Water Quality Monitoring

Reconnaissance Investigation of Emerging Contaminants in Effluent from Wastewater Treatment Plant and Stormwater Runoff in the Columbia River Basin

Jennifer Morace

Abstract

In order to efficiently reduce toxic loading to the Columbia River basin, sources and pathways need to be identified. Little is known about the toxic loadings entering the system from wastewater treatment facilities and stormwater runoff. This study provides preliminary data on these sources and pathways throughout the basin. Nine cities were chosen in Oregon and Washington to provide diversity in location, arid eastside and wet westside characteristics, and population densities. Samples were collected from a wastewater treatment facility in each of the cities and analyzed for wastewater-indicator compounds, pharmaceuticals, PCBs, PBDEs, organochlorine and legacy compounds, currently used pesticides, mercury, and estrogenicity. Currently, these treatment facilities are required to sample their effluent to meet their permit requirements, which are very limited. Little is known about the environmental implications of emerging contaminants in these effluents. Results indicate that a majority of these compounds are present in the effluent and some at environmentally relevant concentrations. Although the grab samples were not time-integrated and the effluent is expected to change in nature throughout time, the continuous input of this number of compounds and at these concentrations may have implications on the receiving waters, the foodweb reliant on these waters, and the ecosystem as a whole.

The second component of the sampling effort was directed at characterizing stormwater runoff for a slightly different set of emerging contaminants—PCBs, PBDEs, organochlorine compounds, PAHs, metals, currently used pesticides, and oil and grease. Studies have shown that stormwater, most often untreated before entering the receiving waters, can deliver significant loadings of these compounds. Unlike effluent from wastewater treatment plants, stormwater runoff is sporadic and unpredictable, and the sudden input of these contaminants has implications for the ecosystem. These two pathways are poorly understood in terms of their toxic contribution to the system, yet they act as integrators of human activities and offer an area where changes could be made to reduce harmful human effects on the environment.

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An Upside-Down River: Impoundments and Eutrophication Alter Downstream Predictions of Water Quality in the Klamath River

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Abstract

Large river impoundments are ubiquitous features in many parts of the world. The River Continuum Concept (RCC) and the Serial Discontinuity Concept (SDC) are two examples of widely acknowledged models of river ecosystems that suggest longitudinal shifts in parameters in response to perturbations such as impoundments. While these concepts may have broad utility, they inadequately address how nutrient enrichment (eutrophication) may alter predictions within regulated rivers. The objectives of our study were to investigate these predictions by determining longitudinal patterns of water quality parameters and organic matter composition within the Klamath River in Oregon and California. We collected monthly water samples for one year at nine sites over 130 miles on the Klamath River, beginning at the headwaters and sampling above and below six reservoirs. Samples were analyzed for dissolved oxygen, conductivity, pH, temperature, turbidity, suspended solids, nutrients (TN, TON, NH_4^+, NO_3^-, TP, TDP, SRP, DOC), and organic matter (OM) composition (chlorophyll a, UV-absorbance, fluorescence index, biological oxygen demand [BOD]). Our results indicate that the Klamath River functions as an "upside-down" river in terms of many of the predictions based on river ecosystem concepts such as the RCC and SDC. Conditions in the headwaters were the most degraded, but conditions generally improved below dams and with increasing distance downstream. The highest concentrations (TN= 3.249 mg/L, NH_4^+= 0.124 mg/L, TP= 0.223 mg/L, DOC= 9.67 mg/L), the most labile OM, and the highest BOD (20-day BOD = 42.7 mg/L) were observed in the headwaters during the summer months. SRP generally remained similar throughout the river or increased slightly in the downstream direction, likely as a result of lower nitrogen:phosphorous ratios and reduced SRP uptake. Using a general linear mixed model, we determined a significant effect of river mile, depending upon time of year and TN, TON, suspended solids, BOD, and OM composition. Overall, downstream improvement in water quality likely results from storage and processing of OM in reservoirs and dilution effects from groundwater and tributaries. Four out of six dams on the Klamath River are planned for removal in the next decade, and these results suggest that the removal of downstream reservoirs may affect the transport of nutrients and organic matter, potentially increasing downstream impairment in the summer months. Dam removal should therefore be considered in conjunction with the restoration of upstream conditions.

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Use of Early Agency Coordination to Efficiently Navigate the Permitting Process for Complex Stream- and River-Related Projects

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Abstract

Early coordination with regulatory agencies made it feasible to permit a major relocation of a catalogued salmon stream as part of the recently completed Ketchikan International Airport Runway Safety Area (RSA) project. The project was funded by both the Southeast Region of the Alaska Department of Transportation and Public Facilities and the Alaska Region of the Federal Aviation Administration (FAA) and undertaken to address a congressional mandate to update safety areas at airports nationwide. The project involved shifting the runway 750 feet to the southeast to provide full 1,000-foot-long safety areas off either end of the runway. At the time the project was awarded, it was the FAA Alaska Region's single largest construction project in history.

The project team convened an interdisciplinary team (IDT) that included the project owner, the project team's design and environmental specialists, and technical specialists from key regulatory agencies. The IDT evaluated multiple options for accommodating the RSA expansion by comparing costs, technical feasibility, and environmental effects of each option. The most feasible alternative for accommodating the runway shift involved a 1,300-foot-long relocation of Government Creek—a salmon stream located immediately adjacent to the south end of the runway. The stream relocation provided opportunities to significantly improve habitat compared to the existing stream conditions. The effects to existing stream and estuarine habitat were mitigated by the ecological improvements made to the newly constructed stream channel and estuary. Through early coordination, regulatory agency concerns were addressed in the initial stages of the design process. This collaboration continued through all phases of design, assuring that permits would be issued without delay for this unprecedented stream relocation project.

Risk and uncertainty associated with the stream relocation were managed effectively by implementing a well-developed adaptive management and monitoring plan. Two phases of stream construction allowed lessons learned on the first phase to immediately apply to and improve the second phase, and minor adjustments to the first phase were facilitated during the construction mobilization for the second phase. The adaptive management plan extended agency coordination through construction and into the post-construction phase, providing multiple opportunities for adjustments to the newly constructed stream to assure project success. The Alaska Department of Fish and Game–Division of Habitat[1] was so pleased with the results that they featured the project on their website in an article called "Mitigation Gone Right!" This collaborative approach with regulatory agencies is currently being successfully applied on complex stream and river relocation projects at the Nome and Cordova airports.

Keywords: early agency coordination, permitting, stream relocation, Ketchikan Airport, Government Creek, adaptive management

Introduction

The following sections provide brief discussions of the complexities, issues, and number of regulatory agencies that can be involved in larger river- and stream-related construction projects, especially when projects must

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[1]Formerly the Alaska Department of Natural Resources Office of Habitat Management and Permitting.

comply with the National Environmental Policy Act (NEPA). Federal and State regulations require mitigation for unavoidable effects to aquatic habitat on such complex projects.

The development process of an engineering project begins with a problem statement and culminates with construction and operation. Historically, project owners initiate coordination with regulatory agencies as necessary at different stages of the project, given the regulations that govern the project's environmental effects. However, integrating regulatory issues into the overall engineering constraints and opportunities analysis early on ensures that such issues do not derail the project schedule and budget when introduced later in the design process. As this paper illustrates, such early agency coordination (EAC) with all regulatory agencies involved in the project reduces schedule and cost risk, helps establish regulatory constraints and priorities, and leads to more timely and efficient project completion.

Regulatory agency personnel are experts in the regulatory processes they administer and often have primary training in engineering or science. The idea that agency personnel can be part of an expert team forms a key part of the philosophy behind early coordination. Making these regulatory experts part of the team early-on results in an alignment of project objectives and regulatory objectives, and establishes a collaborative approach while diminishing the chance of falling into an adversarial dialog. This collaborative relationship continues through the design and construction phases.

Early agency coordination follows the normal process of project development with a series of milestones for design and review. The key innovation of EAC, however, is inviting regulatory agency personnel to participate early in and throughout the entire design development process.

Example Project I - Ketchikan Runway Safety Area Expansion Project

The Ketchikan International Airport (KTN) Runway Safety Area (RSA) Expansion Project provides a good example of effectively using EAC to navigate the permitting process on a large and complex project. The project improved safety at the airport by bringing it into compliance with Federal Aviation Administration (FAA) safety standards. Project design efforts began in June 2004 and were completed in November 2006. Construction started in the spring of 2007 and was completed in the fall of 2009. At the time the project was awarded, it was the FAA Alaska Region's single largest construction project in history.

The RSA expansion project extended the runway embankment 1,500 feet, filling the lower 1,200 feet of Government Creek. A new stream channel and floodplain were constructed around the new RSA fill, and Government Creek flows were diverted into the new channel. The new channel ties into the alignment of a small adjacent stream (Boulder Creek) and enters Tongass Narrows within the Boulder Creek estuary. The relocation provided an opportunity to mitigate for lost habitat by improving ecological function of the stream and floodplain and increasing the amount of instream habitat available to adult and juvenile salmonids.

The KTN RSA Expansion project design, including the hydrologic and hydraulic analysis efforts for the Government Creek relocation, was led by USKH Inc. (USKH), under contract to the Southeast Region of the Alaska Department of Transportation and Public Facilities (DOT&PF). USKH was also the design lead for the new valley of the relocated Government Creek. The lead designer of the relocated stream channel was Shane Cherry. The lead designer of the new Government Creek estuary was Jon Houghton, Senior Marine/Fisheries Biologist with Pentec/Hart Crowser. The project was constructed by SECON.

An interagency scoping meeting was held onsite in September 2004. The intent of the meeting was to introduce agency representatives to the five RSA expansion alternatives that were under development, discuss why other alternatives had been eliminated, and provide a forum for agencies and other concerned parties to raise concerns and issues, or to propose other options.

Both ends of the original RSA were constrained by sensitive environmental resources, with the Airport Creek estuary to the northwest and Government Creek to the southeast.

During the September 2004 interagency scoping meeting, the relative merits, economic feasibility, and environmental effects of each alternative were discussed. Resource agency representatives noted that habitat in lower Airport Creek and its estuary were far superior to habitat in lower Government Creek and its estuary. The bed of Airport Creek was low gradient and dominated by gravel. Its estuary was a productive salt marsh with extensive eelgrass beds and healthy populations of clams, forage fish, flatfish, and crabs. Bird use of the estuary was extensive, and grass meadows along the estuary banks provided unique and important black bear habitat. In contrast, the lower channel of Government Creek was essentially a steep bedrock chute with little substrate, with an estuary that was only about one fifth the size of the Airport Creek estuary.

When it became clear that the relocation of Government Creek might be the most feasible alternative for RSA expansion, the DOT&PF Design Group Chief recommended that an interdisciplinary team (IDT) be established to monitor and participate in the stream design process and requested agency participation. The resulting team consisted of representatives from the Alaska Department of Fish and Game (ADF&G), the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, DOT&PF, and members of USKH's design and environmental documentation team, which included Shane Cherry for stream channel design and Jon Houghton for estuary design.

The first IDT meeting was held at KTN in December 2004. During the meeting, relocation objectives were developed with respect to (1) targeted salmon species and habitat types to be created in both the channel and estuary of the relocated Government Creek, and (2) the proper location and configuration of the new estuary. A reference reach including high-value habitat located upstream of the proposed relocation was selected to inform the design of the new channel, should the relocation option go forward. General support was expressed by the IDT for the Government Creek relocation alternative, and a number of required studies and analyses were outlined for presentation at a second IDT meeting to be held in February 2005.

At the February 2005 IDT meeting, the requested additional information was presented with the exception of geotechnical data, which had not yet been possible to acquire. By that time, the engineering and economic feasibility of the stream relocation alternative had also been established. Also, instream habitat and stream geomorphology had been characterized in both the existing channel and in the high-value upstream reach that was to be used as a design target. General relocation design issues were discussed, including whether or not the confluence of the main branch of Government Creek and its north tributary (informally referred to as the North Trib) should be designed to exclude certain species of salmon in order to protect resident trout species.

Two important topics discussed by the IDT in the February 2005 meeting were formalizing the goals of the relocation and developing metrics for measuring success. Goals of fish passage and habitat parity were agreed upon. However, because a relocation of this scale and type was unprecedented in Alaska, it was further agreed that the design target should be for higher-quality habitat than what currently exists. By setting the design target higher than the goal, the goal might still be achieved if the constructed channel failed to meet the design target. Further research efforts were requested, and the desire was expressed for the design to include access for modifications and corrections to the relocated stream channel and floodplain after initial construction.

After completion of the geotechnical and other additional studies, another IDT meeting was convened in April 2005 to discuss the results. The geotechnical data were inconclusive with regard to the geological characteristics of the proposed relocated channel. It was anticipated that the new channel would probably be constructed within both bedrock and glacial till. Different channel design characteristics would be required for the two material types, particularly with respect to the height and spacing of steps and riffles. After some discussion, there was agreement among IDT members that field design and engineering would be required during construction, and that the construction plans and bid documents would need to be developed accordingly. The timing of diversion of flow into the new channel was discussed and tentatively agreed upon by all represented agencies, and design objectives for protecting resident trout populations in tributaries were further clarified. Although there were still some lingering questions about existing conditions in the Government Creek estuary, it was agreed that enough information had been gathered and developed to move ahead with the environmental assessment (EA) for the project, with the alternative that included the relocation of Government Creek being put forth as the Proposed Action.

A draft EA was produced in the fall of 2005. The EA proposed a multiyear post-construction monitoring plan and commitments for adaptive management to make corrections and modifications to the relocated stream and estuary. The ADF&G expressed reservations about the Proposed Action, taking the position that Government Creek was more valuable as a fish stream to the ADF&G than Airport Creek, and formally recommended against the Proposed Action.

A meeting was held with IDT members in November 2005 to discuss the ADF&G's concerns and those of other IDT members and to further refine habitat goals for the relocated stream. The ADF&G reiterated their lack of support for the Proposed Action and voiced concerns that the new channel would be incised, have erosion concerns, and have lower habitat value than the existing channel.

Subsequently, the DOT&PF made firm commitments to develop specific field design measures during construction and to fund and implement a monitoring and adaptive management program to the extent allowed by FAA funding constraints. A "Finding of No Significant Impact" for the EA was signed by the FAA in January 2006.

Interdisciplinary team members were invited to participate in the development of the post-construction monitoring plan in December 2005. The intent of the monitoring plan was to outline evaluation criteria and methods to evaluate the success of the relocation efforts. Three meetings were proposed that would establish the estuary and stream habitat objectives and outline the field methods that would be used to measure success to meet the objectives.

A draft monitoring plan was developed by Pentec/Hart Crowser in March 2006 and modified and refined during the winter and spring of 2006 during a series of IDT meetings. Minor modifications to the monitoring plan occurred in the fall of 2006, with a final revised plan being accepted by IDT members in late September.

The final monitoring plan described the proposed action, its estimated effects, and the proposed mitigation measures. It then laid out the mitigation goals and objectives and the monitoring methods for the new estuary, the relocated main channel of Government Creek, and two affected tributaries.

In the summer of 2006, it became clear that the confluence of the relocated Government Creek channel with Boulder Creek would have a 20-foot elevation differential, which would form a significant fish passage barrier, effectively isolating the upper portion of the drainage from anadromous fish and resulting in a loss of available habitat for juvenile rearing. After consultation with the IDT, the project team decided to mitigate for the lost habitat by constructing side channels within the floodplain of the relocated channel of Government Creek. These channels would provide quiet water habitat for juvenile salmon, allowing them to avoid predators, rest, or wait out periods of high velocity flows. Having a pre-established rapport with the involved regulatory agencies allowed for a quick resolution to this problem.

The mitigation for the fish passage barrier and the inclusion of a heavy vehicle access road were addressed within a reevaluation of the EA that was approved in the fall of 2006. Final permits for the project were received in late 2006 without any significant complications, since regulatory agencies had been fully involved in the design process since the start of the project.

Construction began in the spring of 2007, and construction of the relocated channel of Government Creek was completed in August of that year. Construction of the lower portion of the North Trib was completed the following year.

Adaptive Management and Post-Construction Adjustments

Adaptive management provides a means of gathering additional information during and after construction and of adjusting the project as necessary to improve performance. Adaptive management can be used to manage risk and more efficiently achieve project performance goals. This approach requires clearly stated performance standards and contingency actions that can be deployed to achieve performance if needed. Adaptive management provides flexibility in managing risk.

The relocated portion of Government Creek was deliberately designed to be self-adjusting, consistent with natural channel and habitat formation processes. While the overall benefits of this approach are great, some channel adjustments can have short-term negative effects. Adaptive management was used to correct negative short-term effects of channel adjustment while allowing for the long-term ecological benefits of a naturally functioning dynamic stream and floodplain.

Since the completion of construction in August 2007, Government Creek has experienced a number of significant flows that have activated the floodplain and side channels. The flood-prone nature of the relocated channel is due in part to a combination of lower stream gradient and higher channel roughness resulting from a larger amount of large woody debris (LWD) in the relocated channel compared to the reference reach. The resulting floodplain activity is ecologically beneficial, leading to greater habitat complexity. Adaptive management activities included some minor repositioning of LWD pieces to help stabilize log jams and maintain sufficient water flow in the primary constructed channels.

The DOT&PF originally elected to rely primarily on gradual natural colonization of the floodplain by riparian vegetation, but after the first year of construction, this approach was modified as part of the adaptive management process. Seven vegetation islands were constructed in the floodplain during the summer of 2008 in areas that were thought to receive less frequent flooding. These vegetation islands consisted of large clumps of native vegetation and soil that were placed within protective barriers of logs and boulders.

One of the key performance requirements involved maintaining continuous fish passage through the new alignment. After the first winter season after construction, two bedrock steps had adjusted so that they impaired fish passage during low flows. Adaptive management included physically modifying those two locations to carve intermediate pools and steps into the bedrock to ensure fish passage.

Government Creek appears to be performing as intended several years after construction. All major segments of the project allow fish passage through their respective reaches and provide spawning habitat for substantial numbers of adult salmon. Additionally, all of the constructed reaches provide rearing habitat for both juvenile salmonids and resident fish species, and rearing has been amply demonstrated. Particularly high rearing use by juvenile coho was seen in the constructed middle and upper side channels. Adaptive management helped to ensure the ecological performance of the project and contributed to the ADF&G view that Government Creek represents "Mitigation Gone Right!" The ADF&G's positive appraisal of the constructed project was particularly important given their formal recommendation against the Proposed Action early in the early agency coordination process.

Example Project II - Nome Airport Runway Safety Area Improvements Project

The Nome Airport Runway Safety Area Improvements project is another example of how the EAC process can facilitate efficient resolution of complex issues in order to evaluate alternatives, determine a mutually acceptable path towards permitting a proposed action, and identifying construction sequencing schedules and project timing windows that benefit the resource as well as ensuring the success of the project. The feasibility of relocating the Snake River around future RSA expansions at the Nome Airport has major design and environmental constraints that make it a perfect candidate for the EAC process. Before formal agency scoping could commence and this project could be brought forward to the public, major environmental and design constraints needed to be determined.

The EAC process developed at Ketchikan has been working well for the Nome Airport project. The project leaders convened a series of meetings attended by key regulatory agencies, and design and environmental specialists. Major environmental and construction constraints and data gaps were quickly determined in the first interagency meeting and site visit. During subsequent meetings, the group worked together to identify possible effects on resources and resolve construction constraints in order to minimize those effects. Through that process, a discussion of mitigation of unavoidable effects has naturally evolved. The project is currently developing habitat features to incorporate into the design, effectively addressing concerns brought up in earlier meetings. Future meetings will focus on incorporating adaptive management and construction sequencing plans as the project moves forward into the permitting and NEPA documentation phase.

Example Project III - Cordova Airport Wildlife and Flood Hazard Mitigation Project

The Cordova Airport is situated on highly productive migratory bird habitat between two rivers. A large number of migratory waterfowl are attracted to the open water and edge habitat around the airport. The Cordova Airport Wildlife and Flood Hazard Mitigation Project was created with the EAC process in mind in order to determine a long-term solution to wildlife hazards and flooding safety issues at the airport. The team includes key agency stakeholders, wildlife hazard experts, local airport personnel, and design and environmental specialists to solve issues identified in the Cordova Airport Wildlife Hazard Management Plan.

The interagency team has met twice. The first meeting presented concept designs for reducing open water near the airport, relocating several streams away from runway surfaces, and raising the runway above the elevation of the 100-year flood. The second meeting focused on identifying a plan for developing NEPA documents and acquiring permits for the projects. A comprehensive mitigation plan will incorporate adaptive management and a phased path forward that is flexible enough to be completed over many construction seasons with different funding sources.

Summary

Major benefits of the early agency coordination approach include the ability to address agency and permitting concerns during preliminary design, and to incorporate minimization and mitigation measures into designs from the earliest stages. When mitigation is part of the design, and when regulatory agencies are involved from the beginning of the project, it is easier to determine a list of avoidance, minimization, and mitigation components even before the completion of the environmental document. Attaining agency buy-in early in the process facilitates timely NEPA document approval and moves permit applications quickly through the permitting process. Agreeing to adaptive management plans during the design process allows the project to stay on schedule and avoid project delays during permitting and construction by establishing contingency actions to address changes in conditions or performance. Perhaps the most valuable result of the EAC process is that it instills a sense of trust among the regulatory agencies and allows the design team to use their depth of knowledge to protect the affected resources. This sense of trust fosters collaboration and allows agencies and design teams to work together to meet the Federal mandates and successfully address the purpose and need of the project. Early Agency Coordination integrates environmental success into project success. This alignment builds a stronger team and benefits both the project and the environment.

Acknowledgments

The authors appreciate the reviews of Lance Mearig, P.E., F. Lawrence Bennett, P.E., and Russ Kraemer, P.E.