EM data to assess progress towards interim pollution load reduction goals. If monitoring data suggest that milestones are not being achieved, and hence TMDL implementation efforts are not successful, implementers are strongly encouraged to consider devising and implementing new BMPs and interim TMDL implementation strategies and/or priorities at these times, as far as possible. Figure 15 shows how this TMDL proposed interim milestone assessment and the annual adaptive management process would fit together.

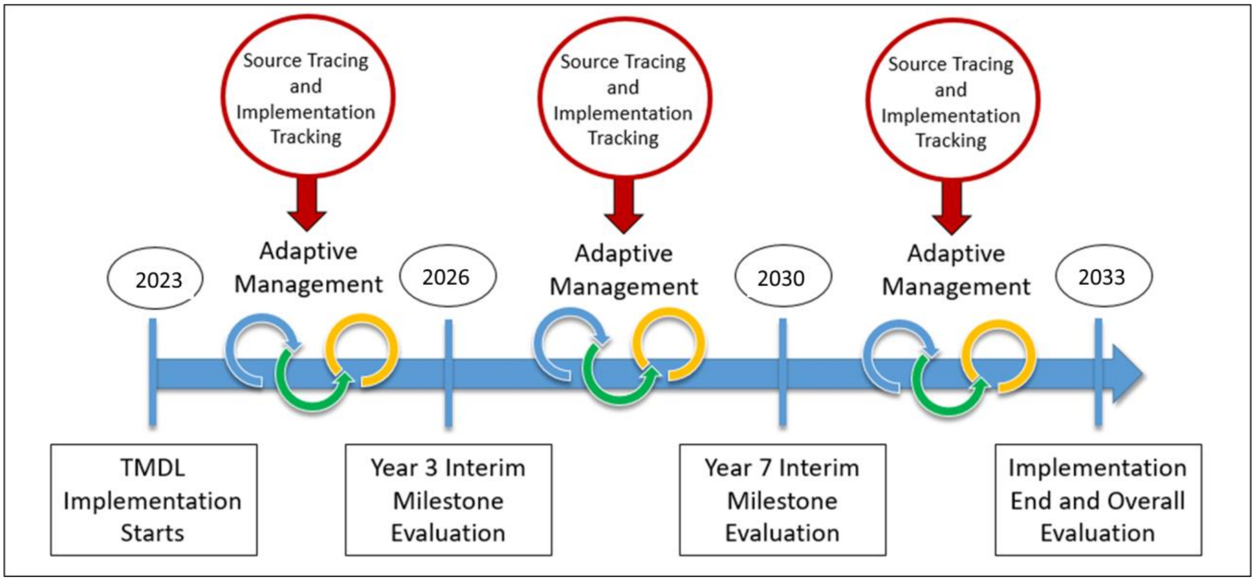

Figure 15. Conceptual model of integrated annual adaptive management and interim milestone evaluation

Decision making considerations

Some caution is prudent as it may not always be self-evident whether an adjustment to the implementation strategy is warranted. While data are valuable, they alone may not be enough to ensure the correct decision is made. Phosphorus may not respond to implementation actions immediately or as quickly as hoped. In such situations, failure to see reductions in phosphorus loads instream could be interpreted erroneously as having no or little benefit and trigger premature changes in BMPs. As described in the Effectiveness Monitoring section and Appendix J, lag time in environmental response to corrective measures is a well-documented phenomenon.

For this reason, this TMDL recommends that implementers verify SRP load reduction findings by reviewing fecal coliform (FC) and *E. coli* loading to assess manure control efforts. As explained under the Priorities section, because these bacteria are associated with the feces of warm-blooded animals and because the primary nonpoint sources of dissolved phosphorus are thought to be associated with manure, this TMDL deems bacteria load reduction to be an additional reliable measure of implementation success. Implementers should be especially wary of changing BMPs or implementation priorities if the data are not in agreement as to implementation status. If SRP load reduction milestones aren't met, but FC and/or *E. coli* loads reductions approximate the desired SRP reductions, it may be advisable to take time to understand the reasons for the discrepancy and to stay the implementation course, at least temporarily.

Interim milestone evaluation

In order to simplify adaptive management decisions and to (hopefully) avoid some of the pitfalls described above, this TMDL recommends using a decision matrix (Table 12) at years 3 and 7.

Table 12. Adaptive management decision matrix

All BMPs installed per schedule?	All BMPs installed per schedule?	Fecal coliform and *E.coli* meets WQ standards?	Fecal coliform and *E.coli* meets WQ standards?	SRP load reductions met?	SRP load reductions met?	Adaptive Mgmt. Decision	Adaptive Mgmt. Decision
Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Continue**	**Revise**
✓		✓		✓		✓	
	✓		✓	✓		✓	
✓		✓			✓	✓*	?*
✓			✓	✓		✓	
	✓		✓		✓		✓

*FC/*E.coli* data suggest BMPs are working, and continued SRP loading may be due to legacy P sinks. Staff are encouraged to begin thinking of ways to find and address these sinks. However, bacteria reductions alone may not be proof of nutrient source reductions and if P sinks are not found, it may be advisable to revise the implementation strategy.

As shown in Table 12, while effectiveness monitoring data should remain paramount in adaptive management decision making, BMP implementation progress must also be considered. In addition, multiple parameters should be evaluated, not only nutrients and pH which are the focus of this TMDL, but also others that respond more rapidly to land use changes (such as FC and/or *E.coli*). For example, if SRP load reduction milestones are met, TMDL implementation will be considered successful and on track towards completion, regardless of whether all BMPs have been installed per schedule.

Reasonable assurance

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the waterbody. TMDLs must show "reasonable assurance" that these sources will be reduced to their allocated amount. Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure that the goals of this TMDL are met.

Ecology believes that the activities identified in this chapter already support this TMDL and add to the assurance that the associated SRP load reductions in the Lower White River will meet pH criteria in the Washington State water quality standards. This assumes that the identified activities are continued and maintained. As described previously, point source reductions will be met by means of the NPDES permit program. At permit renewal/reissuance, permit managers are required to incorporate this TMDL's WLAs (and associated actions) described previously into facilities' permits. In addition, this TMDL has identified approximate permit renewal schedules and directs TMDL leads and/or implementers to monitor permit reissuance efforts and work with permit managers/writers to ensure all TMDL requirements are adequately addressed. Also, the outreach to permitted stakeholders, permit managers and permit writers have ensured the new requirements are reasonable and practical to the extent possible.

In contrast, nonpoint sources are not governed by permit and thus it is more difficult to provide assurances the associated load allocations will be met. However, the BMPs described previously are deemed reasonable and feasible, and funding assistance is available to incentivize implementation. In addition, Ecology has already successfully forged collaborative relationships with local implementation partners (e.g., KC, MIT, and KCD) and already begun identifying priority properties for technical assistance and begun outreach to landowners (see Outreach). Finally, Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards. This serves as a regulatory backstop, ensuring that BMPs will be installed if preferred collaborative approaches prove unsuccessful.

As an additional reasonable assurance measure, this TMDL attempts to estimate the nonpoint load reductions achievable with BMP installation. As described previously, the primary phosphorus transport pathways are runoff and erosion. During transport, this phosphorus may be attenuated by hydrologically connected features in the watershed. This can occur in several ways, most notably by settling to tributary stream sediments. This runoff delivered phosphorus can then be released to the stream later during non-runoff periods.

The following sub-section includes a description of the methods and information sources used to estimate potential nonpoint loading reductions within the TMDL study area. It should be noted that these estimates are provided with an acknowledgement that they carry a significant amount of uncertainty, as they represent a simplification of complex processes and spatial variability. They are best used to provide a roadmap to achieving reasonable reductions, prioritizing BMPs, and understanding the general magnitude of work that needs to be accomplished. They are not intended to constitute a guarantee of compliance with the TMDL, but rather provide support that compliance is probable or likely. Ultimately, compliance will be measured with greater certainty by future effectiveness monitoring and SRP loading estimates at the mouths of the tributaries and measured pH in the Lower White River. Based on the results of effectiveness monitoring, TMDL implementation measures can be adapted as needed to achieve water quality goals.

Simple method for estimating pollutant loads

In lieu of resources to conduct more rigorous alternatives (see Appendix L), this TMDL attempted to estimate reductions using a modified form of the Simple Method. The Simple Method is a widely used tool for estimating stormwater runoff pollutant loads for urban areas. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = R * C * A * 0.226$$

Where,

- L = Annual load (lbs)
- R = Annual runoff (inches)
- C = Pollutant concentration (mg/l)
- A = Area (acres)
- 0.226 = Unit conversion factor

Concentration was based on a survey of scientific literature (see Appendix L) Annual runoff was substituted with average monthly runoff calculated for the May-July and Aug-Oct periods respectively. Average daily load for each period was calculated by dividing the load results by 30. The advantage of this technique is that it requires only a modest amount of information, including the sub-watershed drainage area, pollutant concentrations, and annual precipitation. However, as this tool was developed to estimate concentration in runoff in urban areas, it was necessary to modify the inputs slightly for use in the largely agricultural sub-watersheds of interest in this implementation strategy. Further details regarding input variables are provided in Appendix L. The results of the load reduction analysis for agricultural areas in Boise, Pussyfoot and Second Creeks are shown in Table 13.

Table 13. Nonpoint Anthropogenic Load Reductions and BMP Load Reduction Estimates for Boise, Pussyfoot, and Second Creeks

Flow Tier	Watershed	Nonpoint Reduction	Anthropogenic SRP Load**	Anthropogenic SRP Load Reduction Needed** (lbs/day)	BMP DP Load Reduction Estimate (lbs/day)
Medium Flow (May-Jul)	Boise Creek*	50%	0.514	0.257	0.08
Medium Flow (May-Jul)	Pussyfoot Creek	35%	0.145	0.051	0.11
Medium Flow (May-Jul)	Second Creek	35%	0.034	0.012	0.03
Low Flow (Aug-Oct)	Boise Creek*	50%	0.194	0.097	0.05
Low Flow (Aug-Oct)	Pussyfoot Creek	35%	0.101	0.035	0.06
Low Flow (Aug-Oct)	Second Creek	35%	0.023	0.008	0.02

*Lower Boise Creek, i.e., not including the Enumclaw Golf Course or upper forested watershed
**Numbers taken from Table 2

The above results suggest that the implementation actions prescribed for agriculture can reduce nonpoint loads sufficiently to achieve the TMDL load allocations in Pussyfoot and Second Creeks, but not Boise Creek. The load reduction shortfall in Boise Creek is 0.05 lbs/day and 0.18 lbs/day in low flow and medium flow periods respectively. The Boise Creek sub-watershed is far larger than Pussyfoot or Second Creeks and unlike those two, forestry, not agriculture, is the dominate land use (by area). Therefore, it's not surprising that agricultural controls alone are insufficient to reduce nonpoint loading in Boise Creek to the degree required for TMDL compliance purposes. In order to achieve the assigned load reductions here it will be necessary for implementers to address additional sources. These sources, namely septic systems, the Enumclaw golf course and forestry activities, were evaluated using the same methods described above. Load reduction estimates are shown in Table 14 and discussed further in detail in Appendix L.

Table 14. Boise Creek Load Reduction Estimates for OSS, the Enumclaw Golf Course and Forestry

	Nonpoint Implementation Action	Load Reduction (lbs/day)
Medium Flow (May – Jul)	Septic System Repair	0.02
Medium Flow (May – Jul)	Enumclaw Golf Course	0.03
Medium Flow (May – Jul)	Subtotal	0.05
Medium Flow (May – Jul)	Forestry 50ft Buffer	0.42
Medium Flow (May – Jul)	Total	0.47
Medium Flow (May – Jul)	Load Reduction Shortfall	0.18
Low Flow (Aug – Oct)	Septic System Repair	0.02
Low Flow (Aug – Oct)	Enumclaw Golf Course	0.02
Low Flow (Aug – Oct)	Subtotal	0.04
Low Flow (Aug – Oct)	Forestry 50ft Buffer	0.24
Low Flow (Aug – Oct)	Total	0.28
Low Flow (Aug – Oct)	Load Reduction Shortfall	0.05

The additional estimated load reductions calculated for OSS, the Enumclaw golf course and forestry suggest that these will be sufficient to account for the load reduction short falls on Boise Creek.

In summary, the authors deem the load and wasteload reductions assigned in this TMDL to be achievable. The outreach and technical assistance to permittees and landowners by Ecology and implementation partners, our financial assistance programs, and Ecology's regulatory authorities under the NPDES program and RCW 90.48 provide reasonable assurances the load and wasteload allocations assigned in this TMDL can be met. Furthermore, the load reduction estimates described above provide additional assurances that the nonpoint reductions are attainable, **provided all the actions herein are implemented as written.** However, there can be a time lag from when phosphorus sources are controlled to when phosphorus loading responds in surface water, due primarily to legacy phosphorous sinks (see the Effectiveness Monitoring and Adaptive Management sections). While the above analysis suggests achievement of load reductions within 10 years from TMDL approval is plausible, it is important to manage expectations and be prepared for longer implementation time frames and/or remain open adjustments to the implementation strategy.

The load reduction estimates above assume that **all** sources within 50ft of surface water are addressed. Much hinges on implementers' ability to identify and control/eliminate all sources. Therefore, this TMDL strongly suggests that implementers not rely solely on Ecology's standard compliance practice of documenting what is observable from public right-of-ways. Due to the flat topography, limited public access and prevalence of tall confers and dense shrubs, visibility is limited on the ground. Reliance on 'windshield assessments alone may fail to identify all problems and greatly underestimate the properties needing BMP installation. This TMDL recommends that implementers supplement the above with analysis of most recent publicly available satellite imagery, and/or observation from fixed wing aircraft and boats to the extent practical. Also, this TMDL strongly recommends that implementers expand nonpoint efforts beyond the high priority problem parcels and resolve all medium and low priority issues as well.

Appendices

Appendix A: Watershed characterization and land distribution

Land use

Land use is often one of the most important watershed characteristics key to an understanding of pollution sources (USEPA, 2018).

Lower watershed - While there are likely some nonpoint sources (e.g., onsite septic systems) within the urban centers of the lower watershed, they are not significant as seen in the comparatively low nonpoint source loading from the tributaries, Bowman Creek, and Government Canal. Furthermore, analysis shows (see Reasonable Assurances) that nonpoint load reductions are attainable without needing to seek out and address these sources.

Middle watershed – In contrast to the point sources dominating the lower reach, nonpoint sources are not regulated via permit. Achieving load reductions here in the middle watershed will require proactive technical assistance, outreach, and compliance work on the part of Ecology nonpoint inspectors and other stakeholders. These three creeks are easily the largest streams in the Enumclaw plateau and contribute the highest nonpoint loading to the White River, with the exception of combined diffuse sources. Focusing phosphorus controls in critical source areas is appropriate as most phosphorus export typically originates from relatively narrow locations within watersheds. For example, in a study of the Chesapeake Bay, Poinke et al. (2000) found as much as > 80% of land-based phosphorus originated from < 20% of the watershed area. In addition, practical execution of plans and financial subsidies are more likely to be realized on a subsection of a catchment area (Kovacs et al., 2012).

Upper watershed - Analysis shows (see Reasonable Assurance) that the forested upper section of Boise Creek is likely contributing some of the total nonpoint loading to that tributary. Similarly, Table 2 (main body) shows relatively high nonpoint loading in Red Creek, which appears to have few other nonpoint sources besides forestry. The authors believe that much of the general loading associated with forestry is the legacy effect of less protective forestry practices prior to the Forest Practices Rules coming into effect. It's believed that much of this loading will gradually diminish through natural attenuation and equilibration.

Soils, topography, and hydrology

The soils of the Enumclaw Plateau present a severe to very severe erosion hazard (City of Enumclaw Comprehensive Plan, 2015). These are significant characteristics as surface runoff and erosion are the two most important phosphorous transport mechanisms. Poinke et al. (2000) found phosphorus critical source areas in many humid, temperate climates are often associated areas with poor infiltration due to high water tables or soil moisture. These conditions may also contribute to increased phosphorus leaching from source materials as they likely see increased contact with water.

While this is expected to be less important during the dry summer months that are a focus of this TMDL, it could result in an overall increase in phosphorus available for transport.

Soil characteristics and topography influence hydrology. Soils formed on the mudflow deposits of the Enumclaw plateau tend to form an aquitard, confining underlying aquifers and creating perched water tables. Water here tends to move laterally until it intercepts a stream channel, rather than infiltrate far below the root zone (City of Enumclaw Comprehensive Plan, 2015). Consequently, natural hydrology is quite complex and highly variable. For example, while Boise Creek flows year-round, both Pussyfoot and Second Creeks are intermittent in some reaches, often going dry in places during peak summer.

Hydromodifications often lead to increased erosion, changes in sediment transport and deposition patterns, and removal or disruption of riparian buffers (Rau, 2015b) that may help to slow runoff and filter nutrients.

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[3] http://www.cityofenumclaw.net/216/Comprehensive-Plan

Appendix B: Regulations, ordinances, and plans

In any given watershed there are likely a host of regulations that have some oversight over or impact on implementation efforts. The goal here is not to provide an exhaustive review of these rules, but rather identify a few that implementers will rely on heavily, or that provide unique opportunities or pose potential challenges to implementation. Land use planning regulations (e.g., Shoreline Management Act, Growth Management Act) are discussed under Long-term Actions.

Federal Clean Water Act

The Federal Clean Water Act (CWA) is the principal federal statute for water quality protection. In Washington State, the Department of Ecology (Ecology) is delegated authority for administering the requirements of the Act in state waters. The CWA focuses primarily on the control of point source discharges through the establishment of technology-based effluent limits, administered via the National Pollution Discharge Elimination System program. The CWA does not provide the same regulatory controls for nonpoint sources, the focus of this plan. However, various sections, most notably Section 319, do establish additional nonpoint implementation resources (e.g., funding).

The Washington State Water Pollution Control Act

The Washington State Water Pollution Control Act (Chapter 90.48 RCW) is the principal law governing water quality in the waters of Washington State. It establishes a comprehensive program to protect water quality and the beneficial uses of water and applies to surface waters, wetlands and ground water. Under the Act, Ecology is given broad authority to control and prevent point source and nonpoint sources of pollution to waters of the state. Any person who violates the provisions of Chapter 90.48 RCW is subject to an enforcement order from Ecology pursuant to RCW 90.48.120. The statute also gives Ecology the authority to take action based on a “substantial potential” to pollute. Therefore, Ecology has authority to act proactively to prevent pollution from occurring in the first place (Rau, 2015b). Ecology’s authority also includes the ability to require a polluter to implement specific best management practices (BMPs).

RCW 90.48 is the principal regulation used to control nonpoint sources in waters of Washington State. Monitoring data may be used to trace and substantiate a discharge; however, Ecology inspectors typically rely on visual indicators when making this determination. Ecology inspectors conduct ‘windshield tours’ of watersheds from public right of ways to assess water quality risk associated with agricultural practices and work with local stakeholders like counties, cities and conservation districts to correct problems (Rau, 2015a). In all cases, Ecology’s preferred approach is to connect landowners to these partners, and to emphasize technical assistance and voluntary compliance. Only after several attempts at voluntary compliance have failed will Ecology consider gradually escalating enforcement.

Dairy Nutrient Management Program (DNMP)

The Dairy Nutrient Management Act is administered by the Washington State Department of Agriculture (WSDA). Chapter 90.64 RCW requires all grade "A" licensed dairies to, amongst other things, develop a nutrient management plan (NMP) that describes how animals, manure, and process wastewater will be managed to prevent discharges to waters of the state. The NMP is completed by the dairy producer in consultation with a local conservation district, the Natural Resources Conservation Service (NRCS), or a private planner. Chapter 90.64 RCW also requires regular inspection and monitoring of dairy operations and provides authority to issue penalties. Licensed cow dairies are also required to maintain records to demonstrate that applications of nutrients to cropland are within acceptable agronomic rates. The program is managed through a Memorandum of Understanding between WSDA and Ecology. Ecology is responsible to EPA for Clean Water Act compliance for animal feeding operations (AFOs) and confined animal feeding operations (CAFOs) and retains the authority under Chapter 90.48 RCW to take compliance actions on any livestock operations where human health or environmental damage has or may occur due to potential or actual discharges. However, in accordance with the MOU, Ecology recognizes WSDA as the lead on all compliance actions against non-permitted dairies.

Onsite Septic Systems

Small on-site sewage systems (OSS), also known as septic systems, treat domestic sewage from private residences and other small developments. In Washington State, small septic systems are regulated by several state statues, but principally through Chapter 246-272A WAC. The state OSS rule is administered by the State Department of Health (DOH). Local codes must be consistent with, and at least as stringent as the state laws. Chapter 246-272A WAC establishes minimum requirements for the location, design, and performance of septic systems. Anyone proposing the installation, repair, modification, connection to, or expansion of an OSS, is required to obtain a permit from the local health officer prior to construction. Local health jurisdictions work with local boards of health to adopt and administer the local codes and are responsible for permitting all septic systems and implementing other aspects of the state OSS rule. Septic system owners are responsible for operating, monitoring and maintaining their systems to minimize the risk of failure. Owners are required to have systems pumped, when necessary, to avoid damage or improper use of the system, and to ensure the flow of sewage does not exceed the approved design specifications. Failing septic systems can impair state waters, establishing a regulatory overlap between DOH and Ecology. In these instances, Ecology will work collaboratively with DOH and local health districts to resolve the problem.

Forest Practices Rules

The Washington State Forest Practices Rules (Title 222 WAC) establish protection standards for forest practices activities. Of most relevance to this TMDL are timber harvest, thinning, road construction and maintenance, fertilizer use, required reforestation, and riparian and wetland protection requirements. The Rules are under review through an adaptive management program. The Forest Practices Board, an independent state agency, adopts the Rules. Ecology needs to concur with proposed rules involving water quality protection prior to adoption by the Forest Practices Board. The Forest Practice Rules require, amongst other things, for trees to be left within streamside areas, to protect stream bank integrity, and to capture surface runoff sediment. An approved Forest Practices Application from the state Department of Natural Resources (DNR) is required for any forest practices activities on forestlands in the state meeting certain criteria. DNR is authorized to inspect operations and enforce all rules related to forest practices. Ecology is also authorized to take enforcement action if needed to prevent damage to water quality.

The state's forest practices regulations will be relied upon to bring waters into compliance with the load allocations established in this TMDL on private and state forestlands. This strategy, referred to as the Clean Water Act Assurances, was established as a formal agreement to the 1999 Forests and Fish Report (Forest Practice Rules and Board Manual Guidelines[4]). Therefore, this TMDL does not propose any additional implementation action on Forestry properties.

The state's forest practices rules were developed with the expectation that the stream buffers and harvest management prescriptions were stringent enough to meet state water quality standards and provide protection equal to what would be required under a TMDL. As part of the 1999 agreement, new forest practices rules for roads were also established.

These new road construction and maintenance standards are intended to provide better control of road-related sediments, provide better stream bank stability protection, and meet current best management practices.

To ensure the rules are as effective as assumed, a formal adaptive management program was established to assess and revise the forest practices rules, as needed. The agreement to rely on the forest practices rules in lieu of developing separate TMDL load allocations or implementation requirements for forestry is conditioned on maintaining an effective adaptive management program.

Consistent with the directives of the 1999 Forests and Fish agreement, Ecology conducted a formal 10-year review of the forest practices and adaptive management programs in 2009:

2009 Clean Water Assurances Report[5]. Ecology noted numerous areas where improvements were needed, but also recognized the state's forest practices program provides a substantial framework for bringing the forest practices rules and activities into full compliance with the water quality standards. Therefore, Ecology decided to conditionally extend the CWA assurances with the intent to stimulate the needed improvements. Ecology, in consultation with key stakeholders, established specific milestones for program accomplishment and improvement. These milestones were designed to provide Ecology and the public with confidence that forest practices in the state will be conducted in a manner that does not cause or contribute to a violation of the state water quality standards.

In 2019 Ecology granted a two-year extension to the Assurances (until December 31, 2021). This extension was provided to allow time to address deficiencies in the rules to protect small

[4] https://www.dnr.wa.gov/about/boards-and-councils/forest-practices-board/forest-practices-rules-and-board-manual-guidelines
[5] https://fortress.wa.gov/ecy/publications/SummaryPages/0910101.html

nonfish-bearing headwater streams that were identified in several research studies through the adaptive management process. In order to extend the Clean Water Act Assurances beyond 2021, Ecology will need to see the program is on a clear path to making rule changes that will support cool, clean water in fishless headwater streams.

King County's Livestock Management Ordinance

King County's livestock management ordinance (K.C.C.21A.30), passed in December 1993, establishes requirements for animal husbandry. The ordinance minimizes the adverse impacts of livestock on the environment particularly with regard to their impacts on water quality and salmonid fisheries habitat. It calls for the completion of Farm Plans on farms with livestock and the implementation of BMPs that protect the environment. Highlights of the ordinance include restrictions on the number and size of animals per land area, and establishment of minimum riparian buffer widths. The ordinance also notably emphasizes a workable solution for the handling of livestock waste, which this TMDL considers a primary source of nonpoint phosphorous. Thus, this ordinance could directly address potential phosphorus sources and could be a useful technical assistance and regulatory tool for implementers. However, implementers should take note not all the livestock management ordinance requirements may be sufficient to fully protect water quality. For example, the ordinance allows buffer widths between 10ft and 25ft (with a Farm Plan). This falls short of the 50ft minimum width (on perennial fish bearing streams) this TMDL proposes for phosphorus control purposes, and well short of the 100ft Ecology typically deems necessary to address temperature/habitat concerns.

Where there are discrepancies between this TMDL's recommendations and those of the King County livestock ordinance (or other codes), Ecology staff will use this TMDL as the foundation for their work in the TMDL project area.

King County's Agricultural Protection Districts

The Enumclaw plateau is one of several King County designated Agricultural Protection Districts. These comprise a total of roughly 41,000 acres total where agriculture is encouraged, promoted, and protected from urban development (King County, 2015a). King County offers several programs designed to promote these objectives in these districts. Of particular note is the Farm Preservation Program (FPP). This County Program began in 1979 in attempt to preserve diminishing farmland by purchasing development rights. Approximately 13,200 acres have been permanently protected thus far (King County, 2015b), including farms in the Enumclaw plateau.

The FPP is a voluntary program. In selling the development rights to their property, owners allow restrictive covenants to be placed on it that limit the property's use and development.

These covenants:

- restrict the property to agriculture or open space uses,
- limit the number of residences permitted,
- require that 95% of the property be kept open and available for cultivation,
- require a minimum lot size if the property is subdivided, and

- restrict activities that would impair the agricultural capability of the property.

Ecology Policy staff have reviewed the associated King County ordinance (K.C.C. 26.04) and have concluded the ordinance does not preclude riparian restoration work (e.g., riparian buffers). TMDL Implementation staff are encouraged to familiarize themselves with the ordinance and Ecology's position.

Existing watershed plans

There are two other approved TMDLs that cover the project area of this TMDL, namely the Puyallup River BOD & Ammonia-N TMDL and Puyallup River Watershed Fecal Coliform TMDL. The latter assigned bacteria load reductions for one of the tributaries (Boise Creek) this TMDL deems an implementation priority. This information was used to help prioritize implementation work on reaches within that tributary. Other than this, neither document provided sufficient detail to inform this implementation plan. However, implementation of the bacteria TMDL which has already begun should help implement aspects of this pH TMDL as many BMPs are similar. Several other natural resource recovery/restoration plans have also been developed for the Puyallup and White River watersheds that directly or indirectly address water quality concerns. These include, but aren't restricted to, the White River Basin Plan, the Puyallup River Watershed Council Action Agenda, the Puyallup Watershed Assessment, the Mid-Puyallup Basin Plan, the Puget Sound Partnership Action Agenda, and the WRIA 10/12 Salmon Recovery Plan. Many of these plans have similar water quality goals and identify similar potential pollution sources, but don't emphasize nutrient controls, some place greater emphasis on stormwater compliance and flooding concerns. In addition, similar to the TMDLs mentioned above, none of these plans provide detailed implementation guidance to the degree this TMDL strives to do (i.e., describing priority BMPs and priority reaches). As such, there's little overlap with these plans.

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[6] https://www.kingcounty.gov/depts/dnrp/wlr/sections-programs/rural-regional-services-section/agriculture-program.aspx

[7] https://www.kingcounty.gov/depts/dnrp/wlr/sections-programs/rural-regional-services-section/agriculture-program/farmland-preservation-program.aspx

Appendix C: Potential implementation challenges

All the above may present site-specific challenges that could impede TMDL implementation efforts. Here are examples of some possible challenges:

- Because of flat topography and complex hydrology of the Enumclaw plateau, it can sometimes be difficult to determine the direction of watercourse flow. This can complicate technical assistance and enforcement actions.
- Because of the flat topography and because of poorly draining soils, there's often standing water in pasture during periods of heavy rain. The result is it can sometimes be difficult to relocate livestock such that they're not in direct contact with surface water.
- Even where livestock can be excluded from surface water, because of the abundance of surface water (especially in winter) it can be hard to establish wide enough buffers between livestock and surface waters to be fully protective of water quality.
- Parcel sizes in the Enumclaw plateau are generally relatively small with structures and roads often close to surface water, which can impede implementation of typical nonpoint BMPs.
  - For example, infrastructure may preclude contiguous buffers,
  - Wide buffers (e.g., 100ft) will be difficult to implement because they affect a large percentage of land for small parcels.

- As mentioned, the soils in the Enumclaw plateau tend to facilitate runoff from precipitation and irrigation and are generally highly erodible.
  - This means site conditions will often be conducive to phosphorus transport. Implementation staff may therefore need to work harder and think creatively to reduce or fully eliminate inputs to surface water.
  - This may also necessitate temporary engineered stabilization of actively eroding, denuded sites before or in concert with traditional livestock exclusion and riparian buffer projects.
- As mentioned, many streams in the Enumclaw plateau have been altered hydrologically. These modifications are often responsible for impairments downstream. Implementers will need to first reverse these changes as much as possible. Failure to do so may mean that restoration efforts remain unstable and require ongoing maintenance.
- Some local ordinances may not be fully protective of water quality to the degree necessary to achieve TMDL compliance. It's possible that implementers may therefore face occasional resistance from landowners or other implementers regarding the implementation of TMDL requirements.

None of these challenges need prohibit restoration efforts necessarily. But implementers should expect to encounter these issues at every site and come prepared with solutions, as much as possible.

Appendix D: Nonpoint sources of pollution

Nonpoint sources, particularly agricultural sources, are well known to be potentially significant contributors of phosphorus to surface waters (Sharpley and Moyer, 2000; Sharpley et al. 1994; Daniel et al. 1998; Gitau, 2005).

The USEPA (2018) recommends that watershed cleanup plans identify and address the following: pollution pathways, the types of pollution sources, the relative pollution contribution from these sources, restoration priorities, and target BMPs where they will be most effective. The next sub-sections attempt to follow this structure.

Source types

A review of land uses, aerial imagery, and the results of informal watershed tours of the Enumclaw plateau show the most likely nonpoint sources of dissolved phosphorus in the Enumclaw plateau are as follows (in order of implementation importance):

Agriculture

EPA has identified agricultural sources, including grazing and animal feeding operations to be probable key contributors of phosphorus (and nitrogen) to rivers and streams (USEPA, 2017). Rau (2015b) cites direct animal access to streams, manure or fertilizer overspray or runoff, runoff from pastures, grazing areas, and heavy use areas as significant potential sources of nutrients to Washington's waters. Given the land uses described earlier, livestock agriculture is thought to be the dominant nonpoint source of phosphorus in the Enumclaw plateau. Duda and Finan (1983) demonstrated that the highest potential for eutrophication of surface waters occurs in regions of intense animal production. This is largely because animals are confined/concentrated producing large quantities of manure per unit land area and the manure is often land applied as a means of disposal (Sharpley et al., 1994). Research shows that runoff and erosion are typically the most important phosphorous transport mechanisms. Therefore, manure leachate and improper application of manure fertilizer (Sharpley and Moyer, 2000; Vadas et al. 2005) are thought to be primary nonpoint phosphorus contributors to the tributaries in the Enumclaw plateau, particularly during runoff conditions.

Onsite septic systems

In addition to livestock agriculture, failing or improperly constructed/sited OSS are also thought to be a potentially important phosphorus source in the TMDL project area. Septic systems are known to be potential phosphorus sources in rural areas (Withers et al. 2011; Withers et al. 2009). In some watersheds phosphorus inputs from septic systems may be as or more significant than agricultural sources (Jarvie et al., 2006), especially during drier, low flow conditions (Withers et al., 2011; Neal et al., 2005) which is the focus of this TMDL. Generally, septic systems are considered an effective means of wastewater treatment provided they are designed, sited and maintained correctly (Withers et al., 2011). However, in areas with shallow groundwater or soils that become quickly saturated, as is the case in the Enumclaw plateau, treatment may not be as effective (Withers et al., 2011).

Forestry

Concerns of possible nutrient losses associated with forestry practices have existed since the 1950's (Feller and Kimmins, 1984) and research in the 1960's and 1970's in the northeastern United States forestry practices suggested deforestation caused significant nutrient loss to streams (Martin and Harr, 1988). But research of western forests has produced more mixed results, suggesting that the impact of forestry on nutrient inputs to streams depends a lot on the type of practices and local site characteristics. For example, Harr and Fredriksen (1988) state logging in headwater basins of western Oregon has resulted (amongst other things) in increased nutrient-enriched runoff. However, other studies have shown little nutrient increase (Brown et al. 1973; Martin and Harr, 1988). Most notably perhaps, in a study of the impacts of *current* harvest practices on non-fish bearing streams of western Washington, McIntyre et al. (2018) found that while dissolved phosphorus contributions increased slightly post-harvest, there was no significant post-harvest increase in phosphorus delivery to streams between tested harvest practices. Thus, this TMDL suspects that current loading from the upper Boise watershed is due largely to the legacy impacts of less protective practices prior to the Forest Practices Rules coming into effect.

Some studies have shown agricultural soils to have two to tenfold greater total phosphorus concentrations than forest soils (Sharpley et al., 2013). Loading analysis (see Reasonable Assurance) suggests that if agricultural and OSS sources in Boise Creek are properly addressed downstream, relatively little additional load reductions will be required of forestry properties upstream. Therefore, this TMDL will rely on the more protective practices of the Forest Practices Rules and natural recovery and attenuation of legacy sources to meet additional phosphorus reduction needs in Boise Creek. This should not be interpreted to suggest this TMDL deems all forestry practices to be fully protective of all water quality parameters at all times. Rather, the current practices, if implemented appropriately, should be protective to the degree necessary to address the phosphorus concerns identified in this TMDL. Red Creek is also mostly forested and shows relatively high phosphorus loading. Loading analysis shows that no reductions are needed in Red Creek in order to achieve total nonpoint reductions goals in the White River. However, any reductions achieved here, similar to those expected in Boise Creek, may serve to cushion load reductions needed in the other tributaries.

Golf Course

Golf courses are some of the most intensively managed properties in the urban environment (King et al., 2007), requiring a lot of fertilizer and water. The United States Golf Association (USGA) acknowledges the potential for phosphorus release from golf courses, either via runoff or via tile drainage water (USGA, 2015). In addition, research suggests that phosphorus releases from golf courses, especially subsurface drainage water can be significant (King et al., 2007; King et al., 2006). King et al. (2006) found that dissolved reactive phosphorus concentrations in golf course drainage water were greater than those in agricultural tile drains.

Pollution transport pathways

Runoff and erosion

Research suggests that the chief phosphorus delivery pathways in agricultural areas are runoff and erosion (Sharpley and Moyer, 2000; Gitau et al., 2005; Daniel et al., 1998; Sharpley et al., 1994; Vadas et al., 2008). Dissolved phosphorus moves in runoff through the desorption, dissolution, and extraction of phosphorus from soil, crop residue, and surface applied fertilizers and manure (Sharpley et al., 1994; Sharpley et al., 1993). Rainfall usually interacts with only a thin layer of surface soil before leaving as runoff (Sharpley, 1985). The timing of runoff relative to phosphorus application/availability is an important factor in determining transport. Research suggests (Sharpley et al., 1993 and Sharpley et al., 1994) that most phosphorus loss occurs with one or two intense storms and that phosphorus loss from manure is greatly influenced by the length of time between application and first runoff event. Erosion is generally associated more with particulate phosphorus than dissolved phosphorus (Sharpley et al., 1994) and this TMDL prioritizes BMPs that address runoff. However, erosion is an important consideration in determining the bioavailability of P transported. Suspended sediment can rapidly sorb dissolved phosphorus and transformations of particulate to dissolved phosphorus do occur. (Sharpley et al., 1993) Therefore erosion is still of relevance to this TMDL. During the drier summer months of concern in this TMDL, reduced surficial runoff from rainfall is likely supplemented by irrigation. During the driest periods of late summer, irrigation runoff may be as or more significant a transport vector than precipitation.

Although runoff and erosion typically provide the primary transport mechanism for phosphorus, phosphorus associated with runoff can also be deposited within the sediment layer of small streams. Sediments enriched with phosphorus from runoff can release phosphorus back into the water column during baseflow periods, particularly when the stream water is low in background phosphorus (McDowell, 2015).

Groundwater

Duda and Finan (1983) found that during small storms no surface runoff was observed. In addition, during TMDL monitoring of Second and Pussyfoot Creeks in summer, field staff found some sites to be dry, while others immediately downstream were flowing. This suggests local groundwater inputs may be significant in summer for these ephemeral streams.

Within the study area, the Osceola Mudflow layer (MFL) provides a relatively shallow confining layer that is the dominant surficial hydrogeologic unit. The MFL confining layer may force lateral movement of groundwater and nutrients to tributary streams, based on poor recharge rates within the mudflow deposits and observation of seeps along the White River bluffs. Duda and Finan (1983) found that large spring storms generated runoff where soil moisture was high. And Sharpley et al. (1993) state that a significant linear relationship has been demonstrated between soil phosphorus and dissolved phosphorus concentrations in runoff. In other words, shallow groundwater may significantly increase that phosphorus, which is transported via runoff, especially in spring when soils are still wet.

Artificial drainage

Duda and Finan (1983) found pollutant delivery was enhanced where roadside and field ditches were common. Sharpley et al., (1994) found that phosphorus losses can be significant when artificially drained, even when those soils are naturally poorly draining. Similarly, Duda and Finan (1983) found much higher levels of nutrients in agricultural watersheds with extensive artificial drainage. They also found substantial flow associated with tile drains following storms and visual indicators (e.g., algal blooms below tile drain outfalls) suggesting nutrient transport.

Best Management Practices

Meals et al. (2010) suggest that practices deducing direct delivery of nutrients to surface runoff may yield the most rapid reductions in nutrient loading. Phosphorus removal (treatment) structures can be effective at treating phosphorus-laden discharge/runoff (Penn et al., 2014 and Penn et al., 2012). However, Penn et al. (2014) state that these structures often necessitate costly engineering design and construction expertise. Furthermore, volume and siting restrictions can prohibit large-scale application.

Manure storage

Livestock manure is known to be a significant potential source of phosphorus in agricultural areas (Sharpley et al., 1993 and Daniel et al., 1998). Sharpley and Moyer (2000) found, that while concentrations of dissolved phosphorus in manure leachate varied depending on the livestock source, they were consistently high. In addition, as discussed above, runoff and erosion have been shown to be the primary transport mechanisms for phosphorus. Given the preponderance of livestock agriculture in the Enumclaw plateau area, it's logical that TMDL implementation should emphasize sound manure storage.

Manure storage must:

- Eliminate manure contact with surface water and/or shallow groundwater and prevent polluted runoff by:
  - Ensuring manure is covered so as to eliminate contact with rain.
    - Manure and manure contaminated solids must be stored on a concrete pad or contained in a water tight, leak free structure to prevent contact with soil.
    - Solid manure storage facilities must include a permanent roof, curbed concrete floor, and gutters or other appropriate structures to manage roof runoff. A roof may not be necessary (e.g., manure lagoon, dumpsters, concrete bunker) if structure contains all manure completely, is free of leaks, and additional volume from precipitation can be adequately managed.
- Locate manure storage structures from surface waters
  - A minimum 50ft distancefrom surface waters is required for TMDL compliance purposes for solid waste storage, but 100ft is strongly recommended.
  - A greater distance (i.e., beyond 200ft) may be needed for liquid storage as it's more mobile, depending on the manner of manure storage and if property slopes towards surface water.

Fertilizer application

Inorganic fertilizers are those of mineral or chemical origin, often manufactured in industrial processes. Organic fertilizers are those derived from animal waste. In the agricultural areas of the White River watershed, the latter is likely most commonly used. Research suggests that total phosphorus losses from organic fertilizer is generally greater and often contains more dissolved phosphorus than inorganic fertilizer (King et al., 2015a). For these reasons, organic (manure) fertilizer usage and management is prioritized in this TMDL.

Agriculture

As livestock manure is often used as a fertilizer in agricultural areas (in liquid or semi-solid form applied via a spreader), the environmental concerns associated with fertilizer application are for the most part very similar to those described above under Manure Storage, i.e., phosphorus leachate from manure and transport via runoff are key factors. Whether manure (as a fertilizer) becomes a source of phosphorus depends primarily on how it's applied. Much hangs on the timing and rate of application; for example, Sharpley et al. (1993) cite research demonstrating a direct relationship between the quality of runoff and the application rate of poultry manure and other research showing highest phosphorus losses coincide with most intense rains. Phosphorus concentrations in runoff can be significantly reduced if fertilizer application and 'first flush' events are spaced at least 3 days apart and locating application areas away from the zone of runoff removal will reduce the risk of phosphorus movement (Sharpley et al., 1993).

Appropriate fertilizer application practices must be implemented:

- Timing of manure application is critical.
    - Applicators must avoid periods of intense rain and colder temperatures (i.e., winter) when biological activity is reduced.
        - No land application of manure, litter, process wastewater, or other organic byproducts may occur after October 1 and prior to T-SUM 200[8] unless it's demonstrated to be necessary because current soil nitrogen and phosphorus plus estimated nitrogen mineralization will not provide the nutrients necessary for the double crop, winter cover crop, or perennial crop. No additional phosphorus can be applied during this time if soil phosphorus will meet crop utilization.
    - Applying nutrients to fields with conditions that are likely to lead to runoff or nutrient losses such as frozen or saturated soils, over field tile drains during saturated conditions, when significant precipitation is predicted or when flooding or field inundation is likely is prohibited.
    - Specific attention should be paid to avoiding 'first flush' events, i.e., the first two rainfall events following a dry spell.
    - If precipitation is forecasted within 72 hours that will likely cause runoff to surface waters, fertilizer including manure may not be land applied.

[8] The 'T-Sum' value is the accumulated mean daily temperatures (in ° C) above zero, starting on January 1. Once the sum of those values reaches 200, TSUM 200 is reached.

- Fertilizer applied too close to surface waters increases the risk of transport via runoff.
  - At a minimum, must implement 50ft vegetative buffers along all perennial, intermittent and ephemeral streams.
    - Buffer vegetation must consist of native trees and shrubs to provide a higher level of water quality improvement.
    - 100ft buffers consisting of native trees and shrubs are recommended along perennial streams or intermittent and ephemeral streams with current or historical anadromous fish presence.
  - At a minimum, must implement 35ft buffers along artificial ditches and drainages.
    - Native trees and shrubs are recommended; however, grass filters strips that meet Natural Resource Conservation Service standards may be used in lieu of native vegetation.

- Must apply manure at 'agronomic rates' using soil testing and following a nutrient management plan:
  - Develop field-specific nutrient budgets for all land application fields where manure, litter, process wastewater, or other organic by-products will be applied.
  - Crop specific nutrient budgets must be consistent with land grant university recommendations or equivalent standards.
  - Crop specific nutrient budgets must be based on yearly soil samples taken in the spring prior to land application and account for soil nitrogen and phosphorus as measured through soil sampling.
  - Research suggests that if fertilizers are applied at agronomically acceptable rates, based on soil testing, significant phosphorus losses are unlikely to occur (Sims et al., 1998).
  - CAFOs must not apply nutrients including phosphorus above the amount that can be utilized by crops in a single growing season.
  - Nutrient budgets must be developed before any land application can occur.
  - Nutrients must be applied at times where crops are most likely to utilize applied nutrients.
  - When soil tests demonstrate crops are not utilizing nutrients as planned, nutrient budgets must be reevaluated and adjusted.
  - Regular testing of both manure and soil is important to prevent over application of nutrients and soil phosphorus saturation (Daniel et al., 1998 and Sharpley et al., 1993).
  - Nitrogen is often the focus of fertilizer application, but most fertilizers do not contain N and P in ratios utilized by crops. And as nitrogen is often the agricultural focus, phosphorus is often over-applied (Sharpley et al., 1993).
  - Where N and P ratios differ, fertilizer application may not exceed P needs, regardless of N status.
  - Maintain records to demonstrate that applications of nutrients to cropland are within acceptable agronomic rates. These records include:
    - Soil sampling results
    - Nutrient analysis of manure and all other sources
    - Nutrient application records including, but not limited to:

    - crops grown
    - total amount of nutrients applied
    - date, method and nutrient sources of each application
    - weather conditions leading up to nutrient applications
    - Amount of irrigation water applied to each field each year
- Adjust nutrient applications when soil sampling demonstrate that crops are not utilizing applied nutrients.
  - When soil tests demonstrate elevated soil phosphorus, apply nutrients based on the phosphorus crop removal rate for the planned crop(s) in a single growing season, and develop a long-term strategy to reduce soil phosphorus levels over time using crops rotations and limiting the use of phosphorus until soil levels are reduced.
  - When soil test demonstrate crops are not utilizing nutrients as planned, evaluate and adjust application rates.
- Conservation District and NRCS staff can assist landowners in development of a tailored nutrient management plan and phosphorus reduction strategy. When making referrals, TMDL implementers should emphasize the importance of **dissolved** over total phosphorus.
- Fertilizer placement in soil may be important.
  - By placing manure in the root zone rather than simply spreading it on the soil surface, phosphorus runoff may be reduced and P uptake by plants and soil productivity may be increased (Sharpley and Halvorson, 1994).
  - However, mixing of soil and manure through say tillage may exacerbate transport via erosion, and cause additional environmental problems (e.g., increased sediment delivery to surface waters).

Turf grass

As discussed, golf courses and other turf grasses (e.g., parks, sport fields) are typically highly managed, frequently fertilized, and watered. While the fertilizers used are usually mineral and not manure in origin, they still have the potential to impact receiving waters. Thus, the control measures largely overlap those described for agricultural settings. The same recommendations regarding timing, placement of fertilizer and the need for regular soil testing described above are also recommended for turf grasses. It would be redundant to repeat those here, but the USGA (2015) also recommends the following specifically for golf courses:

- Use slow release or organic formulations for large areas
- Move fertilizer nutrients into the grass thatch and soil by ‘light’ irrigation after application
- Time nutrient applications to coincide with turf needs
- Avoid late fall applications, especially on dormant turf grass
- Monitor irrigation practices in relation to fertilizer applications so as to minimize runoff
- Make multiple, low-dose fertilizer applications rather than a few large applications

In addition to these source control measures, it may be possible to treat turf grass runoff prior to discharge to surface waters. For example, Penn et al., (2012) tested a phosphorus removal structure on irrigated golf greens, using steel slag as the active absorbent media. They found the structure was able to remove 25% of dissolved phosphorus from rainfall and irrigation events. Engineering design and construction costs can be prohibitive but may be effective site-specific solutions where other measures aren't entirely effective.

Turf grass management at parks and sports fields within the City of Enumclaw as it relates to water quality likely falls primarily under the jurisdiction of the City's municipal stormwater permit. For TMDL implementation purposes, permitted requirements are deemed largely self-implementing via the NPDES program. However, this TMDL recommends that City staff employ these same practices as a means to help control phosphorus inputs to the municipal stormwater system from parks and fields. Similarly, it may also be useful for City staff to educate local citizens on the benefits of these same practices on private property, to the extent practicable.

Forestry

Aerial application of fertilizer is used occasionally to support post-harvest regrowth. The forest Practices Rules, specifically WAC 222-38-030, controls fertilizer usage in forestry operations. This requires fertilizer application be conducted by hand within riparian management zones (see Riparian Buffer below) and requires applicators maintain a 25ft buffer from channel migration zones on Type S and Type F Streams (see Riparian Buffers below for a brief explanation). But application requirements near Type Np and Ns streams are less restrictive. Most notably section 3(f) allows Ecology to set site-specific conditions when Ecology demonstrates that downstream uses are likely to be impaired. While the above may not always meet the buffer recommendations established in this TMDL, fertilizer is used infrequently in the Pacific Northwest (Miller and Fight, 1979; Rose and Ketchum, 2002) and is primarily or exclusively a nitrogen-based fertilizer, usually urea (Rose and Ketchum, 2002). Thus, this TMDL does not deem forestry fertilizer application to be a significant source of phosphorus to the project area and no additional requirements are recommended.

Livestock exclusion

As livestock manure is one of the primary sources of phosphorus in agricultural watersheds and much of this TMDL's emphasis is on preventing or reducing leachate and associated transport, it's important to keep livestock out of riparian areas.

- Restricting access will help to:
  - prevent livestock from defecating in the riparian corridor.
  - protect native riparian vegetation from grazing and trampling, in turn protecting the transport control and possible treatment benefits associated with buffers (see Riparian Buffers below).
  - reduce/eliminate stream bank erosion (and phosphorus inputs) associated with livestock access.
- Well-constructed, permanent fencing is usually the most effective livestock exclusion tool.

- It’s important to ensure fencing is sufficiently far from surface waters to prevent manure impacts.
    - Fencing and riparian buffers are typically implemented in combination.
    - Fences should be located at minimum 50ft from perennial and seasonal streams (see Riparian Buffers below) for phosphorus control purposes only.
    - 100ft buffers are strongly recommended to be consistent with protections necessary for other pollution parameters (e.g., temperature).
    - Implementers should note that 100ft buffers are typically required for 319/Centennial funding program eligibility purposes along perennial fish bearing streams in western Washington.

To prevent unauthorized discharges from grazing animals:

- Prohibit all livestock from entering vegetative buffers and surface waters including streams and drainage ditches.
    - Livestock must be excluded from perennial, intermittent and ephemeral streams and drainage ditches and vegetative buffers using permanent fencing.
- Avoid physical damage to pastures such as compaction, pugging and erosion and prevent the generation of polluted runoff:

Animal confinement areas commonly concentrate waste and can be a significant source of polluted runoff.

- Animal confinement areas must be designed and operated to limit runoff and located away from surface waters or conduits to surface waters.
    - Runoff from animal confinement areas may not enter surface waters.
    - Runoff from animal confinement areas must be diverted to properly designed storage or treated using additional best management practices such as filter strips or vegetated treatment areas.

Runoff from animal confinement areas must be contained or diverted to a storage location designed to hold liquid runoff from October 1 to TSUM200.

Riparian buffers

Riparian buffers are stands of vegetated, forested zones (preferably native plants) along streams that serve to buffer surface waters from adjacent and upland anthropogenic impacts. The vegetation and associated organic litter provide physical resistance to surface flow, thus slowing runoff velocities and allowing for the deposition of particulates like sediment and sediment-bound nutrients (Lee et al., 2003).

In addition, the chemical and biological process associated with forested riparian ecosystems transform nutrients and chemicals transported via runoff (Snyder et al., 1998; Lee et al., 2003), reducing or making more benign that which is delivered to surface waters.

Agriculture

Riparian buffers are deemed an effective and relatively cost-effective BMP frequently recommended to remove or reduce sediment and nutrients associated with agricultural runoff (Lim et al., 1998; Daniels and Gilliam, 1996; Smith, C.M., 1988; and Younos et al., 1998).

However, research suggests that buffers are more effective at filtering sediment than phosphorus (Abu-Zreig et al., 2003 and Magette et al., 1989;). For example, Daniels and Gilliam (1996) found phosphorus reductions approaching only half that observed for sediment. Furthermore, soluble phosphorus is removed less effectively than particulate forms (Schmitt et al., 1999 and Dillaha et al., 1988). For example, Schmitt et al. (1999) found dissolved phosphorus reductions of only 30% (for 15m wide buffers) while sediment phosphorus reductions approached 80%. For this reason, this TMDL has chosen not to assign as high an implementation priority to buffers as the source control practices previously discussed. While they do usually provide some reduction benefit, they cannot be relied upon as a primary reduction tool. Buffers will need to be combined with upland source controls to maximize effectivity.

The phosphorus removal performance of buffers varies depending on site conditions (e.g., soil types, slope, climate) but also on buffer size and composition. Research literature reviewed reported large ranges of effective buffer widths, but the majority demonstrated similar effective widths. On the high end, Young et al. (1980) found buffer strip lengths of 36m (118 ft) to be sufficient to reduce nutrient levels to 'acceptable levels. On the low end, Lim et al. (1998) found no reduction in phosphorus concentration in runoff from buffer strips more than 6m (20 ft) wide. However, Abu-Zreig et al. (2003) found short filters, 5m wide (16ft) were not effective at removing phosphorus, and instead found best phosphorus removal with 15m (50ft) wide buffers. Similarly, Schmitt et al. (1999), Srivastava et al. (1996), and Lowrance et al. (2001) found optimal phosphorus reduction performance around 15m to 20m (65ft). Consistent with these findings (which represents the majority of papers reviewed), this Implementation Plan adopts 50ft as the minimum buffer width necessary (on perennial and seasonal streams) to achieve assigned phosphorus reductions only.

However, 100ft buffers are highly recommended to be protective of other water quality parameters (e.g., temperature) and to be consistent with Ecology's 319/Centennial funding eligibility criteria. This also approximates the high-end buffer width reviewed in literature, cited above. Small ephemeral drainages and ditches that don't support anadromous fish, may not require similarly wide buffers as they flow infrequently and/or flow at lower volumes and thus present a decreased pollution transport risk. And because they don't support salmonids the more restrictive protections (i.e., 100ft) required are unnecessary. For these waterbodies this TMDL deems a minimum of 25ft buffer width to be acceptable for phosphorus control purposes only. That represents half the width established for larger waterbodies and approximates the low-end buffer width found in literature cited above.

However, 35ft is strongly recommended for these smaller drainages to provide an additional conservative safety margin (to protect other water quality parameters) and to be consistent with Ecology's 319/Centennial funding requirements.

Management Recommendations

- Buffers must be wide enough to provide maximum possible dissolved phosphorus filtration/treatment.
    - Minimum 50ft on all mainstem channels and/or perennial streams.

    - A 100 ft buffer width is strongly recommended so as to be protective of other more restrictive water quality parameters (e.g., temperature) and to be consistent with 319/Centennial funding eligibility criteria.
    - Buffers as low as 20ft may be acceptable on small conveyances (e.g., ditches, canals) and ephemeral side channels/depressions. However, 35ft is highly recommended to be consistent with 319/Centennial funding requirements.
    - TMDL implementers are encouraged to use best professional judgement, and consider local site conditions (e.g., soils, slope) when determining appropriate buffer widths. For example, buffer widths may need to be larger in order to address faster flow off steep slopes or saturated soils. However, buffer widths should at no time be less than the 50ft and 20ft minimums described above, unless infrastructure (e.g., roads, bridges, buildings) make this impracticable.
    - In this case, implementers may need to consider more aggressive, or additional source control BMPs in upland areas in order to compensate for the reduced protections smaller buffers represent.
- TMDL implementers should give thought to the species composition and structure of riparian buffers.
    - Only native species are recommended for planting.
    - A mix of grasses, forbs, shrubs and trees is recommended.
        - A mixed, complex buffer of grasses, shrubs, and trees is preferable to one plant type alone.
        - However, trees are necessary to address other pollution problems, such as temperature exceedances.
- Buffers must preferably be actively maintained (e.g., weeded, replanted) until the riparian forest becomes self-sufficient, typically 5-10 years after planting. Buffers must remain in place in perpetuity. 319/Centennial funding often requires 10 years of maintenance.
- Buffers may need to be combined with livestock exclusion fencing to ensure riparian vegetation is protected from disturbance.
- TMDL implementers should note, that specific buffer widths are required to be eligible for Ecology 319/Centennial funding. These widths are based on stream type and salmonid presence, and in many situations, ancillary BMPs such as manure storage structures and livestock off-stream watering facilities are only eligible when coupled with riparian buffers.

Forestry

Riparian buffers have the same functional benefits in the forestry context as they do in agricultural settings. The Forest Practices Rules, if implemented appropriately, are deemed sufficient to meet the load reduction needs of this TMDL. The Forest Practices Rules requirements as they pertain to timber harvest in riparian areas are complex. Requirements vary depending on stream type and timber stand class. This TMDL will not attempt to explain these requirements in detail but will rather attempt to summarize and highlight key aspects of the code.

In general, the Rules aim, amongst other goals, to protect aquatic resources and related habitat to achieve restoration of riparian function. WAC 222-30 governs timber harvest practices. No harvest, construction or salvage is allowed within channel migration zones (CMZs). No harvest or construction will be permitted within the bankfull width of any Type S or F stream. The latter refers to the Washington State Department of Natural Resources' (DNR) water type classification. Per this classification system 'Type S' streams are those designated as 'shorelines of the state'. 'Type F' streams are perennial or seasonal streams known to be used by fish or having the physical characteristics to potentially be used by fish. WAC 222-30-021 governs harvest activities within 'riparian management zones' (RMZ) in western Washington. RMZs on Type S and F streams are divided into three zones:

- Core (nearest water) – no timber harvest allowed except at bridge and road crossings.
- Inner – in general harvest is allowed, but practices must meet or exceed 'stand requirements', i.e., number of trees per acre, the basal area and the proportion of conifer appropriate for the site class.
- Outer - Timber harvest in the outer zone must leave twenty riparian leave trees per acre after harvest.

The width of each zone depends on site class, bankfull width, and management option, but in general, the Core zone alone is 50ft. In addition, per WAC 22024-020 except for road crossings, roads are not allowed in natural drainage channels, CMZ, or RMZs. And managers are directed to avoid duplication of roads and minimize stream crossings. WAC 222-24-050 requires all large forest landowners to improve roads to meet standards of the Chapter.

Therefore, the Forest Practices Rules are thought to generally meet or exceed the buffer recommendations of this TMDL and thus no further action is deemed necessary. However, this does not imply that this TMDL deems the Rules sufficient to eliminate all phosphorus delivery to surface water. For example, requirements for Type Np (no fish and do not meet the physical criteria of a Type F streams) and type Ns (do not have surface flow during at least some portion of the year and do not meet the physical criteria of a Type F streams) streams are not as stringent as those described above. However, given that in this TMDL phosphorus reductions from forestry properties are only needed in Boise Creek and those reductions are relatively small (see Reasonable Assurances) the protections detailed above should be sufficient for TMDL compliance purposes. But this TMDL makes no judgment as to whether these practices are sufficient to protect other water quality parameters (e.g., temperature).

Onsite septic tank Inspection, repair and maintenance

While failing septic systems are likely contributing to phosphorus delivery to tributaries of the Enumclaw plateau, they are likely not the dominant source. As discussed, research suggests that in agricultural areas livestock manure and fertilizer application are usually more significant sources. In addition, runoff and erosion are the likely primary phosphorus transport pathways, not shallow groundwater movement. This is especially true of waterlogged soils, which are typical of the Enumclaw plateau. Lastly, phosphorus load reduction estimates for the Pussyfoot and Second Creek drainages (see Reasonable Assurance) show that load reduction goals are probably achievable without having to address septic system failures, provided all agricultural sources are adequately resolved. For this reason, this BMP is prioritized lowest of the first five TMDL compliance BMP minimums.

However, this TMDL still deems septic inspection, maintenance, and repair work a valuable component of TMDL implementation. Unlike the sources discussed above, most of the typical load from septic systems may be dissolved phosphorus, the focus of this TMDL (Withers et al., 2011). In the dry summer months, the focus of this TMDL, septic sources will likely become relatively more significant, as river flows are lower and septic inputs are independent of runoff (Jarvie et al., 2006). In addition, load reduction estimates show that for Boise Creek specifically, phosphorus load reduction needs will likely not be met through agricultural controls alone. Finally, OSS improvements in Pussyfoot and Second Creeks will provide additional assurance that load reductions are met, should implementers fail to address all agricultural sources. Therefore, proactive septic inspection and repair work will need to be part of the suite of BMPs implemented.

As discussed elsewhere, local health districts are typically chiefly responsible for oversight of OSS. In the three Enumclaw plateau tributaries of interest in this TMDL, Seattle & King County Public Health is the agency charged with this oversight within areas of state waters. Due to resource constraints, and the difficulties of verifying failure, corrective actions are typically conducted on a complaint response basis, or where source-tracing data point to a specific parcel. Seattle & King County Public Health (2019) provides detailed guidance on proper OSS management, summarized here:

- Regularly inspect and maintain septic systems
    - The frequency of maintenance depends on the type of system, ranging from 3 months to 3 years.
        - Gravity systems - every three years
        - Pressure distribution systems, proprietary systems, mound and sand filter systems - annually
    - Contacting a certified On-site System Maintainer (OSM) is recommended to inspect and monitor systems.
- Pump septic tanks every 3-5 years
    - A general rule of thumb is the more people using the system, the more frequent pumping needs to be.
- Using less water may increase the life of a septic system. Using too much water is a frequent factor in failed systems.
    - repair all leaky faucets and toilets
    - Use "low flow" fixtures on faucets and shower heads
    - Spread laundry washing throughout the week and wash full loads
    - Dishwashers and washing machines should not be run at the same time
- Nothing except toilet paper should be flushed into a septic system
- Don't drain large volumes of water into a septic system
    - Large volumes of water can 'drown' a drainfield and chlorine can destroy important bacteria in a septic tank and drainfield.

- Drain hot tubs and swimming pools away from the system, especially the drainfield.
- Direct water from land and roof drains away from the drainfield.

- Landscape with care
  - Grass is the best cover for a septic tank and drainfield. Other plants with very shallow root systems can also be used for landscaping.
- Keep septic tank lids easily accessible
  - Have "risers" installed to make septic tank pumping and monitoring visits easier and less time-consuming.
- Contact a certified professional for septic repairs
- Don't use a garbage disposal
  - Garbage disposals add solids and grease which can build-up quickly and clog or choke a drainfield.
- Don't put household chemicals down the drain
  - This includes chemicals such as paint products, drain and floor cleaners, motor oil, antifreeze, and pesticides. These chemicals destroy bacteria in a system that are necessary to break down solids.
- Don't park cars and trucks on a drainfield or septic tank
  - This will prevent soils from being packed down and pipes from breaking.

- Don't use septic tank additives
  - These products may be harmful by adding extra solids to the system that can clog a drainfield. The chemicals can also pollute ground and surface water.

With the exception of Seattle & King County Public Health staff, most TMDL implementers likely will not be directly involved in septic repair and/or septic compliance efforts. However, TMDL implementers are encouraged to be on the lookout for signs of septic failure during site visits and look for opportunities to ask landowners about their septic systems and provide associated technical assistance. Septic repair or replacement can be expensive, but funding is available through the Craft3 loan program[9] to help property owners in Pierce and King Counties cover the burden. Implementers should consider referrals to their partners at Seattle & King County Public Health if they find the following:

- Bad odors around the drainfield area especially after heavy water use or rainfall
- Very wet spots with lush green grass growth over the drainfield or septic tank areas
- Standing water in the drainfield area
- Plumbing or septic tank back-ups
- Slow draining fixtures
- Gurgling sounds in the plumbing systems

[9] https://www.craft3.org/Borrow/clean-water-loans

Soil amendment

Even with concerted effort, the above strategies may not be entirely satisfactory. It may take a long time for water quality to respond to phosphorus reduction efforts (Sharpley and Halvorson, 1994). For example, some studies of lake eutrophication have shown little decrease in lake productivity with a reduction in phosphorus inputs (Daniel et al., 1998), possibly due to internal nutrient cycling. Even if the source control strategies described above are successful at eliminating new additional phosphorus inputs, it's possible that decades of nutrient application/leaching will have saturated soils with phosphorus such that transport to surface waters continue. Therefore, it may be helpful to consider practices that serve to better bind phosphorus to soils, thus impeding transport.

To be viable, an amendment tool should be cheap and effective and not decrease phosphorus availability to crops such that it reduces agricultural productivity (Callahan et al., 2002). Alum and gypsum (calcium sulfate) are common agricultural amendments, however because of the potential toxic effects of aluminum (Brauer et al., 2005) this TMDL deems gypsum to be preferable. Gypsum addition increases the ionic strength and calcium concentration in soils, which form less soluble calcium-phosphorus complexes reducing mobility and promoting flocculation (Brauer et al., 2005; Favaretto et al., 2012; Ekholm et al., 2011; and Jaakkhola et al., 2011). Gypsum has long been used for agricultural purposes, serving as a source of crop nutrients (calcium and sulphur), and improving soil physical and chemical properties (Chen and Dick, 2011). However, gypsum can also be effective at reducing losses of dissolved reactive phosphorus (Jaakkola et al., 2011), the focus of this TMDL.

Gypsum is considered a generally safe soil amendment, easy to handle, and isn't classified or regulated. It's not combustible or explosive and shouldn't produce unusual hazards during normal use (Chen and Dick, 2011). But it's important to emphasize that gypsum soil amendment is not without risk. For example, exposure to high levels of gypsum dust can irritate skin, eyes and the respiratory system (Chen and Dick, 2011). In addition, the NRCS FOTG 333 cautions against use where sulfate additions are restricted and states that under anaerobic conditions, gypsum added to liquid manure storage facilities can result in dangerous levels of hydrogen sulfide emissions. Furthermore, it states that if soil pH is less than 5, the application of products with high sulfite content may be harmful to plants that are present at the time of application. Long-term use of gypsum or using at higher rates than necessary can have adverse impacts on soil or plant systems. This can include raising the soil pH to a level that is detrimental to plant growth or nutrient balance and creating a calcium imbalance with other mineral nutrients such as magnesium and potassium. The NRCS also advises against livestock contact with stored gypsum or fields where gypsum has been recently applied. There are also potential negative environmental impacts. One common source of gypsum is from smokestack sulfur scrubbers in industrial facilities. While the NRCS FOTG deems flue gas desulfurization (FGD) gypsum to be 'acceptable' as a soil amendment, this TMDL recommends care given the possible presence of trace legacy contaminants. Wallboard gypsum is often derived from FGD (Chen and Dick, 2011) and hence the same cautions are advised. Finally, Favaretto et al. (2012) found that gypsum additions could also result in increased ammonium mobility.

Gypsum soil amendment is assigned a low implementation priority in this TMDL. It may serve as a useful solution in particularly difficult situations, say where direct drainage (e.g., subsurface tile drains, or surface ditches) bypasses other source control/transport BMPs. It could also serve as a useful adaptive management tool, if the priority BMPs identified prove insufficient. However, in all cases TMDL implementation staff are encouraged to take a cautious approach and only make recommendations to landowners in this regard after consultation with staff with appropriate expertise (e.g., NRCS) or to simply refer landowners to these agencies for assistance. It should also be noted that currently (2021) the NRCS does not provide landowners financial assistance for soil amendment in Washington State. TMDL implementation staff will likely need to work with NRCS staff to have this added as an eligible activity to their funding portfolio.

Management Recommendations

- Care should be taken in choosing the source of gypsum
    - Gypsum is available in mineral (mined) form
    - Industrial sources of gypsum are also available
    - Mineral sources are recommended
    - Recommend the user request chemical analysis of material before purchase/application
- Restrict gypsum soil amendment to situations where priority BMPs are ineffective, i.e.:
    - Tile drains, artificial surface drainage
    - Use as an adaptive management tool
    - Use phosphorus soil testing to identify areas where phosphorous is high, and hence where gypsum may be most effective
- When using gypsum as a soil amendment care should be taken:
    - Don’t use where there are sulfate restrictions
    - Don’t apply on windy days which could generate dust (Chen and Dick, 2011)
    - Don’t add to liquid manure storage facilities
    - Don’t use where soil pH is less than 5
    - Don’t allow livestock contact with gypsum piles or fields shortly after gypsum has been applied
- Gypsum storage:
    - May be stored in the open, but
    - Cover is recommended, preferably a structure, to minimize water interaction, access by animals, and to reduce dust
    - Spraying uncovered gypsum stockpiles periodically with water can help keep dust down
- Gypsum may be surface applied:
    - As a dry powder using a conventional dry material spreader
    - Mixed with irrigation water. This may improve soil infiltration and reduce loss through runoff provided fields aren’t over irrigated and not applied close to surface waters or on steep slopes.

    - Don’t recommend gypsum usage within the riparian buffer zone (i.e., minimum 50ft from surface waters)
- Costs vary depending on:
    - Reasons for usage, crop types, and whether conventional or conservation tillage practices are employed
    - Distance to source (transport costs). Chen and Dick (2011) advise no further than the following distances or shipping costs exceed value:
        - 551 miles by barge
        - 211 miles by rail
        - 100 miles by truck
    - Source type. Industrial sources may be more readily available and hence cheaper
    - Application rate. To improve water quality Chen and Dick (2011) recommend the following application rates:
        - ‘Low’ = 1000 lbs/acre
        - ‘Normal = 6000 lbs/acre
        - ‘High’ = 9000 lbs/acre
    - Costs generally average from $20-$35 per ton (Ohio State University Extension, 2019a) or $230 -$370 per acre (Chen and Dick, 2011)
- The WSDA regular inspects dairy operations in the TMDL implementation area which may provide additional outreach opportunities
    - TMDL implementers are encouraged to engage with WSDA inspectors to
        - Have property owners regularly conduct P soil testing
        - Or review soil testing records where this is already required
        - Promote gypsum soil amendment on P saturated soils, as part of a suite of BMPs

Tile drain management

Many productive farmlands are located in areas that were once primarily wetlands (King et al., 2015a). Drainage, particularly subsurface drainage (i.e., tile drains) is critical to agricultural productivity in humid areas with poorly drained soils (King et al., 2015a; King et al., 2015b; and Smith et al., 2015). Without subsurface drainage, fields would be too wet to work with machinery, and soil water would create anoxic conditions harmful to crops (Smith et al., 2015). Drainage can increase crop yields and give farmers more control over field operations such as earlier planting and increased crop choices (King et al., 2015a). Subsurface drainage was once achieved via concrete or clay pipe and restricted to random wet spots, but since the 1970s pipes are increasingly made from plastic tubing and used in a systematic fashion to drain whole fields (King et al., 2015a). Agricultural ditches may also convey phosphorus to surface water. There’s some evidence to suggest that ditches may act somewhat as a phosphorus sink and that regular dredging and removal of vegetation may reduce phosphorus delivery (King et al., 2015a). However, King et al. (2015b) state the assimilative capacity of ditches is limited, citing an Indiana study that found ditches only served to function as a sink for 2 years. This TMDL focuses its attention rather on tile drain management as its better understood and there's a greater body of scientific evidence showing associated phosphorus reductions.

While runoff and erosion appear to be the primary phosphorus transport pathways, research suggests that tile drains can also be a significant source of phosphorus, and in particular dissolved phosphorus to surface waters (Duda and Finan, 1983; Smith et al., 2015; King et al., 2015a; King et al., 2015b; and Gentry et al., 2007). Tile drains alter the hydrologic regime such that vertical movement of nutrients through soil is facilitated, providing direct connection to surface waters (King et al., 2015b). Transport distance to surface water is shortened and natural evapotransportation processes are bypassed (Smith et al., 2015) increasing total water yield (King et al., 2015a). For example, some studies have shown that 42% to 86% of streamflow may be attributable to tile drain flow (Smith et al., 2015, King et al., 2015b). Perhaps of greatest relevance to this TMDL, some research suggests that dissolved phosphorus from tile drains continues at constantly elevated concentrations with successive flow events (Gentry et al., 2007), this in contrast to runoff/erosion pathways that appear to be most significant immediately following 'first flush' events. In addition, phosphorus losses from tile drains appear greatest in spring (King et al., 2015b) with dissolved phosphorus dominating the total phosphorus loss at this time (Schelde, et al., 2006). Unsurprisingly King et al. (2015a) state several studies show that shallower drains (0.5m) appear to convey greater dissolved phosphorus than deeper drains (1.0m), and that higher soil phosphorus is correlated with higher concentrations of dissolved phosphorus in subsurface drainage. As discussed under Fertilizer Application above, phosphorus losses tend to be higher from organic (manure) fertilizer than inorganic mineral forms.

Furthermore, phosphorus losses in tile drains are greater where fertilizers are broadcast over the soil surface, rather than incorporated in the soil (King et al., 2015a). Again, this has significant implications for conservation tillage practices.

Management Recommendations

Many of the general management practices aimed at reducing delivery of phosphorus via tile drains are the same as those described under other BMPs (e.g., appropriate fertilizer application rates and timing) and it would be redundant to repeat them here. Instead, the management recommendations that follow focus specifically on drainage water management strategies. These practices are typically divided into three classes: a) disconnecting phosphorus pathways between soil and tile drains, b) restricting flow from tile drainage, and c) end-of-tile treatments (King et al., 2015a).

- Disconnect flow pathways
    - Periodically disrupt flow of water and nutrients though soil 'macropores' (e.g., earthworm tunnels, cracks) by means of deep tillage.
    - Careful management is essential as tillage can increase sediment delivery and phosphorus loss via erosion and runoff.
    - Therefore, a fine balance must be struck between the management of these disparate pathways.

    - TMDL implementers should note that while conservation tillage practices are eligible for Ecology 319/Centennial cost-share grant funding, tillage is usually not allowed under this grant program.
- Restrict tile drain flow
    - This entails the active management of the timing and amount of water released through subsurface drainage. It works on the premise that the drainage intensity (and environmental impacts) and agricultural water need varies depending on the time of year (NRCS FOTG 554).
    - Control is usually achieved by installation of an enclosed control structure near the end of the tile drain outlet, within which are placed stackable boards or 'stoplogs'.
    - The outlet flow can be restricted to a specific depth using the boards, i.e., the boards prohibit release until flow in the pipe exceeds the height of the control structure. By adding or removing individual boards the water level (soil water depth) can be finely controlled.
    - Reduction in flow volumes of 20% to 95% and reductions of phosphorus losses of as much as 83% have been reported (King et al., 2015a) using this technique.
    - Some sites work better than others (NRCS FOTG 554).
        - Flatter the site the better
        - The more intensive the tile system the better
        - To be cost effective fields should be at least 20 acres in size
    - However, this technique is not without its limitations and risk.
        - Higher water table depths may result, causing anoxic conditions to form in soil with resulting negative impacts to crops.
        - As water control structures are typically used primarily in the non-growing season (Ohio State University Extension, 2019b), they may have limited application during the summer months of focus in this TMDL.
        - Costs typically average $30 - $100 per acre (Ohio State University Extension, 2019b), which may be prohibitive for some.
    - For this reason, this TMDL recommends that implementers take great care when using this practice.
        - Use only at priority sites and
        - Where active management can be assured (to avoid damaging anoxic soil conditions)
        - Use only in consultation with staff with the appropriate expertise and experience (e.g., NRCS)
- End-of-tile treatment
    - This refers to passing tile drain flow through various filter cells, cartridges and/or structures.
    - Filter materials may be natural or industrial in origin, and must promote phosphorus sorption and removal (e.g., rich in calcium, iron and aluminum).
    - Research shows that dissolved phosphorus removal of 52% to 81% is achievable through end-of-tile treatment (King et al., 2015a).

    - However, treatment has its limitations. E.g., Kovacic et al. (2000) found constructed wetlands to be ineffective at removing phosphorus.
        - Treatment devices are typically designed to manage only certain volumes, above which they are ineffective.
        - This is particularly relevant for TMDL implementation purposes given that most phosphorus delivery is associated with large storms and 'first flush' events.
        - Filter media efficacy may decline over time.
        - Some filter media perform well in laboratory conditions, but not well in the field.
        - Filter media must be selected with care so as not to be environmentally harmful.
        - Treatment structures/devices must often be carefully sited (moderately sloped, open areas) so to function properly.
        - Costs of treatment design, installation and maintenance are often high.
    - Treatment device installation is recommended at priority phosphorus source locations and where other BMPs aren't practicable (e.g., golf courses, lawns/fields) or where they have failed.

Given the nature of local soils and climate, it's likely that tile drains are prevalent in the Enumclaw plateau. Phosphorus losses from subsurface drainage are often difficult to control because it's usually hidden, and it bypasses the usual suite of nonpoint BMPs. Because the scale of the problem in the Enumclaw plateau isn't yet fully understood, and because fixes are inherently difficult and expensive, this TMDL deems tile drain management to be a low priority at this time. However, as described above, tile drains can be significant contributors of dissolved phosphorus to waterways. If future implementation work shows this to be the case or if the priority BMPs fail to achieve the desire effect, TMDL implementers are encouraged to consider making tile drain investigation and management a greater priority.

Conservation tillage

Conservation tillage refers to farming practices that reduce or largely eliminate conventional plowing and maintain crop residues. These alternate practices aim to reduce soil disturbance and thus promote soil health and reduce loss of topsoil through erosion. Conservation tillage, especially no-till, is gaining popularity, particularly in wheat, corn and soybean crop systems. Studies show that conservation tillage, in particularly no-till agriculture, significantly reduces sediment delivery to surface waters (Norton, 2008; McIsaac et al., 1995; and King et al., 2015a). Delivery of nutrients associated with sediment, e.g., particulate phosphorus may be reduced. Thus, conservation tillage practices are often recommended for water quality enhancements purposes. As stated previously, livestock agriculture, not crop agriculture dominates the Enumclaw plateau. Therefore, conservation tillage opportunities may not be as great here as in say the dry land wheat growing areas in eastern Washington. However, conservation till/no-till is also increasingly being used for pasture renovation ('overseeding') purposes, which typically happens on a 5–7-year rotation. And conservation tillage practices are also beginning to see use in western Washington vegetable cropping and other row crop systems.

However, research suggests that dissolved phosphorus is not reduced in conservation tillage systems, in fact some studies show a significant increase in dissolved phosphorus loss, as much as 2-3 times greater than under conventional till systems (Sharpley et al., 1993; McIsaac et al., 1995; King et al., 2015a). This phenomenon does not appear to be well understood. For example, King et al., (2015a) attribute increased dissolved phosphorus loss to conservation tillage's tendency to stratify soil (and phosphorus), presumably increasing that lost in runoff. However, Schelde et al. (2006) state that conservation tillage systems create 'preferential flow paths' or 'macropores' (e.g., plant root spaces, earthworm tunnels, soil cracks) which enhance leaching of contaminants. The latter may be particularly important where subsurface drainage (i.e., tile drains) is present as it would serve to facilitate conveyance of nutrients to said drainage.

Norton (2008) found gypsum amendment helped reduce dissolved phosphorus loses with conservation tillage systems. However, several authors recommend periodic tillage even within conservation/no-till tillage systems. In theory, this will break down the 'preferential pathways' that deliver phosphorus to subsurface drainage and mix the soil such that phosphorus stratification is reduced (Sharpley et al., 1993; Sharpley et al., 1994 and King et al., 2015a). Tillage may also help to incorporate applied manures in soils further reducing phosphorus losses (Sharpley et al., 1993). However, as stated there are significant environmental benefits to conservation tillage. TMDL implementers are advised to think holistically and consider all water quality parameters of concern. The potential negative impacts of increased sediment delivery should be carefully weighed against the potential benefits of reduced dissolved phosphorus transport gained from occasional tillage. If used, this TMDL recommends implementers err on the side of caution and only recommend tillage infrequently. Furthermore, this TMDL recommends implementers consult closely with staff with appropriate expertise in conservation tillage systems and gypsum amendment (e.g., NRCS). Implementers should also note that the use of tillage in conservation tillage systems may make the practice ineligible for some cost share programs.

Management Recommendations

- Conservation tillage, particularly no-till, is recommended
    - Large reductions in sediment and particulate phosphorus transport are possible
    - Generally speaking, conservation tillage can be highly environmentally beneficial
    - However, conservation tillage may increase dissolved phosphorus losses to surface water
- Occasional conventional till within a conservation till system should be considered
    - It may help to break preferential pathways that facilitate nutrient leaching
    - It may help to break down soil and nutrient stratification, perhaps reducing dissolved phosphorus losses though runoff
    - It may help facilitate incorporation of manure fertilizer with soils, reducing associated nutrient losses though runoff
- Occasional conventional tillage may fit well with some western Washington farming systems

    - Vegetable production often requires semi-regular tillage to control weeds and manage tough crop residue
    - This is especially true for organic vegetable systems where herbicides may not be used
    - If relatively less intensive tillage systems (e.g., strip till) are used in combination with cover crops between vegetable rotations, erosion may be significantly reduced
    - If the above is used in conjunction with a riparian buffer, soil/nutrient losses may be substantially reduced
- Gypsum soil amendments may help to ameliorate some of the increase dissolved phosphorus transport problem
- Care should be taken when using tillage in conservation till systems
    - Conventional till may undermine the agricultural and environmental benefits associated with the practice
    - Conventional till could increase soil erosion, and hence sediment and particulate phosphorus delivery to nearby surface waters
    - If used, conventional tillage should preferably be conducted when it's dry and calm (wind may increase dust problems), but timing may not be compatible with agricultural schedules
    - Using conventional tillage may result in landowners being ineligible for some conservation tillage cost-share programs
    - Implementers should think holistically and carefully weigh the environmental costs and benefits of conservation tillage vs conventional tillage before recommending either practice
    - Recommendations should be made in concert/consultation with staff with the appropriate expertise/experience (e.g., NRCS)

Because conservation tillage systems don't appear to reduce dissolved phosphorus transport, and livestock agriculture, not crop agriculture, is most prevalent in the implementation area, this TMDL does not rank this BMP highly. However, because erosion is commonly a source of particulate phosphorus, steps should be taken to prevent erosion or stop eroded soils from reaching surface waters.

Irrigation efficiency

As the primary transport pathways for phosphorus are runoff and erosion, actions that would serve to reduce water surficial flow from irrigation could help to reduce phosphorus inputs to surface waters (Sharpley et al., 1993). As stated previously, during the dry summer months of concern in this TMDL, irrigation may be a significant transport factor in that it supplements reduced precipitation. Agricultural irrigation is typically a costly, energy intensive endeavor, so savings through efficiency projects are often of agricultural/economic benefit as well. Most water wastage is the result of over-irrigation or faulty irrigation equipment.

Management Recommendations

The Farm Journal AgWeb (2019) and Irrigation Association (2019) recommend the following practices:

- Use qualified professionals to plan and help manage irrigation systems.
- Identify the soil type and its soil water characteristics to manage the water supply.
- Understand crop water needs to know when and how much water should be applied.
- Use a consistent method of irrigation scheduling.
  - Scheduling can reduce energy use by 7 to 30%.
  - It can also ensure crops are not under or over-watered.
- Select appropriate irrigation methods that will efficiently deliver water to the crop.
- Adopt and apply innovative technology to improve water management.
  - Buried pipes rarely leak and are less maintenance intensive.
- Maintain irrigation equipment.
  - The average life expectancy of a sprinkler head is about seven to 10 years.
  - The diameter of the sprinkler head nozzle is very important for uniform water application; and the nozzle diameter can grow with use, especially if there is sand or grit in the water.
  - Replace broken sprinkler heads as soon as possible.
  - Do a "can test" to check the uniformity of the application pattern.
  - Repair all leaks on the center pivot as soon as detected.
  - Above ground pipelines frequently have worn gaskets and up to 30% of the water can be lost before it gets to the discharge point.
  - Replace leaking gaskets and plug any holes in the pipeline.
- Maintain accurate records to facilitate better decisions on crop inputs.
- Anticipate water shortages and have planned strategies to respond.
- Landowners should be aware that reductions in water usage may eventually impact their water rights. Implementers and/or landowners should consult with Ecology's Water Resources Program for more information.

The Washington State Conservation Commission manages the Irrigation Efficiencies Grants Program (IEGP) that improves on-farm irrigation and helps vulnerable salmonid populations. The IEGP provides cost-share funding and technical assistance to private landowners for installing BMPs such as pivot sprinkler systems, drip irrigation systems, and piped conveyance systems. Water-right holders use program funding and resources to increase the efficiency of their on-farm water application and conveyance systems. The saved water is returned to drought-prone streams that are home to ESA-listed fish species, without risk of relinquishing the irrigator's water right. Eligible participants must have valid water rights in one of 16 identified fish-critical basins (the Puyallup-White River Basin is one). The program pays up to 85 percent of total costs for landowners to implement prescribed BMPs that increase the efficiency of crop water delivery to irrigated agriculture (up to $400,000 per contract). On-farm projects receive Irrigation Water Management planning. Source metering and fish screening is prescribed as appropriate. The pro-rated portion of saved water is transferred to the state's Trust Water Rights program for in-stream flows (proration based on cost share amount).

Another potential source of funding assistance for irrigation efficiency work may be Streamflow Restoration efforts. The Streamflow Restoration law (Chapter 90.94 RCW) was passed and signed in January 2018 in response to the Hirst decision, a 2016 Washington State Supreme

Court decision. The law clarifies how counties should issue building permits for rural homes that use a permit-exempt well for a water source. The Puyallup-White watershed was one of 15 watersheds affected by the Streamflow Restoration law. The law requires local planning groups in the 15 watersheds to develop projects and actions that offset the impacts of new permit-exempt domestic water use. The plans must result in a net ecological benefit. The law also sets aside $300 million over 15 years to support these actions, distributed through a competitive grant program.

The law requires planning in 15 watersheds that were impacted by the 2016 Hirst decision. At a minimum, plans must recommend actions to offset the potential consumptive impacts of new, rural, domestic water use on protected rivers and streams. The plans must also result in a net ecological benefit to the watershed. The law requires planning in 15 watersheds that were impacted by the 2016 Hirst decision. At a minimum, plans must recommend actions to offset the potential consumptive impacts of new, rural, domestic water use on protected rivers and streams. The plans must also result in a net ecological benefit to the watershed. The law requires planning in 15 watersheds that were impacted by the 2016 Hirst decision. At a minimum, plans must recommend actions to offset the potential consumptive impacts of new, rural, domestic water use on protected rivers and streams. The plans must also result in a net ecological benefit to the watershed. Irrigation efficiency work is typically handled by water resource agencies and thus generally outside the regulatory and technical assistance purview of TMDL implementation. Thus, this BMP is assigned a low priority. However, TMDL implementers are encouraged to keep irrigation efficiency opportunities in mind when in the field as part of a holistic approach to phosphorus reduction. Implementers should consider referrals to Ecology's Water Resources Program and/or the Conservation Commission and Conservation District staff on a case-by-case basis as circumstances dictate.

Property Acquisition

Perhaps the most protective BMP available to implementers is property acquisition as it provides implementers the greatest control of activities on site. When combined with restoration activities, acquisitions can be powerful water quality improvement tools. Ecology's 319/Centennial and Floodplains-by-Design funding programs provide funding for property acquisitions. The former emphasizes acquisitions for water quality improvement purposes, while the latter emphasizes flood protection. Washington's Recreation and Conservation Office (RCO) also provides funding for property acquisitions, primarily to protect and restore habitats and for salmon recovery purposes. While the Floodplains-by-design and RCO programs aren't water quality focused, there's often overlap between those program's goals and water quality improvement needs. One of the chief challenges with property acquisitions is that opportunities for purchase may be limited and purchase costs are often high. This may be especially true in the Enumclaw plateau, which is seeing increased interest from developers. For these reasons this BMP is deemed the lowest priority for TMDL implementation purposes. Nonetheless, implementers are encouraged to be on the lookout for acquisition opportunities.

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Appendix E: Long-term actions

GMA

The Growth Management Act (GMA) is a series of state statutes that requires cities and counties to develop a comprehensive plan to manage their population growth. It is primarily codified under Chapter 36.70A RCW. The GMA establishes a series of 13 goals that should act as the basis of all comprehensive plans. The legislature added the goals and policies of the Shoreline Management Act (below) as the fourteenth GMA goal:

- Concentrated urban growth
- Sprawl reduction
- Regional transportation
- Affordable housing
- Economic development
- Property rights
- Permit processing
- Natural resource industries
- Open space and recreation
- Environmental protection
- Early and continuous public participation
- Public facilities and services
- Historic preservation
- Shoreline management

The Washington State Department of Commerce is the primary state-level contact for GMA-related issues. They provide technical assistance to help local governments comply with the GMA and implement their comprehensive plans effectively. Perhaps most importantly as far as TMDL implementation is concerned, under the GMA, all cities and counties are directed to designate natural resource lands (including those related to forestry, agriculture, fisheries, and mining) and identify steps to preserve them. In addition, all cities and counties in Washington are also required to adopt critical areas regulations. As defined in RCW 36.70A.030(5): "Critical areas" include the following areas and ecosystems: (a) Wetlands; (b) areas with a critical recharging effect on aquifers used for potable water; (c) fish and wildlife habitat conservation areas; (d) frequently flooded areas; and (e) geologically hazardous areas. Counties and cities are required to include the best available science in developing policies and development regulations to protect the functions and values of critical areas. Here lies a possible nexus with TMDL recommendations.

Shoreline Management Act

The Shoreline Management Act's (SMA) purpose is to manage and protect the shorelines of the state by regulating uses and development in the shoreline area. Per RCW 90.58.030 'shoreline' means:

- All marine waters.
- Segments of streams where the mean annual flow is more than 20 cubic feet per second.
- Lakes and reservoirs 20 acres and greater in area.
- Associated wetlands.
- Shorelands adjacent to these water bodies. This is typically the land area within 200 feet of the waterbody, although there are important exceptions.

SMA jurisdiction includes the Pacific Ocean shoreline and the shorelines of Puget Sound, the Strait of Juan de Fuca, rivers, and streams and lakes above a certain size. It also regulates "wetlands" associated with these shorelines. Those shorelines designated as having 'statewide significance, such as the White River, have a higher threshold for permit issuance. In developing master programs for shorelines of statewide significance, RCW 90.58.020 directs local governments to give preference to uses in the following order of importance:

- Recognize and protect the statewide interest over local interest
- Preserve the natural character of the shoreline
- Result in long term over short term benefit
- Protect the resources and ecology of the shoreline
- Increase public access to publicly owned areas of the shorelines
- Increase recreational opportunities for the public in the shoreline
- Provide for any other element as defined in RCW 90.58.100 deemed appropriate or necessary

In addition, the RCW states the public's opportunity to enjoy the physical and aesthetic qualities of natural shorelines of the state shall be preserved to the greatest extent feasible. Perhaps most notably in the context of this TMDL, the RCW declares end uses shall be preferred which are consistent with control of pollution and prevention of damage to the natural environment or are unique to or dependent upon use of the state's shoreline.

The primary responsibility for administering SMA regulatory program is assigned to local governments, with an oversight role by the Department of Ecology. Local governments have adopted shoreline master programs which establish goals and policies that are implemented through use regulations. No substantial development is permitted on the state's shoreline unless a permit is obtained from the local jurisdiction that demonstrates consistency with the shoreline master program and the policies of the SMA.

The SMA's goals are as follows:

- Protect shoreline ecosystems
- Respond to pollution discharges into bodies of water
- Encourage water-dependent uses
- Provide for maximum public use and enjoyment of the shorelines
- Preserve, enhance, and increase views of and access to the water

However, per RCW 90.58.065[17], SMA guidelines shall not require modification of or limit agricultural activities occurring on agricultural lands. Therefore, most importantly for this TMDL, the ability to influence agricultural practices via the SMA is limited. But it does apply to new agriculture on land not formally used for an agricultural use, conversion of agricultural lands to other uses, and development not meeting the definition of agricultural activities and is thus still worthy of TMDL implementers' attention.

State Environmental Policy Act

The State Environmental Policy Act (SEPA) is intended to ensure that environmental values are considered during decision-making by state and local agencies. The law helps state and local agencies identify environmental impacts likely result from projects and decisions such as:

- Issuing permits for private projects such as an office building, grocery store, or apartment complex.
- Constructing public facilities like a new school, highway, or water pipeline.
- Adopting regulations, policies, or plans such as a county or city comprehensive plan, critical area ordinance, or state water quality regulation.

SEPA directs agencies to:

- Consider environmental information (impacts, alternatives, and mitigation) before committing to a particular course of action;
- Identify and evaluate probable impacts, alternatives and mitigation measures, emphasizing important environmental impacts and alternatives (including cumulative, short-term, long-term, direct and indirect impacts);
- Encourage public involvement in decisions;
- Prepare environmental documents that are concise, clear, and to the point;
- Integrate SEPA with existing agency planning and licensing procedures, so that the procedures run concurrently rather than consecutively; and
- Integrate SEPA with agency activities at the earliest possible time to ensure that planning and decisions reflect environmental values, to avoid delays later in the process, and seek to resolve potential problems.

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[17] https://app.leg.wa.gov/RCW/default.aspx?cite=90.58.065

SEPA's basic policy of maintaining and improving environmental quality is implemented primarily through extensive procedural requirements designed to ensure that governmental agencies give proper consideration of environmental matters in making decisions on actions, whether proposed by private parties or the governmental entities themselves that may impact the environment. If initial governmental review of a proposed action indicates that the action will have probable and significant adverse environmental impacts, preparation of a detailed environmental impact statement (EIS) will be required. The environmental review process in SEPA is designed to work with other regulations to provide a comprehensive review of a proposal. SEPA gives agencies the authority to condition or deny a proposal based on the agency's adopted SEPA policies and environmental impacts identified in a SEPA document.

Appendix F: Organizations that implement the TMDL

King Conservation District (KCD)

As a separate municipal state corporation created under Chapter 89.08 RCW, the KCD administers programs to conserve the natural resources of King County. KCD efforts focus on individual contact with farm owners and residents within the entire King County. The goals of the district are to promote practices that maximize productive land use, while conserving natural resources and protecting water quality through education, funding assistance, and cooperation. KCD advises landowners on the implementation of BMPs to protect water quality and fish and wildlife habitat and designs and installs stream enhancement projects. KCD holds classes, conducts farm tours and provides grants and cost-share funding for water quality-related farm improvements.

King County

The Water and Land Resources Division (WLRD) in King County Department of Natural Resources and Parks has programs in watershed and natural resource stewardship, stormwater compliance, and water quality monitoring.

The **Stormwater Services Section** provides education and technical assistance to prevent the contamination of stormwater through implementation of King County Code 9.12: Water Quality. Programs include source control inspections and technical assistance to businesses in the basin. The section also responds to drainage and water quality complaints that frequently include poor pet waste management and other bacterial pollution. Additionally, the section identifies and facilitates the removal of any illicit discharges to the storm drainage system, including such bacteria sources as illicit sanitary sewer connections. The NPDES and State Waste Discharge General Permits cover discharges from municipal separate storm sewers (MS4s). Phase I of the municipal stormwater program went into effect in 1990 and applies to incorporated cities with a population over 100,000 and unincorporated counties with populations of more than 250,000 (e.g., King County) according to the 1990 census. The permit also applies to MS4s owned by public entities located in a Phase I city or county.

The **Permitting Division** (within the **Local Services Department**) reviews development proposals to ensure that they are designed to be consistent with the Surface Water Design Manual. DDES also inspects developments during construction to ensure that stormwater runoff is controlled and that required stormwater facilities are installed according to required standards. Code Enforcement officers within the section investigate complaints of irresponsible or hazardous development in unincorporated King County that are also violations of King County Code, including zoning, housing/building, shorelines and critical areas.

The **Livestock Program** promotes proper livestock management practices and financially assists agricultural landowners with BMP implementation. The program implements the County's 1993 Livestock Management Ordinance (KCC 21A.30)(LMO) which requires land owners under King County jurisdiction to implement best management practices to minimize the transport of nonpoint pollution from livestock to water bodies and supports the raising and keeping of livestock while minimizing the adverse impacts of livestock on water quality and salmonid fisheries habitat.

King County's **Farmland Preservation Program** (FPP) preserves rapidly diminishing farmland by purchasing the right to develop it. FPP properties include dairies, beef, horse and other animal operations as well as nurseries, turf farms, and farms raising hay, silage, berries, row crops, flowers and Christmas trees. The FPP is a voluntary program. In selling the development rights to their property, owners allow restrictive covenants to be placed on it which limit the property's use and development. The covenants restrict the property to agriculture or open space uses, limit the number of residences permitted, require that 95% of the property be kept open and available for cultivation, require a minimum lot size if the property is subdivided, and restrict activities that would impair the agricultural capability of the property. In addition to preserving agriculture, the program also preserves 'non-agricultural uses that conserve and enhance natural, scenic, or designated historic resources and that do not permanently compact, remove, sterilize, pollute, or otherwise impair the use of the soil.'

Public Health Seattle – King County

Public Health Seattle-King County (PHSKC) enforces rules adopted by the state Board of Health, including rules necessary to assure safe and reliable public drinking water and protection of public health. PHSKC is responsible for assuring that installed, modified, or repaired OSS in King County meet state and local regulations. The Wastewater Program regulates OSS in accordance with Chapter 246-272 WAC. PHSKC requires pumpers and installers of OSS to be county certified. Staff of the Wastewater Program issue installation and repair permits and respond to sewage complaints regarding septic systems. They also educate homeowners and provide enforcement. The program considers development and operation of community wastewater treatment systems to replace inadequate and, in some cases, failing septic systems. The Public Health Wastewater Program educates, advises, and permits owners of OSS.

City of Enumclaw

The city of Enumclaw's WWTP is one of two significant phosphorus discharges to the Lower White River and as such is instrumental to TMDL success. Ecology engaged at length with city staff in development of the TMDL and has already begun discussions regarding the implementation if future TMDL related permit requirements. Enumclaw is defined as a Phase II community under the municipal stormwater NPDES permit. Phase II communities are those that own and operate a storm drain system, discharge to surface waters, are located in urbanized areas, and have a population of more than 10, 000 but less than that of a Phase I community (see King County section above).The Public Works Department of the city of Enumclaw is authorized to enforce the following ordinances: Ordinance 2343 that adopts the use of the Ecology stormwater manual, Ordinance 2461 that deals with stormwater management, and Ordinance 2455 that regulates domestic animals, urban livestock and poultry.

City of Buckley

The city of Buckley's WWTP is the other significant phosphorus discharge to the Lower White River and as such is critical to TMDL success. Ecology engaged at length with city staff in development of the TMDL and has already begun discussions regarding the implementation of future TMDL related permit requirements. The city is included in the group of western Washington communities falling under Phase II NPDES stormwater jurisdiction by Ecology. The city developed and adopted a Comprehensive Stormwater Management Plan and Stormwater Management Program to meet the stormwater provisions recommended by Ecology and the Puget Sound Water Quality Management Plan, which directs municipalities in the Puget Sound Basin to develop and implement a comprehensive stormwater management program. The city of Buckley adopted provisions under BMC 14.30 and 14.40 to meet the intent of managing stormwater to minimize contact with contaminants, mitigate the impacts of increased runoff due to major buildout and development within the city's drainage areas, provide management of runoff from large and small construction sites, and to preserve wildlife habitat.

Muckleshoot Indian Tribe

The Muckleshoot Indian Tribe is a federally recognized Indian Tribe in Washington State and has a 6 square mile reservation located adjacent to the City of Auburn. In addition to the Reservation, the Tribe has treaty interests in fisheries and water resources in an off-Reservation area, known as the Tribe's Usual and Accustomed (U&A) Area (see United States v. Washington, 384 F. Supp. 312, 367 (W.D. Wash. 1974); affirmed 520 F.2d 676 (9th Cir. 1975); cert. denied, 423 U.S. 1086 (1976)), which includes the White-Puyallup River watershed. Through its federally reserved treaty rights, the Tribe is a co-manager of salmon and steelhead fisheries resources within the Tribe's U&A area. Water quality and aquatic habitat in the watersheds and in nearshore marine areas of the U&A have been degraded by forest and agricultural practices, suburban and urban land uses, municipal and industrial discharges, combined sewer overflows, stormwater runoff, and other nonpoint pollution. This has caused or contributed to a declining abundance of returning salmon and steelhead. The restoration of sustainable and harvestable salmon, steelhead, and shellfish populations is an overall priority for the Tribe.

Washington State Department of Transportation (WSDOT)

WSDOT's municipal stormwater permit requires the agency to manage and control polluted stormwater runoff to protect downstream waters from pollution. Besides covering state highways and transportation-related facilities, this permit also covers stormwater discharges from rest areas, park and ride lots, ferry terminals, and maintenance facilities within urban areas of Washington. WSDOT municipal stormwater WLAs and associated compliance actions are described in Chapter 2 of this TMDL and will be incorporated in WSDOT's permit at permit renewal.

Washington State Department of Agriculture (WSDA)

Ecology is the lead state agency for water quality problems associated with livestock operations with the exception of dairies. Dairy Nutrient Management is a water quality program administered by Washington State Department of Agriculture under Chapter RCW 90.64, Dairy Nutrient Management Act. Elements of the program are managed in conformance with a Memorandum of Understanding with the Washington State Department of Ecology.

Per RCW 90.64.023, WSDA is responsible for conducting a routine inspection program to evaluate licensed dairies for evidence of violations, identify corrective actions to address actual or imminent discharges to state waters, monitor the development and implementation of nutrient management plans and identify producers that would benefit from technical assistance programs. Further, 90.64.023 states that dairy farms shall be prioritized for inspections based on criteria including, but not limited to, existence or implementation of a dairy nutrient management plan, proximity to impaired waters of the state and proximity to other waters of the state.

Given the load reductions needed in the Enumclaw plateau, the numerous dairies and large amount of agricultural lands in the plateau, water quality impairments near and adjacent to agricultural lands and the importance of addressing fertilizer application practices to reduce SRP from nonpoint sources, implementers should work with WSDA to evaluate and understand conditions on dairy farms located in the White River watershed and identify and correct conditions that are likely contributing SRP to the White River or its tributaries. Priority actions include:

- Review of soil phosphorus levels for all fields used by dairy operations to apply manure in the White River watershed.
- Review of nutrient application records to better understand the timing, rate and amount of nutrient applications and potential need for adjustments to better control SRP.
- Inspection of manure storage facilities, manure handling equipment and livestock confinement areas and their potential to discharge SRP to surface waters.
- Inventory of riparian buffers on fields adjacent to surface waters used for manure application and/or livestock grazing – identification of fields that do not have buffers consistent with the TMDL recommendations.
- Evaluation of livestock grazing areas – determine the condition of pastures and whether these conditions may be contributing to SRP discharges.
- Review of irrigation management practices and potential for discharge of SRP based on those practices.
- Identification of drain tiles lines and evaluation of nutrient management practices used to prevent discharges of SRP to surface waters via those drain tile lines.

Implementers should refer dairy producers to technical assistance providers when elevated soil phosphorus levels are discovered, when manure storage and handling or livestock grazing practices are likely causing SRP discharges, when riparian buffers and livestock exclusion setback fail to meet the requirements of the TMDL or when other conditions are discovered that likely contribute to discharges of SRP to surface waters.

Natural Resource Conservation Service (NRCS)

The NRCS is the U.S. Department of Agriculture's principal agency for providing conservation technical assistance to private landowners, conservation districts, tribes, and other organizations. The NRCS provides technical assistance to land users to better address natural resource management problems and to make sound management decisions.

This assistance can help land users:

- Maintain and improve private lands and their management
- Implement better land management technologies
- Protect and improve water quality and quantity
- Maintain and improve wildlife and fish habitat
- Enhance recreational opportunities on their land
- Maintain and improve the aesthetic character of private land
- Explore opportunities to diversify agricultural operations and
- Develop and apply sustainable agricultural systems

This assistance may be in the form of resource assessment, practice design, resource monitoring, or follow-up of installed practices. Unlike Ecology, the NRCS is a non-regulatory agency - the assistance they provide is voluntary. Nonetheless, the NRCS is typically one of Ecology’s most important partners in addressing agricultural nonpoint pollution sources. NRCS staff have extensive practical experience implementing nonpoint BMPs and have a field presence in almost every County in the US. Their firsthand knowledge of watersheds and the personal relationships they’ve established with local landowners can be invaluable.

Washington Cattleman’s Association (WCA)

The Washington Cattlemen's Association is a statewide non-profit trade organization dedicated to promoting and preserving the beef industry through producer and consumer education, legislative participation, regulatory scrutiny, and legal intervention.

The WCA is a grassroots organization that devotes itself to promoting agriculture and the cattle industry. Although satellite imagery showed few large livestock herds, it’s possible that implementation staff will need to work with the WCA in the future and may be included in outreach efforts.

Washington State University (WSU) extension

Washington State University Extension strives to use research-based information to improve the productivity, efficiency, and safety of products coming from the state's fields and pastures, orchards, processing plants, and vineyards and wineries. They ensure that new information is locally relevant and applicable. WSU extension tests and translates research results into best practices that increase profits and cut costs. WSU extension also informs new research by sharing the challenges farmers face with the University's scientists spawning new research leading to additional relevant solutions. WSU extension could be a valuable partner in outreach efforts to landowners in both urban and rural areas and their research could inform BMP implementation. WSU extension has offices in both Pierce and King County.

The Washington Farm Bureau

The Bureau is an independent, non-governmental, voluntary organization governed by and representing farmers and ranchers for the purpose of analyzing their problems and formulating action to achieve educational improvement, economic opportunity and social advancement. Farm Bureau is local, county, state, national and international in its scope and influence. Nationally the Farm Bureau is comprised of more than 6.5-million-member families, 2,800 county Farm Bureaus that are federated to form state Farm Bureaus, which in turn make up the American Farm Bureau Federation. The Farm Bureau in Washington has more than 41,000 member families. Their level of direct involvement is uncertain currently, but implementation staff may need to include the Bureau in outreach efforts.

Pierce County Public Works and Utilities, Surface Water Management Division

In addition to other responsibilities, the Surface Water Management Division of Pierce County's Public Works and Utilities Department is responsible for managing water quality and flooding through basin-specific planning efforts, for ensuring compliance with the stormwater quality management requirements of the Clean Water Act, and for gathering existing water quality data performing physical surveys, water quality monitoring, and coordinating public input for initiatives of the Surface Water Management Division. Pierce County manages a stormwater system. The unincorporated areas of the county are covered under a Phase I municipal stormwater NPDES permit. The county has oversight of the permit requirements and has developed both a stormwater manual and a best management practices manual for potential dischargers to this system. Chapter 11.05 of the Pierce County Code, Illicit Stormwater Discharges (Ordinance No. 96-47), makes it unlawful for any person to discharge any pollutants into municipal drainage facilities. The county usually uses education and technical assistance to address nonpoint source pollution entering drainage ditches but can require immediate cessation of discharges and implementation of best management practices.

Pierce Conservation District (PCD)

The PCD provides education and technical assistance to residents, develops conservation plans for farms, and assists with design and installation of BMPs. When developing conservation plans, PCD uses guidance and specifications from the U.S. Natural Resources Conservation

Service. Farmers who receive a Notice of Correction from Ecology are normally referred to PCD for assistance. In 2002, PCD requested and was granted fee funding from the Pierce County Council, in accordance with Chapter 80.08.400 RCW. This provided a stable source of funding and allowed an increase in services.

King CD Stream Steward Program and the Pierce Stream Team

These teams are a coalition of volunteers whose goal is to improve the quality of streams in Pierce and King County for the benefits of fish, wildlife, and people. KCD's Stream Steward Program trains and supports local community members to test water quality on creeks and streams in targeted creek and river basins. Currently, KCD Stream Stewards test water quality parameters in Boise Creek. After attending a training on how to test water quality parameters, Stream Stewards go out in pairs monthly to run the water quality tests at their assigned locations.

KCD Stream Stewards conduct the following water quality tests each month:

- Water and air temperature
- pH
- Nitrate nitrogen
- Dissolved Oxygen
- Turbidity
- E. coli
- Wildlife
- Stream Bed Conditions
- Habitat

Pierce Stream Team offers opportunities for volunteers to participate in water quality monitoring, streamside restoration with native plants, storm drain stenciling, and stream cleanup projects. Stream Team educates the public through educational displays about streams and related issues at a variety of events, including the Puyallup Fair.

Stream Team is a program of the Pierce Conservation District and is available to work with partner entities and organizations to collect water quality data, restore riparian areas, and help implement other components of the NPDES permit.

Puyallup Tribe of Indians

The Puyallup Land Claims Settlement Agreement states that the Tribe and EPA have exclusive jurisdiction for administration and implementation of environmental laws on trust lands within the 1873 Survey Area of the Puyallup Reservation. EPA granted the Tribe treatment as a state under Section 518(e) of the Clean Water Act, to carry out the water quality standards program under Section 303 of the Clean Water Act on trust lands within the Reservation, including the Puyallup River. In October 1994, EPA approved the Tribe's water quality standards, which apply to the Puyallup River within Reservation boundaries.

Tacoma Pierce Health Department (TPCHD)

TPCHD regulates OSS in Pierce County in accordance with Ch. 246-272A WAC and Tacoma Pierce County Board of Health Resolution 2010-4222 and has an on-site operations and maintenance program. High-volume business systems and complex systems, both business and residential, are required to perform yearly inspections. Moderate volume business systems and systems using enhanced treatment technology are required to perform inspections every three years. Other residential systems must be inspected at time of sale. Sanitary surveys or other investigative work is usually complaint or problem driven and usually must be grant-funded. Education and outreach are accomplished through a variety of tasks, including providing educational DVDs, presentations, and “as-built” information to property owners; giving presentations to community groups and organization; and mailings of educational materials to targeted audiences.

Appendix G: Priorities

Several studies have underscored the importance of concentrating implementation resources on sensitive source areas within a watershed, rather than implementing general strategies over a broad area (Sharpley et al., 1993 and Sharpley et al., 1994). In addition, the USEPA (2018) state that environmental response to implementation will be most rapid when targeted in those areas that have the greatest influence on water quality and related problems.

Watershed scale

Kovacs et al. (2012) recommend that to be most cost effective, implementation should be concentrated on critical source and transfer areas, i.e., areas where the most significant transfers of pollutants from land to water are likely to occur. For tributaries with proactive implementation, implementation is prioritized based on anthropogenic loading. Implementation on the remaining tributaries should occur on an opportunistic basis, so they are not prioritized. As more anthropogenic loading occurs in spring medium flow conditions (April – June), this period should be a priority for implementation activities. Meaning that practices should be installed or timed such to address and/or avoid spring runoff events, especially the first and second storms after a prolonged dry spell.

This TMDL deems proactive implementation efforts to be necessary only in Boise, Pussyfoot and Second Creeks. Given the anthropogenic loading and nature of land uses here, these watersheds have the greatest potential to see improvement from nonpoint implementation efforts. As mentioned previously, Red Creek contributes a relatively high additional anthropogenic loading. However, satellite imagery suggests there's little activity in this watershed, besides forestry. This TMDL relies on a combination of the implementation of the Forest Practices Rules and natural attenuation to address forestry loading. Because no additional actions are prescribed for forestry, it wouldn't be appropriate for TMDL implementers to spend much time in Red Creek. Hence, this stream is excluded from the three proactive implementation priorities. Government Canal drains a primarily urban area and hence likely presents few opportunities for nonpoint work, the exception perhaps being onsite septic system repairs. TMDL modelling suggests all the SRP loading in Bowman Creek is natural, and it's not possible to formulate a coherent implementation strategy targeting the remaining diffuse sources. Therefore, Red Creek, Bowman Creek, Government Canal, and the remaining diffuse sources are not deemed suitable for proactive implementation work and are not an implementation priority. Loading analysis (Reasonable Assurances) shows that overall nonpoint source load reduction targets are attainable without resorting to work in these tributaries. However, if this strategy fails to achieve the needed reductions, implementers may need to expand proactive nonpoint work to Government Canal as part of an adaptive management effort. In which case, given the local land uses, it would make sense to focus attention on septic system failures here.

Sub-watershed scale

The Puyallup Fecal Coliform TMDL (Mathieu and James, 2011) gives 'dry season' (July - October) FC load reductions for Boise Creek. This TMDL adopts these reduction priorities for SRP load reduction purposes. The Puyallup FC TMDL did not provide dry season reduction targets for

Pussyfoot and Second Creeks. Ecology's FC source assessment study of Pussyfoot and Second Creeks (Dickes, 2015) is less useful for prioritization purposes as load reduction targets were not calculated. Also, large portions of these Creeks flow intermittently in summer, further complicating prioritization. However, the FC geometric mean results of this study do provide some indication of bacteria 'hotspots' and hence possible priority SRP nonpoint sources. These were used to establish reach priorities.

For Pussyfoot Creek, FC data suggests the highest priority for SRP reductions should be from 180th Ave SE to 188th Ave SE. Downstream of 180th Ave Pussyfoot Creek enters Muckleshoot Tribal property and thus is not within Ecology's jurisdiction. FC exceedances upstream of this point and on the south fork are lower, suggesting a medium prioritization is appropriate. On the south fork, upstream of 196th Ave SE, exceedances are lower still. FC exceedances on the Second Creek were consistent throughout, suggestive of a medium implementation priority. FC exceedances on most ditches draining to the Pussyfoot and Second Creek mainstems were much higher suggesting these should receive implementation attention. Furthermore, Dickes (2015) observed several residences in close proximity to ditches and occasional pipes of unknown origin draining to theses ditches. Implementers are encouraged to review the source assessment report cited for more detailed information.

Reach scale

Areas within each reach are further prioritized based on proximity to surface water. Parcels within 100ft of surface water are considered a priority for implementation purposes (Figure 6). Parcels further from surface water are unlikely to be significant contributors of dissolved phosphorus, unless artificial drainage serves as a direct conduit. Ecology does not assume that all parcels close to surface water are contributing phosphorus. Only field work in combination with water quality monitoring can make this determination. These parcels are shown solely to provide implementers a general visual guide as to where they should focus their attention for TMDL implementation purposes, and to give a general sense of the workload this may entail.

Ecology nonpoint inspectors use a combination of visual cues (e.g., denuded riparian areas, eroded banks, unconfined livestock, livestock manure presence, drainage gullies etc.) via 'windshield tours' and monitoring data to prioritize properties for technical assistance. Properties are classified as high, medium, or low priorities based on pollution risk to water. Ecology staff typically refers properties to King Conservation District and/or the King County Livestock Program for follow up. If this proves unsuccessful, Ecology staff may take lead on further outreach. If technical assistance proves unsuccessful Ecology staff will gradually ratchet up compliance efforts, potentially ending in enforcement. Ecology nonpoint staff, working with partners like King Conservation District and King County Livestock Program, have already identified several high and medium priority properties that may be contributing pollution to surface waters. Due to privacy concerns, this TMDL will not list these properties, but they present a good starting point for TMDL implementation efforts. Once staff have worked through this priority list, they are encouraged to identify additional opportunities for technical assistance, concentrating on the parcels near surface water shown above.

As discussed, failing OSS are thought to be an additional potential source of phosphorus loading. While livestock sources are deemed more significant, septic systems should not be ignored. Seattle – King County Health staff will likely be chiefly responsible for identifying and addressing failing systems. However, other implementers have a possible role to play given their broad geographic reach and frequent presence in the field. They can help provide some basic, limited education/outreach, help identify possible failing systems and make referrals to the local health district. To this end, implementers should evaluate effectiveness monitoring data and be vigilant for signs of septic system failure when on site. Special attention should be given to parcels with septic systems within 100ft of surface water as these have the greatest potential to be contributing phosphorus. This TMDL recommends that implementers focus their OSS inspection efforts here initially.

King County monitoring data collected 2011 and 2012 (Raymond, 2013) suggest that Enumclaw stormwater conveyances between Warner Road and highway 410 are conduits for bacteria. In particular, microbial source tracking (MST) data were suggestive of human waste contamination, possibly indicative of nearby septic system failures. However, much of this area is now connected to City sewer (Eric Palmer, City of Enumclaw, personal communication. May 23, 2019). Furthermore, King County's OSS GIS layer now shows few remaining septic systems in the area. So, it is possible previous OSS problems are now largely resolved. However, this TMDL recommends that implementers investigate further and work with implementing partners to find resolution.

Parcel scale

Site characteristics or resource constraints may make implementation challenging such that not all BMPs can be implemented to the extent necessary, or some may need to be dropped altogether. In such instances implementers must, to the degree practicable, install BMPs in order of priority, with (if necessary) decreasing effort applied at increasing distances from surface water. In order to assure nonpoint load allocations are met, implementers will need to eliminate or substantially reduce all sources and pathways within 50ft of surface waters (see Reasonable Assurances). Implementers may be able to compensate for shortfalls by opportunistically applying optional BMPs.

Under normal circumstances, BMP installation should be prioritized as described in the TMDL main body, but implementers may need to use best professional judgement to reprioritize BMPs based on site conditions. For example, if lower priority BMPs are missing then priorities should be reordered. Similarly, activities closer to surface water pose a greater risk to water quality and may necessitate a shuffling of priorities. Timing may be an additional consideration necessitating reordering of priorities, at least temporarily. For example, as discussed previously, most dissolved phosphorus is transported during the first or second 'first flush' rainfall events. Implementers may need to order BMP installation to have protections in pace before these events occur. Similarly, riparian plantings may be more successful if installed in the fall or spring, necessitating a temporary reordering of priorities. And logistic and administrative challenges associated with funding and landowner approvals may result in unforeseen delays and necessitate further reordering of priorities.

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Appendix H: Funding sources

There are multiple sources of funding for the BMPs available in the TMDL implementation area. Federal, state, local, and private funding opportunities may be available. A detailed description of the funding sources thought to be most significant in TMDL project area is given below.

Federal cost-share and rental payment programs

Probably the most useful funding sources available for BMP implementation are the various cost-share and rental payment programs administered by the United States Department of Agriculture (USDA). Of the various agencies housed within the USDA, the Farm Service Agency (FSA) and the Natural Resources Conservation Service (NRCS) may be the most useful for TMDL implementation purposes. Technical assistance provided by these agencies helps people reduce soil erosion, enhance water supplies with groundwater recharge, improves water quality, increases wildlife habitat, and reduces damages caused by floods and other natural disasters. The various funding programs these and other agencies offer are described below. Each program has specific eligibility requirements and site characteristics determine which program is best suited to the property in question.

USDA Farm Service Agency

Conservation Reserve Enhancement Program (CREP)

The Washington Conservation Reserve Enhancement Program (CREP) provides funding to farmers and ranchers to help protect stream corridors and conserve priority salmon stocks. Landowners enroll land located along water bodies to create buffer zones. These buffers are planted with native trees and shrubs to cool stream temperatures and filter polluted runoff. Participants are reimbursed for 100% of the costs to establish the buffer and receive an annual rental payment per acre enrolled. Payments are made to participants after conservation practices and activities identified in an EQIP plan of operations are implemented. Contracts can last up to ten years in duration. CREP is funded by the USDA Farm Service Agency and the State of Washington. The federal government contributes about 90 percent of the total costs, while the State covers the remaining 10 percent. The minimum width of a buffer starts at 35 feet and can extend to an optional maximum of 180 feet. Agricultural producers and owners of non-industrial private forestland and Tribes are eligible to apply for EQIP. Eligible land includes cropland, rangeland, pastureland, non-industrial private forestland and other farm or ranch lands.

Conservation Reserve Program (CRP)

The Conservation Reserve Program (CRP) is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

Continuous Conservation Reserve Program (Continuous CRP)

The Continuous-CRP program is similar to CREP. It provides cost-share to producers to implement riparian buffers on agricultural land. Washington State does not contribute to the Continuous CRP program. Therefore, the Continuous CRP program pays only 90% cost-share for fencing, livestock water, and tree planting and a smaller rental payment per acre over the 10–15-year contract. The main difference between CREP and Continuous CRP is that CREP is only available on streams where threatened runs of salmon or steelhead are present. As a result, Continuous CRP is a valuable program for the smaller tributaries in the watersheds that may not provide ESA habitat but still influence stream temperature.

Emergency Conservation Program

The Emergency Conservation Program (ECP) helps farmers and ranchers to repair damage to farmlands caused by natural disasters and to help put in place methods for water conservation during severe drought. The ECP does this by giving ranchers and farmers funding and assistance to repair the damaged farmland or to install methods for water conservation.

Farmable Wetlands Program

The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. FWP is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers. Participants must agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes. Plant cover may include plants that are partially submerged or specific types of trees.

USDA Natural Resource Conservation Services

Environmental Quality Incentive Program (EQIP)

The Environmental Quality Incentives Program (EQIP) is designed to promote agricultural production, forest management, and environmental quality. Through EQIP, the Natural Resources Conservation Service (NRCS) provides financial assistance to eligible farmers and ranchers to address soil, water, and air quality, wildlife habitat, surface and groundwater conservation, energy conservation, and related natural resource concerns. The program requires the development of lists showing practices eligible for payment, allowed payment rates, criteria used to rank applications, and a description of the program and the application process. This is a locally driven process where 'local work groups' made up of local governments, agencies, and agricultural producers identify specific annual priorities for funding. Millions of dollars are available to each state to implement regional priorities identified by the work groups.

Agricultural Conservation Easement Program (ACEP)

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps tribal, state, and local governments and non-governmental organizations protect working agricultural lands. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands. Land protected by agricultural land easements provides additional public benefits, including environmental quality, historic preservation, wildlife habitat and protection of open space. Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, improve water quality by filtering sediments and chemicals, reduce flooding, recharge groundwater, protect biological diversity and provide opportunities for educational, scientific and limited recreational activities. NRCS may enroll eligible land through:

- Permanent Easements are conservation easements in perpetuity. NRCS pays 100 percent of the easement value for the purchase of the easement, and between 75 to 100 percent of the restoration costs.
- 30-Year Easements expire after 30 years. Under 30-year easements, NRCS pays 50 to 75 percent of the easement value for the purchase of the easement, and between 50 to 75 percent of the restoration costs.
- Term Easements are easements that are for the maximum duration allowed under applicable state laws. NRCS pays 50 to 75 percent of the easement value for the purchase of the term easement and between 50 to 75 percent of the restoration costs.
- 30-year Contracts are only available to enroll acreage owned by Indian tribes. Program payment rates are commensurate with 30-year easements.

Conservation Stewardship Program (CSP)

The Conservation Stewardship Program (CSP) helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment. Through CSP, participants take additional steps to improve the resource conditions on their land—including soil, air and habitat quality, water quality and quantity, and energy conservation. CSP provides two types of payments through five-year contracts: annual payments for installing new conservation activities and maintaining existing practices; and supplemental payments for adopting a resource-conserving crop rotation. Producers may be able to renew a contract if they have successfully fulfilled the initial contract and agree to achieve additional conservation objectives. Eligible lands include private and Tribal agricultural lands, cropland, grassland, pastureland, rangeland and nonindustrial private forest land. CSP is available to all producers, regardless of operation size or type of crops produced.

Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. RCPP encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales. Eligible Partners include agricultural or silvicultural producer associations, farmer cooperatives or other groups of producers, tribal, state or local governments, municipal water treatment entities, water and irrigation districts, conservation-driven nongovernmental organizations and institutions of higher education. Under RCPP, eligible producers and landowners of agricultural land and non-industrial private forestland may enter into conservation program contracts or easement agreements under the framework of a partnership agreement.

Agricultural Management Assistance

The Agricultural Management Assistance (AMA) helps agricultural producers use conservation to manage risk and solve natural resource issues through natural resources conservation. NRCS administers the AMA conservation provisions while the Agricultural Marketing Service and the Risk Management Agency implement other provisions under AMA.

USDA Rural Development

Single Family Housing Guaranteed Loan Program

This program assists approved lenders in providing low- and moderate-income households the opportunity to own adequate, modest, decent, safe and sanitary dwellings as their primary residence in eligible rural areas. Eligible applicants may build, rehabilitate, improve or relocate a dwelling in an eligible rural area. The program provides a 90% loan note guarantee to approved lenders in order to reduce the risk of extending 100% loans to eligible rural homebuyers.

Single Family Housing Repair Loans & Grants

Also known as the Section 504 Home Repair program, this provides loans to very-low-income homeowners to repair, improve or modernize their homes or grants to elderly very-low-income homeowners to remove health and safety hazards.

US Fish and Wildlife

Partners for Fish and Wildlife Program

The Partners for Fish and Wildlife Program was established in 1987 with a core group of biologists and a small budget for on-the-ground wetland restoration projects on private lands. Through voluntary agreements the Partners program provides expert technical assistance and cost-share incentives directly to private landowners to restore fish and wildlife habitats. This successful, results-oriented program has garnered support through the years and has grown into a larger and more diversified habitat restoration program assisting thousands of private landowners across the Nation.

State

Recreation and Conservation Office

Salmon recovery grants

In 1999, the Washington State Legislature created the Salmon Recovery Funding Board. The board provides grants to protect or restore salmon habitat and assist related activities. Since 1999, the board has awarded more than $477 million in grants to more than 1,700 projects in 31 of the state’s 39 counties. Salmon Recovery Boards identify projects annually for funding. Many salmon recovery projects benefit water quality.

Farmland preservation grants

The Washington state Recreation and Conservation Office manages a Farmland Preservation Grant program that provides funding to cities, counties, nonprofit organizations and the state Conservation Commission to buy development rights on farmlands to ensure lands remain available for farming in future. Through the Farmland Preservation program grant recipients can also help to restore ecological functions. Eligible projects include land acquisitions through easements, ecological restoration projects (including livestock exclusion fencing, riparian buffer planting, hydro-mod restoration) and farm stewardship plans. The primary purpose of this grant program is to conserve farmland, but up to 50% of total acquisition costs may be devoted to restoration activities per grant, so significant TMDL implementation could potentially be accomplished through this source.

Aquatic Lands Enhancement Account (ALEA)

In 1984, the Washington State Legislature created ALEA to ensure that money generated from aquatic lands was used to protect and enhance those lands. ALEA grants may be used for the acquisition, improvement, or protection of aquatic lands for public purposes. They also may be used to provide or improve public access to the waterfront. The ALEA program is targeted at re-establishing the natural, self-sustaining ecological functions of the waterfront, providing or restoring public access to the water, and increasing public awareness of aquatic lands as a finite natural resource and irreplaceable public heritage.

Washington Wildlife and Recreation Program (WWRP)

The Washington Wildlife and Recreation Program provides funding for a broad range of land protection and outdoor recreation, including park acquisition and development, habitat conservation, farmland and forestland preservation, and construction of outdoor recreation facilities. The Washington Wildlife and Recreation Program was envisioned as a way for the state to accomplish two goals: Acquire valuable recreation and habitat lands before they were lost to other uses and develop recreation areas for a growing population.

Department of Natural Resources

Community Forestry Assistance and Environmental Justice Grants

Community Forestry Assistance grants provide financial assistance to help develop powerful, sustainable urban forestry programs. The intent of this grant is to assist communities to develop urban forest planning and programming tools and activities that may not otherwise receive local funding.

Tree City USA Tree Planting and Maintenance Grants

The Tree City USA Tree Planting and Maintenance Grants support communities working to improve and enhance tree canopy cover as a component of a comprehensive urban and community forestry management program.

Department of Ecology

Water Quality Combined Funding

Ecology combines multiple water quality funding sources (Centennial Clean Water, Section 319, and Clean Water State Revolving Fund) into a single funding cycle, requiring only one application. With these funds, Ecology has provided funds for extensive riparian planting and livestock management practices throughout the state. This funding program is likely to be a significant source of funding for the buffer creation, riparian planting, livestock fencing, manure storage and off-stream watering needed as part of this plan. However, as stated previously, in order to be eligible for these funds, landowners must be willing to install the riparian buffer widths established by the National Marine Fisheries Service (NMFS). In the Boise, Pussyfoot and Second Creek watersheds this means a minimum buffer width of 100ft either side of the stream channel. The upper Boise Creek watershed, roughly east of the Enumclaw city limits to its forested headwaters has buffer widths reduced to 50ft either side of the stream channel.

Centennial Clean Water Program

The Centennial Clean Water Program (Centennial) is a state funded program created by the

Washington State Legislature in the middle 1980s. Centennial provides grants for wastewater infrastructure and nonpoint source pollution control projects. Infrastructure (facility) projects are limited to wastewater facility preconstruction and construction projects in qualified hardship communities. Although it is rarely done, Ecology may also make loans using funds from Centennial.

Section 319

Congress established the Clean Water Act Section 319 Program (Section 319) as part of the CWA amendments of 1987 to address nonpoint sources of water pollution. EPA offers an annual grant to Washington to implement the Washington's *Water Quality Management Plan to Control Nonpoint Sources of Pollution*. The grant from EPA requires a 40 percent state match, and Ecology provides this match through Centennial grants for nonpoint source pollution control projects.

Clean Water State Revolving Fund (SRF)

The United States Congress established the Water Pollution Control Revolving Fund Program (CWSRF) as part of the Clean Water Act (CWA) Amendments of 1987. The Environmental Protection Agency (EPA) offers states capitalization grants each year according to a formula established in the CWA. The state must provide a 20 percent match of the Capitalization Grant. Twenty percent of CWSRF is set aside for nonpoint source pollution control activities.

Direct Implementation Funds (DIF)

The Department of Ecology periodically identifies a small amount of the federal Section 319 funds it receives for the purpose of directly implementing TMDL other nonpoint projects. These are small grants (usually less than $60,000) to focus on specific implementation actions on high priority sites. The projects are proposed by staff to achieve a specific water quality objective. Ecology then works with a partnering entity through implementation. Often, this involves funding riparian protection and planting.

Coastal Protection Fund - Terry Husseman Account

The Terry Husseman Accounts offers small grants (less than $50,000) for specific on-the-ground restoration projects proposed by partners. Typical projects address water quality issues or fish and wildlife protection or enhancement in or adjacent to waters of the state, such as streams, lakes, wetlands, or the ocean. The coastal protection account was created to utilize money collected via water quality penalties for water quality protection. Availability of funds varies depending on recent violations and penalties. The Terry Husseman grants do not include money for administration. The funds are to be used for materials and labor only.

Floodplains by Designs

Floodplains by Design is a partnership of local, state, federal, and private organizations focused on coordinating investment in and strengthening the integrated management of floodplain areas through Washington. Floodplains by Design grant projects are multi-benefit: both reducing flood hazards to communities and restoring natural functions of Washington's rivers and their floodplains. These projects bring together many different uses in the floodplain to benefit the entire community and ecosystem, improve flood protection for towns and farms, restore salmon habitats, improve water quality, and enhance outdoor recreation.

Streamflow Restoration

Funding opportunities are described under the Irrigation Efficiency section.

State Conservation Commission

The Washington Conservation Commission has historically had funds available for projects proposed by conservation districts. These funds have gone toward a variety of BMPs throughout the state.

Local government

Clean Water Loans

Tacoma Pierce County Health Department and the Seattle-King County Public Health Department both offer affordable loan program through Craft3, a nonprofit lender serving Washington and Oregon. Craft3's Clean Water Loan is available to help septic system owners repair, upgrade or replace failing systems. Loans can cover all upfront and construction costs, including septic system design, permits, and installation and includes a reserve of up to $1,750 to help property owners pay for ongoing inspections, repairs and compliance issues.

Private organizations

Several private organizations may also provide funding assistance for environmental improvement and/or restoration work. The authors have not attempted to determine what (if any) are available and applicable to the TMDL implementation work prescribed in the tributaries of the Enumclaw plateau.

Appendix I: Outreach

TMDL implementation necessitates outreach to interested and effected parties and because the reach of TMDLs is so broad, a comprehensive and coherent outreach strategy is needed. This TMDL will not attempt to provide a detailed outreach and communications plan. That should be developed post TMDL approval/adoption in concert with key implementation stakeholders like King County (KC), King Conservation District (KCD), Muckleshoot Indian Tribe (MIT), Seattle-King County Public Health (Public Health), and the City of Enumclaw (Enumclaw). Rather this TMDL will recommended a general outreach approach, emphasizing key points or messages when necessary. In addition, this section will describe those outreach efforts that have already begun. This TMDL divides outreach into three parts: the administrative outreach requirements of TMDL development and adoption, the opportunities for and progress made thus far in forging collaborative relationships with stakeholders, and education needs to reach private landowners and watershed residents.

Administrative outreach

Every TMDL has to navigate certain internal and external procedural or administrative outreach steps prior to approval.

Internal

Ecology has a lengthy internal TMDL review and approval process prior to publication, the purpose of which is to catch and address errors or shortcomings, to ensure that all basic TMDL requirements are met and that the conclusions, statements and recommendations therein are consistent with Ecology policies. This necessitates communication with staff both within Ecology's Water Quality Program, and in other Ecology Programs. Internal (Ecology) outreach should include:

- Senior TMDL Program staff
    - Check all basic TMDL requirements are met – e.g., EPA's TMDL 'checklist' items
- Water Quality Policy Program staff
    - Check for consistency with Ecology and Water Quality Program policies/procedures
- Southwest Regional Office (SWRO) regional unit and section supervisors and executive management
    - General information
- SWRO regional permit managers and writers
    - Ensure TMDL development staff understand unique permit management and/or implementation challenges at sites
    - Coordinate to ensure as far as possible that proposed WLAs and associated requirements are achievable and aren't too onerous
    - Familiarize permit managers with new permit requirements and ensure they understand future expectations
- SWRO regional nonpoint pollution inspectors

    - As Ecology's chief means of ensuring nonpoint LAs are achieved, inclusion of nonpoint inspectors is critical to TMDL success
    - Nonpoint staff should be informed of proposed nonpoint actions and have an opportunity to provide input, and if needed recommend alternatives
    - Ensure that nonpoint staff understand expectations and as far as possible are committed to implementing the TMDL
- Other regional Ecology program staff, primarily Shorelines and Environmental Assistance (SEA), Water Resources (WR) and Environmental Assessment Program (EAP) staff
    - Ensure that references/descriptions of SEA and WR procedures are accurate
    - Ensure that they are aware of TMDL recommendations as they pertain to their Programs
    - Facilitate future engagement with SEA/WR staff on attempts to have new TMDL requirements included in their plans and/or guidance documents (as much as possible).
    - Ensure EAP staff are familiar with and have an opportunity to comment on the TMDL's effectiveness monitoring proposal

Outreach to Ecology permit managers/writers, policy staff, nonpoint inspectors and staff in Ecology's SEA, WR and EAP Programs is done. These staff have all had the opportunity to review and comment on the TMDL and the authors have gone to great lengths to ensure that they clearly understand requirements and their role in TMDL implementation. Where appropriate/possible their suggested changes have been incorporated in the document. In particular, conversations with Ecology's permit managers/writers were critical to developing the WLAs and associated requirements.

External

Ecology has several procedures and general practices built into the Washington state TMDL process that ensures outreach to external parties. These parties may include:

- Local government, federal government, and sister state agencies
    - E.g., tribal governments counties, cities, local health districts, EPA, NRCS (USDA), WSDA, DOH, Conservation Commission
- Permittees
- Local, stream-side landowners
- Watershed citizens
- Non-profit groups

Outreach to private landowners and/or citizens, school groups and non-profit groups will be accomplished primarily through active education efforts described under the Education heading below. However, all TMDLs are required to pass through a formal public comment process which is typically the means by which the general public may engage in the TMDL development process. Outreach to other agencies and permittees is typically achieved through the establishment of formal review panels and workgroups, or through direct contact.

These groups are sometimes open to the public and may provide an additional formal citizen engagement opportunity. The following describes the groups/panels employed in this TMDL to reach out directly to external stakeholders:

- TMDL Advisory Group
    - These are typically large meetings, usually at a local venue (City of Enumclaw) to communicate TMDL developments to a wide range of interested parts, local governments, sister agencies and permittees.
    - Since development of the current TMDL model, WLAs and LAs, and implementation plan, several Advisory Group meetings have been called.
    - Invitees include all relevant local governments, sister state agencies, and permittees. Meetings have typically not featured a large public audience.
    - TMDL development staff have attempted to answer questions and incorporated comments and suggested edits into the finished TMDL product as far as practicable.
- TMDL Workgroup
    - This TMDL has been developed by means of a Workgroup composed of representatives of Ecology, the EPA and MIT.
    - The Workgroup was formed as a means to ensure collaborative decision-making and transparent TMDL development amongst these key partners.
    - A Memorandum of Understanding (MOU) between these parties formalizes this relationship, wherein, amongst other things, the parties affirm their interest in addressing the pH problem and their commitment to joint development of the TMDL.
    - The TMDL Workgroup has met roughly monthly throughout TMDL development, with brief pauses to accommodate schedule conflicts.
    - Ecology has been the chief author of the TMDL with EPA and MIT serving in an advisory/review capacity. However, the EPA and MIT authored small sections of the TMDL where their respective expertise warranted it.
- TMDL Public Comment
    - A formal public comment period is a required part of all Washington State TMDLs
    - Public comment usually begins after a 'final' TMDL draft is completed and the TMDL has been processed though Ecology's internal review steps
    - Public comment is typically a 30-day period following public announcements, but may be extended if the need demands
    - Ecology will respond formally to all comments and make edits to the TMDL as necessary
    - This correspondence is then appended to the final TMDL packet submitted to EPA for review

As described previously, there can be lag times in response to BMP implementation due to ongoing inputs from legacy phosphorus sinks. Stakeholders already skeptical of the need for or efficacy of BMPs may be further dissuaded if phosphorus loading is slow to respond. It's important that these realities are clearly communicated to stakeholders early so as to manage expectations and not see diminishing support for TMDL implementation.

Collaborative relationships

Relationship building is a key component of TMDL outreach and overall TMDL implementation success. Ecology has already begun to develop collaborative relationships with key stakeholders and hopes to build on and leverage these as TMDL implementation intensifies. Here are some examples of these relationships:

- KCD, KC, Public Health, Enumclaw,
    - Several years ago, Ecology launched a focused effort in priority watersheds in SWRO, geared at active implementation of some completed TMDLs. One of the areas selected was the Enumclaw plateau, specifically the Boise, Pussyfoot and Second Creek drainages.
    - This focused attention means that more nonpoint and TMDL staff time are dedicated to this area, more funding is made available for support efforts like effectiveness monitoring, and projects in this area are a SWRO priority for grant funding.
    - Ecology has spent several years forging close relationships with key partners (KC, KCD, MIT, Public Health, City of Enumclaw) as part of these implementation efforts. Ecology has already collaborated with KC and KCD staff on early education efforts to property owner's adjacent surface water.
    - Ecology staff also regularly partner with KC staff in attending the annual KC fair at Enumclaw – to educate the public about water quality problems in the area and Ecology's work.
    - Ecology meets regularly with these partners to identify potentially polluting properties and to collaborate on necessary solutions and follow-up with landowners. Many of these solutions are identical or similar to the BMP action prescribed in this TMDL.
    - Seattle –King County Public Health, at the time of writing, expressed interest in applying for Ecology 319/Centennial monies to develop a pollution identification and control (PIC) program for the Boise, Pussyfoot and Second Creek watersheds.
    - Ecology hopes to leverage and foster these existing relationships and efforts in implementation of this TMDL. Ecology hopes to expand upon ongoing implementation efforts.

- WWTPs
    - Ecology has met several times with staff from the City of Enumclaw and Buckley to discuss WWTP operation and various WLA and associated permit limit proposals.
    - During this time, the cities communicated their concerns regarding restrictive limits in the context of their small ratepayer base and limited economic resources for plant upgrades, amongst other issues.
    - The cities also provided useful technical information regarding plant operation and associated cost estimates that proved very useful for development of the final WLAs.
    - Ecology in turn communicated the needs of the TMDL, modelling efforts and various WLA proposals and likely associated permit requirements to the cities. The WLAs and associated narrative reflect the mutually acceptable loads.
    - While Ecology's relationship with the cities is formally one of regulator – permittee, Ecology hopes that the cordial and constructive relationship fostered thus far continues as we work together to implement the new TMDL permit requirements.
- MIT
    - In addition to the TMDL Workgroup (above) outreach described above, Ecology has also worked directly with MITFD staff on occasion via phone/e-mail. Both these communication avenues were used to develop a reserve allocation for MIT growth based on similar point sources of adjacent cities and for fish hatchery production needs.
    - MIT produced a report describing future fish production scenarios to replace lost natural productions and to provide sustainable harvestable levels of fish. These data were instrumental in developing WLAs for the expansion of White River Hatchery facilities.
    - As with the cities above, Ecology hopes to maintain its existing cordial relationship with the MIT, particularly in regard to future collaboration on nonpoint implementation and effectiveness monitoring efforts.
- EPA
    - Like MIT above, Ecology has engaged directly with EPA, Region 10 staff on numerous occasions (outside the TMDL Workgroup forum) to brainstorm solutions to TMDL development problems and to ensure that EPA's TMDL requirements are met.
    - EPA staff have provided valuable TMDL modelling and policy feedback at times, which has proved invaluable in developing the TMDL.
    - Ecology expects to continue collaborative work with EPA implementing this TMDL, in particular ensuring that TMDL WLAs and the reserve allocations assigned to MIT facilities are included in future EPA administered NPDES permits.

- WSDA, NRCS and Conservation Commission

- Ecology staff have not yet engaged directly with these agencies concerning development of this TMDL specifically.
- However, TMDL and nonpoint staff have reached out to WSDA dairy inspectors on several occasions to coordinate on general dairy management issues.
- Similarly, TMDL staff have reached to local NRCS field office staff to get valuable expertise and feedback on TMDL implementation proposals (e.g., Soil Amendment).
- Ecology has not engaged directly with Conservation Commission staff regarding this TMDL. However, Ecology staff have reached out to King Conservation District staff on numerous occasions to attempt to seek input on effectiveness monitoring proposals and to identify problem sites and establish collaborative nonpoint correction protocol.
- Ecology expects to leverage these relationships as it continues to implement the TMDL.

Education

While the outreach to governments and agencies described above is a useful and necessary component of TMDL implementation, outreach to private landowner and the general public is perhaps even more critical to TMDL success. In lieu of a permit system to regulate nonpoint pollution sources, many of the actions described in this TMDL rely on the voluntary participation of private citizens. This TMDL recommends the following as a general outreach approach to landowners:

- Ecology staff should coordinate with key stakeholders on developing collaborative, detailed education/outreach strategy
    - Key stakeholders include KCD, KC, MITFD, Enumclaw and Public Health
    - Be sure to include staff with communication/outreach training/expertise
- Identify target audience
    - Landowners with property adjacent surface water, especially those with septic systems
- Identify geographic areas to focus outreach efforts
    - Focus on implementation priorities, working through ranked reach priorities sequentially
- Anticipate problems and develop solutions
    - Identify barriers to implementation
    - Brainstorm potential solutions to overcome barriers and facilitate behavior change
- Develop messaging
    - Concentrate on the 5 TMDL minimum compliance BMPs
    - Emphasize funding assistance opportunities
    - Incorporate solutions to barriers (above)
- Ensure messaging consistency
    - To the extent possible make sure messaging is consistent amongst partners/stakeholders and across various media and events

- Produce educations materials to support messaging
  - E.g., flyers, brochures, pamphlets, post cards, door hangers
  - Restoration project and creek signage (especially in Pussyfoot and Second Creeks where it appears residents are least familiar with water quality issues)
- Use social media/mass media
  - E.g., Facebook, Twitter, Instagram, Nextdoor
  - Messages should be short, targeted to audience
  - This is a good way to spread the word about local programs and advertising upcoming workshops or other education events (below)
  - Make use of local TV and newspapers to spread messaging. May necessitate creation of short video or written articles.
- Use education events and tools
  - Develop new public events or make use of existing education events to present messaging and answer questions
  - E.g., King County Fair (annually in Enumclaw), King CD's 'mud and manure' workshops
  - Use Ecology's 'Enviroscape'[19] model to teach basic riparian ecology and BMP function
  - Promote King County's 'Stream Team' citizen science monitoring efforts and incorporate messaging (above) into training as far as possible
  - Consider partnering with local schools to further spread messaging

[19] https://www.enviroscapes.com/

Appendix J: Effectiveness monitoring

Ecology's TMDLs have traditionally called for one year of EM study roughly 20 years post TMDL completion/adoption. While this provides a useful means of assessing long-term project success, these authors believe that more can be accomplished with a more rigorous and robust EM strategy and by better integrating EM into other facets of TMDL implementation. Therefore, this TMDL proposes supplementing the traditional post project EM. This TMDL has attempted to establish an EM program that not only assesses long-term trends, but also provides a 'real-time' feedback mechanism to measure progress via interim milestones and to inform adaptive management during implementation (see Adaptive Management section below).

Implementation monitoring

Monitoring locations are shown in Figures J1, J2 and J3 respectively.

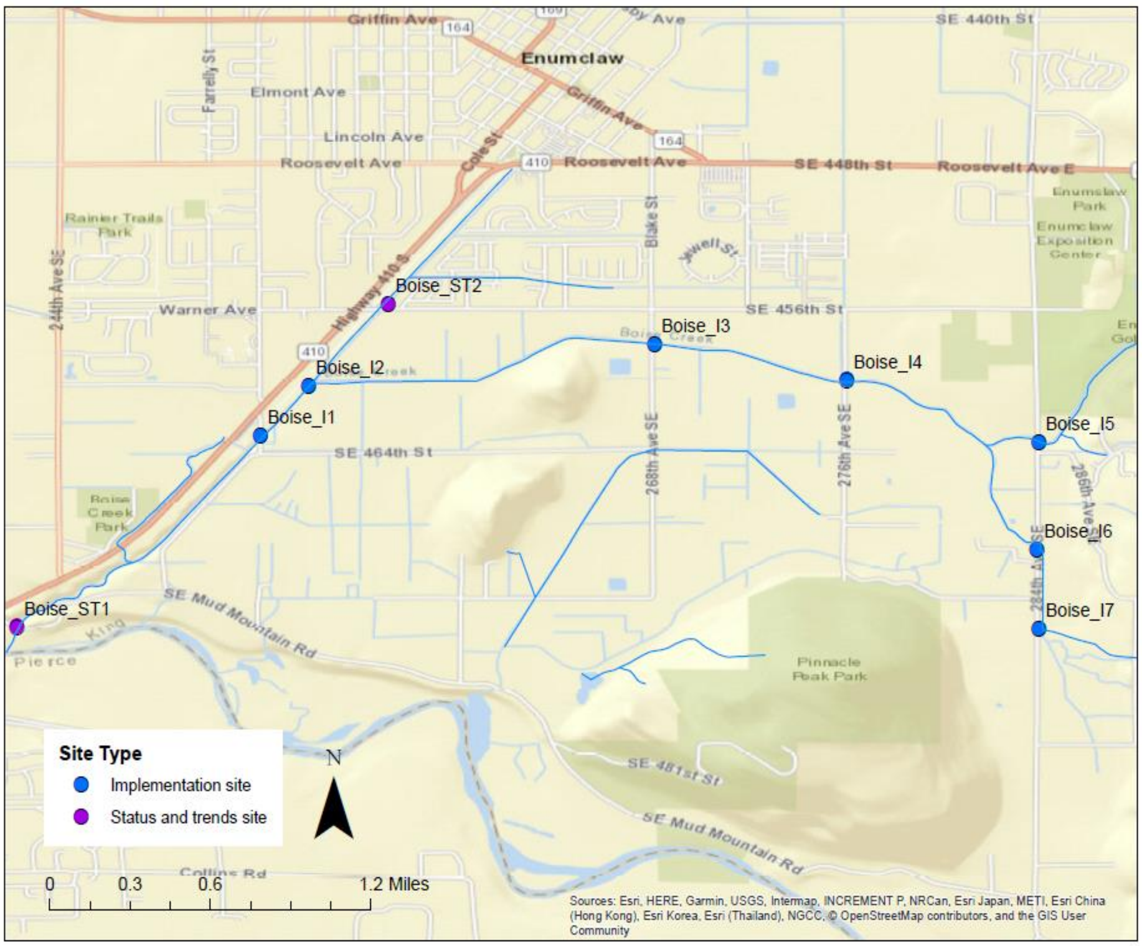

Figure J-1. Effectiveness monitoring sampling locations in Boise Creek

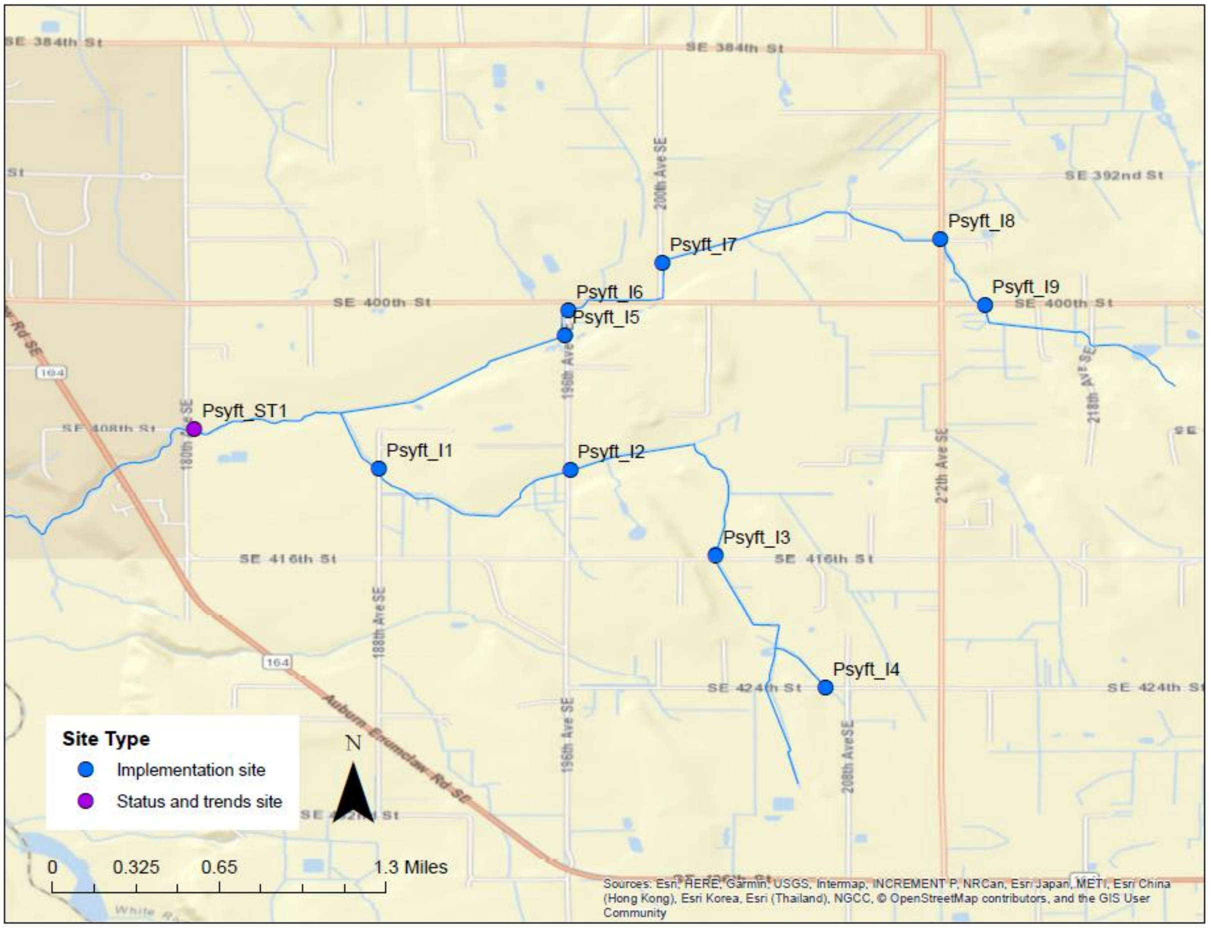

Figure J-2. Effectiveness monitoring sampling locations in Pussyfoot Creek

Figure J-3. Effectiveness monitoring sampling locations in Second Creek

EM program goals will be met by achieving the following project objectives:

Objective 1: Status and trends

The status and trends portion of this project will monitor the lower most accessible location in each waterbody monthly for 10 years. An additional upstream site on Boise Creek was added to this category as previous monitoring at the City of Enumclaw's municipal stormwater system in this area had shown high fecal coliform exceedances. These sites will be sampled to track general water quality trends in each of the tributaries by monitoring a larger suite of parameters. The lab analytes will be bacteria (fecal coliform, E.coli) and nutrients (total phosphorus, ortho-phosphorus, total persulfate nitrogen, nitrate, nitrite, ammonia). These parameters will be analyzed by Ecology's Manchester Lab in Port Orchard. Field parameters collected using a calibrated YSI Pro DSS (multi-parameter digital sampling system) will include temperature, conductivity, dissolved oxygen, turbidity, and pH.

Objective 2: Implementation and adaptive management

The implementation and adaptive management objective will be met by sampling all sites twice per month during years 1, 5, and 10. During these focused years, there is overlap with the monthly sampling at the status and trend's locations. The sites that are not included with the status trends objective will not be visited during the intervening years. All sites are spread more-or-less evenly throughout the watershed and are restricted by public access (e.g., private roads) and safety concerns. The results from this objective will provide information needed for adaptive management purposes. Lab parameters sampled will be limited to bacteria (fecal coliform, E. coli). If ample water is available, field parameters including temperature, conductivity, dissolved oxygen, turbidity, and pH will be collected using a calibrated YSI Pro DSS. Although site visits will be conducted all months of the year, Pussyfoot and Second Creeks are expected to be dry between the months of August through October, due to the seasonal nature of the streams. For this reason, the sample plan and budget include only 9 months of sampling at these two watersheds.

Objective 3: Source tracing

Ten percent of the monitoring budget has been set aside for uncertain sampling needs. Monitoring for this objective will trace sources of bacteria pollution and identify likely causes as they arise. The sites are currently unplanned locations and will be necessary to further narrow and/or trace suspected pollution sources on an as needed basis. Site locations will be identified through results from routine sampling locations and nonpoint field assessments. These could also be incidental locations (such as ditches and drains) that typically do not carry water but are discharging into the waterbody due to increased rain or other discharges. Bacteria samples and field parameters will be collected at these locations.

While the focus of implementation monitoring is to track progress in the Enumclaw Plateau specifically, there is still an ongoing need to characterize broader nutrient and pH changes. For this reason, this TMDL also recommends additional 'opportunistic' data collection, staff, budget, and time allowing:

- Conducted jointly by Ecology EAP and/or SWRO monitoring staff, consistent with the staff assignments for implementation monitoring.
- Before scheduled field run staff should check flow in the White River to see if the rivers in a medium or low flow tier and check the USGS gage to see if pH is greater than 8.2.
- If yes, and there is enough available time and sample budget, collect
    - up to 2-3 additional nutrient samples (headwaters and RM 4.4, and maybe RM 20.4 downstream of known major sources).
    - discrete afternoon pH measurements at RM 7.6 (USGS gage) and RM 4.4 (and preferably RM 6.2 if time). This would both corroborate the high pH readings from USGS gages and assess how much higher the pH was downstream.

Continuous pH monitoring

The continuous pH monitoring must be conducted under an approved Quality Assurance Project Plan (QAPP) or equivalent document. This work may also be conducted under Ecology's programmatic water quality impairment QAPP provided an approved project workplan memo is completed.

Critical periods are defined as periods between May 1 and October 31 when flow levels have been in Tier 3 for three or more days, when flows are expected to continue in Tier 3 for several additional days, and when river turbidity levels are less than 50 FNU. No more than one continuous monitoring period will occur in each calendar year.

Continuous pH data will be collected during the critical periods at the following four locations: RM 25.2, RM 20.4, RM 7.5, and RM 4.4. Data will be collected at RM 25.2 and RM 7.5 only if the current ongoing monitoring programs at these locations is discontinued.

Post implementation monitoring

This TMDL recommends continuous sampling for one to two weeks duration in the mainstem under tier 2 and 3 flow conditions. As part of EAP's regular post TMDL implementation effectiveness monitoring effort - conduct a minimum of two synoptic surveys, one each during low and medium flow conditions which shall include continuous pH monitoring and nutrient sampling throughout the TMDL area.

Includes the following important elements:

1) To be conducted by Ecology Environmental Assessment Program (EAP) effectiveness monitoring unit.
2) 1–2-week sonde deployments to measure continuous pH.
3) Nutrient sampling for total phosphorus, soluble reactive phosphorus, total nitrogen, ammonia, and nitrate-nitrite.
4) Flow measurements at ungauged tributaries and point sources.
5) Table 15 contains locations and parameter recommendations.
6) Depending on project planning and implementation progress may occur 10-12 years after approval.

Special emphasis should be placed on establishing monitoring locations to be able to differentiate between the impacts from the point and nonpoint source discharges to the extent practicable. Timing of monitoring in relation to permit compliance is key, and monitoring staff are directed to reach out to permit managers and/or the TMDL lead to confirm permit status. Proposed synoptic monitoring locations are shown in Table T1.

Table J-1. Proposed Synoptic Survey Locations and Monitoring Parameters

C = conditional, R = required

Study ID	Location Description	Latitude	Longitude	Nutrients	Sonde Deployment	Flow
Mainstem	**Mainstem**	**Mainstem**	**Mainstem**	**Mainstem**	**Mainstem**	**Mainstem**
W28	White River below Mud Mtn Dam	47.15486	-121.95206	C	C	
W25.2	White River at Rainier School	47.167059	-121.993199	R		
	White River Upstream of Diversion Dam				USGS	USGS
W20.4	White River below Buckley	47.186853	-122.065091	R	R	
W7.5	White River at R St SE	47.27482	-122.20858	R	USGS	USGS
W6.3	White River above A Street	47.266334	-122.228909	C	C	
W5	White River at 8th St	47.24987	-122.24383	C	C	
W4	White River downstream of 16th St E	47.24137	-122.23445	R	R	R*
Point Sources	**Point Sources**	**Point Sources**	**Point Sources**	**Point Sources**	**Point Sources**	**Point Sources**
MFH	White River Hatchery	47.16986	-122.00362	R		R
EC	Enumclaw WWTP	47.18811	-122.00521	R		DMR
BK	Buckley WWTP	47.16807	-122.03517	R		DMR
SW6.2	Stormwater outfall at ~RM 6.2	47.26678	-122.22877	R		R
MNL	Manke Lumber outfall			R		R
Tributaries	**Tributaries**	**Tributaries**	**Tributaries**	**Tributaries**	**Tributaries**	**Tributaries**
TR27.6	Red Creek near mouth	47.15689	-121.95459	R		R
BOI	Boise Creek near mouth	47.17605	-122.0186	R	C	USGS
TR15.7	Second Creek downstream of SR164	47.22385	-122.10468	R		R
TR15.6	Pussyfoot Creek at SR164	47.23345	-122.10554	R		R
TR8	Bowman Creek at mouth	47.274553	-122.210295	R		R
TR5.3	Government Canal at Butte Ave	47.2585	-122.24506	R		R

* ADCP necessary during higher flow or Bridge Flow at RM3.3 (subtract USGS tailrace flow to estimate RM4).

Soil/sediment sampling

In addition, monitoring staff should be open to sediment/soil phosphorus sampling in future. If BMPs have been successfully installed and most/all phosphorus sources controlled as directed in this TMDL but phosphorus loading to surface water remains high or unchanged, it may suggest continued inputs from legacy phosphorus sinks (see Adaptive Management section). This is perhaps beyond the scope of traditional post project EM, but soil/sediment sampling would be invaluable in identifying phosphorus hotspots for future adaptive management control purposes and is thus highly recommended. Areas where phosphorus is likely to accumulate should be a high priority for sampling. These locations may include riparian buffers, vegetated strips, and instream benthic sediments, particularly areas of slower flow and higher retention times like pools, eddies, dead zones, and channel margins (Sharpley et al., 2013). To reduce costs and staff time, this TMDL recommends that soil/sediment sampling be restricted to the three watersheds in the Enumclaw Plateau of primary interest in this implementation strategy (Pussyfoot, Second and Boise Creeks).

Lag time in water quality response and monitoring

Lag time represents the amount of time elapsed between installation or adoption of nonpoint management measures and measurable improvement in water quality. Sometimes lag time can be substantial to the point where even 'long-term' monitoring efforts may fail to show definitive results (Meals et al., 2010). Decadal lag times in receiving waters are not uncommon (Sharpley et al. 2013) and should be taken into account when developing monitoring programs. The elements of and reasons for lag time are discussed in more detail in the Adaptive Management section, but there are few points of particular concern to EM and are discussed further here. Meals et al (2010) give several monitoring program design recommendations to address lag time concerns. This TMDL has attempted to address recommendations in effectiveness monitoring project design. The recommendations and design response are as follows:

- Monitor small watersheds close to sources
    - Recommendation (Rec) - Lag times associated with transport phenomena will likely be shorter in smaller watersheds.
    - Response (Rsp) real-time 'implementation' monitoring is concentrated in the Enumclaw Plateau sub-watershed, rather than on the entire Lower White River.
- Monitor indicators at all points along transport pathways
    - Rec - Periodic synoptic surveys over the course of a project will identify changes as they occur and document progress.
    - Rsp – Implementation monitoring of the Enumclaw sub-watershed was designed to be geographically wide in scope and to capture known potential transport pathways such as City of Enumclaw stormwater discharges. The implementation monitoring project was deliberately budgeted so as to accommodate developing source tracing needs as field staff found new potential sources.

      In addition, interim and post project synoptic surveys are recommended as described previously.

- Supplement stream monitoring with special studies
    - Rec - This may help project managers understand watershed processes and help explain lag time delays.
    - Rsp – As previously described interim and post project synoptic surveys are proposed (contingent on resource availability). In addition, soil/sediment sampling is recommended as described above.
- Select indicators carefully
    - Rec - Some water quality variables can be expected to change more quickly than others.
    - Rsp – The effectiveness monitoring strategy described above includes a wide suite of parameters, ranging from those expected to respond fairly quickly to BMP application (e.g., E. coli and Fecal Coliform) to nutrient and pH sampling that may take longer to respond.
- Incorporate lag time into simulation modeling
    - Rec - Models should represent actual landscape processes to provide more realistic predictions of water quality changes.
    - Rsp – Meals et al. (2010) state that most current models do not address lag time well. While Ecology believes the QUAL2Kw model used in this TMDL study represents the best available 'industry standard' at the time of production, admittedly it may not handle lag time effectively.
- Design monitoring to detect change effectively
    - Rec - Target monitoring to the effects expected from BMPs implemented, in the sequence that those effects are anticipated.
    - Rsp – As already described above, this TMDL's effectiveness monitoring strategy is designed to detect changes across the Enumclaw Plateau implementation focus area. It includes a wide suite of parameters, those that directly measure compliance measures, and those that are anticipated to respond sooner to land use changes.

Despite attempts to accurately assess and track water quality response through the robust EM strategy described above, lag time will likely hamper this effort to some degree. For example, Sharpley et al. (2013) found that many monitoring programs they surveyed lasted for periods of <5-10 years, but these timeframes were often insufficient to properly assess success. Implementers are advised to give this careful consideration when choosing how to respond to monitoring results (see Adaptive Management section below). While this TMDL contends that compliance is achievable in 10 years, allowances must be made for possible longer implementation periods. It may be necessary to extend or adjust implementation efforts after the first 10 years of implementation (see Adaptive Management below). If so, it's likely that effectiveness monitoring efforts will also need to be extended or adjusted.

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Appendix K: Adaptive management

Process steps

Step 1.

The activities/BMPs in this TMDL are implemented/installed, following the priorities and implementation schedule described in this TMDL previously:

- Implementers should install all necessary minimum TMDL compliance BMPs and optional BMPs as appropriate, described previously. Installation should proceed according to the implementation schedule given previously.

Step 2.

Progress is assessed by comparing best management practices (BMPs) installation and other actions with those prescribed in the TMDL:

- An annual assessment (in collaboration with stakeholders) of progress is made, considering successes and failures.
- Data collected during effectiveness monitoring may be used to identify and/or trace additional pollutions sources.

Step 3.

Changes (if necessary) and/or additions will be made to the implementation activities prescribed for the following year:

- Barriers to BMP installation should be identified and solutions found, these then being incorporated in the list of prescriptions for the following year.
- New source identified/traced via monitoring will be incorporated in the existing list of action items and associated schedule (see Step 2, second bullet).

Step 4.

Additional actions prescribed for the following year are implemented, incorporating actions that were not previously completed and lessons learned from analyzing implementation barriers:

- The process described above begins again
- This continues until Year 3 and Year 7 when progress towards meeting implementation milestones are assessed

Decision making considerations

Lag time in phosphorus response occurs largely because of legacy phosphorus sinks, particularly in agricultural areas (Sharpley et al., 2013). Legacy phosphorus accumulates in soils when phosphorus inputs (via fertilizer application or livestock manure for example) exceed declines through plant uptake. Jarvie et al. (2013) state that as much as 70-80% of applied phosphorus in agricultural areas ended up stored in sinks such as soils and river sediments. These sinks can serve as sources of phosphorus and continued elevated nutrient loading to surface waters long after the original sources of phosphorus have been eliminated or controlled.

There are several examples where phosphorus source control has not been sufficient to significantly reduce phosphorus loading in receiving rivers and bays (Sharpley et al., 2013). And several studies have found little decrease in lake productivity with reduced phosphorus inputs following implementation, this being attributed to increased bioavailability and internal recycling (Daniel et al., 1998 and Sharpley et al., 1993). In some cases, remediation measures can have unintended consequences and may actually exacerbate the legacy phosphorus problem. For example, conservation tillage practices (e.g., 'no till'), while an important BMP for reducing soil loss and particulate phosphorus delivery in agricultural areas, has been shown to increase dissolved phosphorus delivery to surface water in some cases (Kleinman et al., 2011 also see Appendix N, #8 Conservation Tillage). As another example, some studies have demonstrated vegetated strips and riparian buffers can act as phosphorus sinks and sources of legacy phosphorus (Sharpley et al. 2013). This is the primary reason why this TMDL recommends soil/sediment sampling as an adaptive management measure after TMDL implementation, should implementation measures fail to achieve expected reductions.

Lag time is an important consideration primarily for two reasons: firstly, gains made in BMP installation may be masked, making it difficult to determine whether conservation measures work (Jarvie et al., 2013), and secondly standard source control BMPs alone may not be sufficient to achieve nutrient reductions in the timeframes desired. Failure to see anticipated nutrient reductions may not necessarily mean that implementation actions aren't working or are incorrect, simply that more time is needed to see results.

Post implementation evaluation

At the end of the 10-year implementation period (i.e., 2032) if pH water quality standards are met, but SRP load reductions and BMP installation is incomplete, this TMDL will nonetheless be considered completed. If BMPs are all installed by 2032, but pH standards are still not met, this TMDL implementation plan should be revised, the same decision matrix provided in Table 29 should be used. If SRP reductions are achieved, it may be indicative of other factors in addition to phosphorus input causing pH impairment. As stated above, if bacteria exceedances are resolved but SRP loading remains high, it may be evidence of legacy phosphorus sinks. As described under Effectiveness Monitoring above, implementation/monitoring staff are highly encouraged to consider soil/sediment nutrient sampling to assess this. If nothing has changed in the 10 years, staff should determine whether BMPs were installed as prescribed in this TMDL. If not, the reasons should be investigated and addressed in future work, as much as possible. If the BMPs were installed, it's perhaps a sign that the wrong BMPs were selected, and staff should search for alternatives. However, consideration should be given to the possibility of legacy phosphorus sinks as discussed previously.

Depending on the reasons for the failure, changes may include:

1) Identifying new BMP actions and/or re-prioritizing reaches
   - For example, implementers could consider placing greater emphasis on the 5 'optional' BMPs, like soil amendment, and/or
   - Locating and addressing phosphorus sinks.
   - Focusing on reaches where new pollutions sources have been identified, or where new data suggest problems are worst.
2) Expanding implementation efforts to other Whiter River tributaries
   - For example, implementers could widen scope to include those with next highest SRP loading, like Red Creek, Government Canal and Bowman Creek.
   - Implementers should consult the loading table in the TMDL (Table 20) and assess neighboring land uses to select tributaries where implementation work is most likely to deliver load reductions.
3) Modifying BMP installation requirements
   - Making installation parameters more rigorous, for example increasing buffer widths, or emphasizing roofed manure storage structures.
4) Changing monitoring strategies
   - Location, frequency, parameter suite, methods,
   - Special studies to inform restoration priorities, e.g., sediments/soil nutrient sampling to identify phosphorus sinks, or focused source tracing.
5) Seeking new or more appropriate funding sources
   - Several private organizations provide funding assistance for environmental improvement and/or restoration work, e.g., Fish America Foundation, Home Depot - Building Health Community Grants, National Fish and Wildlife Foundation, National Forests Foundation, Pheasants Forever, Trout Unlimited - Embrace a Stream
6) Reassigning implementation responsibilities,
   - Assigning more nonpoint staff to the Enumclaw Plateau, or if implementing #2 above, to other tributaries included in the expanded scope of operations.
7) Increased, or improved training for implementers
   - Investigate the need and/or opportunities for incorporating TMDL source assessment and BMP recommendations into regular formal training for staff assigned to work in the Enumclaw Plateau.
8) Improved (more or targeted) outreach to landowners
   - Implementers could tailor message to focus on known problem sources or land use types
   - If data shows certain tributaries or reaches are particularly problematic, implementers could focus outreach to these areas.
9) Targeted use of enforcement
   - If BMP installation does not progress fast enough, use Ecology's enforcement authorities (RCW 90.48) more rigorously, and or more selectively in problem reaches.

Modifying the nonpoint implementation strategy is a relatively simple exercise. However, should changes to the point source WLAs be necessary, this would require a TMDL amendment, a repeat of the formal public comment and EPA review/approval processes, and possibly more modeling.

Consequently, TMDL amendment is often a lengthy, resource intensive exercise. While Ecology acknowledges this is the preferred adaptive management approach, it may not have the staff or financial resources to revisit the WLAs and modeling in addition to nonpoint strategy, especially in light of competing cleanup priorities. In the vent it become necessary, Ecology TMDL staff commit to seeking support and resources to re-do the TMDL but cannot provide guarantees at this time that this process will be timely or expeditious.

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Appendix L: Reasonable assurance

The QUAL2Kw model used for this TMDL's pollution loading analysis does not estimate nutrient losses or movement associated with runoff/erosion at a watershed scale. Due to resource and time constraints, it was not possible to develop a separate tool using other models (e.g., HSPF, WASP, SWAT) better suited to the task. Therefore, this TMDL utilized simpler, less rigorous approaches. EPA's STEPL model is one such potential tool. It's a spreadsheet-based application that relies on simple algorithms to calculate nutrient and sediment loads from various land uses and the load reductions associated with BMPs (USEPA, 2019). Unfortunately, STEPL provides estimates for **total** phosphorus reductions only. The ratio of dissolved phosphorus to particulate and total phosphorus in runoff varies from site to site depending on soil types, land cover, and land use (Daniel et al., 1998) and it's not advisable to assume or apply generalized conversion ratios for load reduction estimation purposes associated with runoff at the watershed scale. Therefore, STEPL was not deemed appropriate for estimating **dissolved** phosphorus reductions associated with runoff considered in this TMDL. Several authors have attempted to develop independent BMP dissolved phosphorus load reduction estimating tools (e.g., Rao et al., 2009 and Gitau et al., 2005) but a common limiting factor is the availability of input data (Sharpley et al., 2002 and Sharpley et al., 1993). Such was the case in this TMDL project area.

Simple method for estimating pollutant loads

Runoff

The biggest challenge in adapting the Simple Method for non-urban stormwater purposes is in deriving accurate runoff inputs. Where impervious surfaces dominate, it's plausible to rely on precipitation alone to accurately account for runoff. However, in rural areas with few impervious surfaces, this approach would be over simplistic as water absorption and transport over/through vegetated and bare soil is far more complex than runoff off concrete or asphalt surfaces. To address this, this TMDL used outputs from the Thornthwaite Water Balance Model (McCabe and Markstrom, 2007) rather than precipitation data alone to better account for runoff in the TMDL focus area. This water-balance model analyzes the allocation of water among various components of the hydrologic system, using a monthly accounting procedure. The Thornthwaite model is useful because, at a minimum, it only requires two input variables to determine runoff – monthly temperature and precipitation data, which are readily available. The USGS's Java based water balance user interface is available to download from USGS's website at: USGS Thornthwaite model.[20]The user interface provides scalers to change model variables, however as limited data were available, these were kept at their default settings, with the exception of latitude. Average monthly maximum temperature and precipitation data for the Enumclaw plateau (from 1913 to 2012) were obtained from the National Weather Service (NWS) Cooperative Observer Program (COOP) station at Buckley. Because of irrigation during the TMDL critical period, precipitation data alone likely underestimates overland flow.

[20] https://wwwbrr.cr.usgs.gov/projects/SW_MoWS/Thornthwaite.html

So, precipitation data were supplemented with NRCS pasture/turf irrigation recommendations for the Buckley area (USDA, 1997). These data and the Thornthwaite Model runoff outputs (from combined precipitation and irrigation inputs) are shown in Table L1. Table L1. Average Maximum Monthly Temperature, Precipitation, Irrigation and Thornthwaite Model Runoff Data for the Enumclaw Plateau During the TMDL Critical Period

Flow Tier	Medium Flow	Medium Flow	Medium Flow	Low Flow	Low Flow	Low Flow
Month	May	Jun	Jul	Aug	Sep	Oct
Temp (F)	65.1	70.1	76.3	76.3	70.3	60.1
Precip (in)	3.26	2.99	1.27	1.52	2.59	4.47
CIR* (in)	1.64	2.32	4.61	3.15	1.50	0.00
Runoff (in)**	1.61	0.95	0.64	0.41	0.29	1.11

7) *CIR = Pasture/Turf Crop Irrigation Requirement
**Runoff derived from Thornthwaite Model Output

May through July generally sees more stream flow than August through October, especially in the seasonal Pussyfoot and Second Creeks. For the purposes of consistency with the flow-tier approach adopted in this TMDL's loading analysis, the months May-July represent 'medium flow' conditions and August-October represent 'low flow' conditions.

Concentration

Several studies have attempted to quantify dissolved phosphorus concentrations in runoff from livestock manure (e.g., Vadas et al., 2004; Vadas et al., 2005; Vadas et al., 2008; and Sharpley and Moyer, 2000), but because leachate is highly concentrated it was not thought to be representative of typical runoff concentrations for a watershed with varied and diffuse land uses. Instead, research was sought out that looked at runoff from a mixed used agricultural landscape. Kronvang et al. (2003) found a median dissolved phosphorus concentration in surface runoff of 0.18 mg/L adjacent streams in a mixed crop agricultural setting. King et al. (2015) found dissolved phosphorus concentrations in runoff ranged from 0.08 to 0.16 mg/L (mean, 0.13 mg/L) in a diverse agricultural landscape. And Kozlowski et al. (2016) found a range of 0 to 1.6 mg/L, with an average of 0.13 mg/L in runoff from Nevada rangeland. A value of 0.18 mg/L was used in the load reduction calculations as it was deemed a closer fit with conditions in the Enumclaw plateau given the abundance of concentrated livestock agriculture and active fertilizer application.

For the forested parts of upper Boise Creek, a value of 0.13mg/L was used as the absence of livestock agriculture and fertilizer usage likely means reduced dissolved phosphorus concentrations.

Area

Area was calculated using GIS analysis, based on a 50ft exclusion zone equivalent to minimum 50ft riparian buffer width given previously. This approach assumes that if the TMDL compliance minimum BMPs are applied successfully as a holistic suite at all sites within a 50ft distance of surface water, then all phosphorus contributions will be eliminated within this exclusion zone. To clarify, this does not imply that the 50ft riparian buffer BMPs alone will be sufficient to completely eliminate/treat dissolved P, rather that P will be sufficiently addressed if all sources/transport pathways within this distance from surface water are eliminated. Total exclusion zone acreage for Boise (not including the golf course and upper forested watershed upstream of the golf course), Pussyfoot, and Second Creek was calculated as 56 ac, 73 ac, and 20 ac respectively. MIT property was intentionally excluded from this analysis as Ecology has no jurisdiction over activities on Tribal property. Ecology nonpoint inspectors traditionally focus their technical assistance on the highest priority (i.e., most egregious problem) sites. It's unlikely they will be able to correct all sources everywhere. Thus, as an additional conservative measure, the total acreage numbers above were reduced by two thirds for use in loading estimate calculations. This assumes that if low, medium, and high priories are represented more or less equally, high priority parcels represent approximately one third of the total acreage. Areas for the Enumclaw Golf Course and upper forested Boise Creek were calculated separately and were 27 ac and 415 ac respectively.

Load reduction estimates suggest that the implementation actions prescribed for agriculture can reduce nonpoint loads sufficiently to achieve the TMDL load allocations in Pussyfoot and Second Creeks, but not Boise Creek. In order to achieve the assigned load reductions here it will be necessary for implementers to address additional sources.

OSS

Load reductions associated with septic system repair cannot not be estimated using the above approach because delivery to surface water is not runoff dependent. Fortunately, EPA's STEPL model includes a tool for estimating load reductions from septic system repairs. As described above, the fact that STEPL estimates total phosphorus reductions is problematic for this TMDL which focuses on dissolved P. However, unlike the runoff estimates above, it's thought using dissolved to total P ratios is appropriate given nutrient inputs to septic systems and treatment efficacy likely remain relatively constant. Withers et al. (2011) found that SRP fractions were dominant in septic tank discharge, representing between 70% and 85% of the total P. The STEPL estimated load reductions associated with septic system repair were reduced to 70% (most conservative) to determine the dissolved P estimates. Dissolved P inputs from failing septic systems was assumed to be largely independent of rainfall/irrigation, thus the same load reduction estimates were applied to low and medium flow conditions. GIS analysis shows that Boise Creek has a total of 36 priority parcels with septic systems (i.e., parcels within 100ft of surface water). The load reduction estimate assumes one septic system per parcel. STEPL assumes 2.43 people served per septic tank and a failure rate of 2%.

Enumclaw golf course

Load reductions were estimated for the golf course using the same method as that used for agricultural areas in the three tributaries (i.e., the modified Simple Method, assuming all sources are eliminated within a 50ft buffer). Without an exhaustive literature review, the authors were unable to find concentration numbers for dissolved P in runoff from golf courses specifically. Therefore, the lowest end of the concentration range cited previously (i.e., 0.13 mg/L) was used to be conservative. Nonetheless, the load reductions estimated may be overestimates of what's achievable given Boise Creek bisects the Enumclaw Golf Course and the intensive management typically associated with golf courses. Furthermore, as described previous tile drains are often a significant phosphorus transport mechanism on golf courses, which may bypass other recommended BMPs (e.g., riparian buffers). In order to address these concerns and to be consistent with the calculations performed for agricultural properties, the acreage was also divided by three as an additional conservative measure. Regardless, there is a possibility for installing wider riparian buffers along some sections of the Enumclaw Golf Course and there may be opportunities to reduce nutrient runoff through enhanced nutrient management strategies, meaning some associated phosphorus load reductions are likely.

Forestry

Even with the addition of septic system reductions, Boise Creek medium flow load allocations are still not met. Given the predominance of forestry in the upper watershed it's likely that legacy impacts from forestry activities prior to the Forest Practices Rules are contributing some additional loading, and this loading will naturally attenuate over time as the landscape recovers. For the purpose of load reduction estimates the 50ft minimum buffer zones recommended for agricultural areas, are considered analogous to the 50ft no harvest core zones (Type F and S streams only) required under the current Forest Practices Rules. The load reduction associated with protection of this 50ft zone in forestry areas in Boise Creek is shown in the TMDL main body. This was calculated using the same modified Simple Method detailed above, using a lower dissolved P concentration as described above under the **Concentration** section above and excluding the additional irrigation runoff inputs. To be consistent with the agriculture and golf course calculations above, forestry acreage was divided by three. This should serve as an additional conservative measure and address the fact that the forest buffer requirements cited apply only to Type S and F streams.

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