Water Markets for the Yakima Basin: Researching and Developing Strategies for Multi-Benefit Markets

DRAFT Technical Report

June 2022

Kittitas Reclamation District in partnership with Trout Unlimited

For:
US Bureau of Reclamation agreement number R17AP00311 and
WA Department of Ecology agreement number WRYBIP-2019-KittRD-00005

Introduction.

The Kittitas Reclamation District (KRD) and their cooperative partner, Trout Unlimited (TU), provide this DRAFT Technical Report as partial fulfillment of: (1) a U.S. Bureau of Reclamation WaterSMART Water Marketing grant—agreement number R17AP00311; and (2) a Washington Department of Ecology Water Resources Yakima Basin Integrated Planning Agreement—number WRYBIP-2019-KittRD-00005. KRD and TU have completed the steps necessary to initiate and complete technical analyses to develop a DRAFT Yakima Basin Water Smart Market Strategy.

This DRAFT Technical Report is organized into three sections. Section 1 describes and summarizes the Outreach. Section 2 describes and summarizes the various Planning and Scoping (Technical Analyses) activities. Section 3 is the draft water market strategy developed from these technical analyses.

Section 2 is a compilation of seven subsections: literature review, GIS database, instream flow and water rights, crop water needs and values, legal and policy review, water management and protection, and market activity and simulations. The authors of these sections are identified at the start of each section.

The sections of this document were developed by different technical experts and contractors. In some sections the formatting has been revised. The reformatting was done solely for readability and consistency for grant deliverables.

A table of contents is provided on the next page and identifies the start of each section and subsection. To keep the table of contents useful and simple, it does not provide page numbers for the separate analytical documents.

Please note, we did not consider and specifically excluded from the market strategy analysis water rights (both district and non-district) on the Yakama Nation reservation. The Yakama Nation reservation water rights are the subject of complicated treaty, congressional and Yakama Nation water code laws, rules and regulations. As a result, Yakama Reservation water rights are not subject to being transferred and traded in a market-based setting such as the smart market.

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Section 1: Outreach

Outreach and Partnership Building. This section provides a description and overall summary of planning and outreach activities conducted from March 2019 through June 2022—the period of project activities. These activities, led by TU staff in close coordination with KRD staff and ERA Economics staff, were conducted to inform the market research and obtain feedback during technical analyses.

Much of this project was conducted during COVID-19 public health crisis. Health restrictions required a shift from in-person meetings to an online/virtual approach. Additionally, uncertainty about the scope and extent (e.g., public meetings limits, length of public health orders) of health restrictions created challenges to schedule outreach in 2020. Project staff shifted the approach and operated within the public health guidelines to successfully conduct project outreach.

Initial stakeholder outreach and partnership building began in late 2018/early 2019. Initial efforts focused on refinements to the outreach approach and formation of the Technical Work Group. The "TWG" was composed of:

- Arden Thomas, Kittitas County
- Kelsey Collins, WA Department of Ecology
- Cory Wright, Kittitas County
- Danielle Squeochs, Yakama Nation
- Trevor Hutton, WA Department of Ecology
- Jeff and Jackie Brunson, private water right owners
- Jeff Slothower, attorney (KRD)
- Justin Harter, Naches-Selah Irrigation District
- Kevin Haydon, WA Department of Ecology/USBR
- Lisa Pelly, Trout Unlimited
- Peter Dykstra, attorney
- Bob Barwin, (ret) former water resources professional
- Richael Young, ERA Consultants
- Scott Revell, Roza Irrigation District
- Tom Ring, (ret) former water resources professional
- Urban Eberhart, Kittitas Reclamation District

- Kat Satnik, Kittitas Reclamation District
- Nick Plath, private water right holder/user
- Michael Callahan, WA Department of Ecology

TWG meetings took place from 2019 – 2022 and typically focused on specific analytical approaches to different analytical needs. For example, a clear understanding and description of water right transfer rules was a need identified early in the project. The project team brought the need and approach to solve the issue to the TWG and expertise was offered to the project team on revisions to the approach. Moreover, members of the TWG provided reviews of the rules at different points of the process. This process was repeated to various extents for the different analyses for this project. From autumn 2021 – through spring 2022, the TWG provided feedback a review of different analyses completed. In spring 2022, TWG members provided valuable feedback on the draft market strategy.

The project team used a multi-pronged approach for outreach to non-TWG stakeholders. The first prong was public outreach through press releases, news articles, and a website. A press release was made public around March 2019. The press release helped create additional outreach through news articles in local newspapers. Additionally, in March 2019, the project team began development of a project website: https://yakimabasinwatermarketing.org/. This website allowed the project team to provide key details on the project. Initially, the website was intended to also provide a method for public meeting information; however, public health restrictions limited the websites' application in that regard.

The second prong was direct outreach to Yakima Basin staff from project funders, U.S. Bureau of Reclamation and Washington Department of Ecology. The project staff provided two substantial project briefings. In May 2021, the project team covered the progress to date (including challenges), facilitated a discussion about status of technical analyses and impact of COVID on work progress, and provided an updated on the planned next analytical steps. In May 2022, the project team again provided an update on project status and next steps, in addition to a robust discussion about the draft market strategy and the process to implement a pilot project based on the strategy.

Further outreach under the second prong was to the Yakima River Basin Water Enhancement Project Workgroup. The workgroup meetings were open to the public and provided an avenue for outreach to water resource professional affiliated with the workgroup and to public stakeholders. Workgroup presentations were made in 2019, 2021, and 2022. Additionally, project staff provided quarterly progress updates as part of the Yakima Basin Integrated Plan project updates. These updates are available to the public.

Another direct form of outreach was to a Washington State University complementary project entitled Technology for Trade[1]. Initial coordination efforts began in February 2019 and continued throughout the project. In December 2021, TU provided an update directly to the WSU project members to highlight progress and identify potential sources of beneficial research coordination. In June 2022, TU staff provided an update to the WSU project team to further explore interactive benefits between the two projects.

Additional public outreach was done to Washington's Joint Legislative Task Force on Water Resource Mitigation. Project staff provided a presentation in 2020 to the Task Force to help them understand one element of the Yakima Basin Integrated Plan's approach to address water resource issues in the Yakima Basin. The Task Force was responsible for a review of the treatment of surface and groundwater appropriations as they relate to instream flows and fish habitat, and to recommend a mitigation sequencing process and scoring system to address such appropriations.

Finally, TU staff provided a presentation to over 60 staff members of TU's Western Water & Habitat Program in January/February 2018. These staff members work on water resource (and fish restoration) projects throughout the western U.S. TU's Yakima Project staff provided the update (and ongoing written updates to senior staff) as an approach that may work in other western basins.

Internally, TU facilitated regular project check-ins with KRD, TU, and ERA Economics (formerly Mammoth Trading). These check-ins were the primary method of providing project updates to key project team members. This regularly resulted in discussions of next steps for planned outreach. Additionally, these check-ins facilitated feedback on some technical analysis steps.

[1] The Technology For Trade project is a multi-year multi-party collaboration funded by the USDA National Institute of Food and Agriculture. The project's simplified goal is to improve water management and flexibility, generally.

Section 2: Scoping and Planning

TU and KRD, along with technical experts and the TWG, completed scoping and planning ("technical analyses") activities to inform the strategy development. These activities cover analyses of market activity (past and simulated), literature review and comparison, legal and policy reviews, a look at water rights and streamflow needs, and a review of water management and protection limitations. A GIS database was developed for use during the different analyses. Finally, an analysis of crop water needs and crop water values was completed to provide data for the market simulation.

Much of the technical analyses were completed to provide basic information on water resources or market activity in the Yakima Basin. ERA Economics[2] used the various technical works to inform simulations (modeling) of water trading activity in the Yakima Basin.

[2] Mammoth Trading merged with ERA Economics in 2021. Project work at ERA Economics was completed by and under the supervision of Richael Young, who was part owner and principal at Mammoth Trading.

S2.1: Literature Review

The literature review consists of two documents. Both documents were completed by graduate students from the University of Washington's Evans School of Public Policy and Governance. TU and KRD coordinated with these students to provide following documents (advanced drafts). Key findings and recommendations are provided within the literature review.

Water Marketing: Literature Review

Agreement No. WRYBIP-2019-KittRD-00005

Prepared by

Elan Ebeling, Zach Kearl, Emma Weaver, And Noah Wentzel

Prepared for

The Kittitas Reclamation District

ABOUT THE AUTHORS

This report was produced in consultation with Kittitas Reclamation District and Trout Unlimited by four recent graduates of the Master of Public Administration program at the Evans School of Public Policy and Governance at the University of Washington. The authorship team previously collaborated as consultants to the Washington State Department of Ecology to produce a case study report on water marketing policies and programs in the western United States in fulfillment of their MPA capstone requirement. Their diverse professional histories combine experience in research, project management, communications, business development, and engineering.

All usage of “we” or “our” throughout this report refers to the authors.

EXECUTIVE SUMMARY

This report, commissioned by Kittitas Reclamation District (KRD) and Trout Unlimited (TU), summarizes findings from a review of water marketing and water banking literature in the western United States and relevant international contexts. The purpose of this report is to improve knowledge and data available to guide the formulation of market strategy in the Yakima River Basin. The findings presented in this report support that goal by reviewing water market performance and strategy within the identified literature. Our literature sample was generated through database searches of academic publications and grey literature supplemented by key Yakima-specific documents. Over 300 documents were identified for consideration in the search process, of which we selected a final sample of 89 documents that were most relevant for review in this project.

The findings of this report are organized around the following thematic elements we identified in the literature sample:

- **Transaction Costs**: Structural barriers to market entry and low-cost bargaining that inhibit market activity
- **Externalities**: Secondary effects of trading on communities and environmental goods that result from water trading
- **Valuation and Economic Welfare**: Assessment of the economic value of water goods and potential gains from trade
- **Public Perception of Water Markets**: Acceptability of market institutions as a demand management tool to stakeholder groups
- **Suggestions Provided by the Literature for Improving Water Markets:** Summarizes recommendations explicitly provided by the literature to improve water market performance and address common issues
- **Findings in Washington State Literature:** Summarizes findings in literature provided by Trout Unlimited specific to Washington State and the Yakima River Basin in order to provide insights pertinent to the Yakima Basin Integrated Plan

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1. PROJECT CONTEXT

This report was commissioned by the Kittitas Reclamation District ("KRD") in partnership with Trout Unlimited ("TU") as a component of a larger water market strategy research and development effort for a potential "smart" water market strategy in the Yakima River Basin. This report was made possible by the Washington Department of Ecology ("Ecology") through a grant, Agreement No. WRYBIP-2019-KittRD-00005.

Both KRD and TU are participants in the Yakima River Basin Integrated Water Resource Management Plan ("the Plan" or "YBIP") to provide guidance for the project's ongoing priority of facilitating efficient and equitable reallocation of water resources through market mechanisms. Market reallocation of water is one of seven elements identified in the Plan to address Yakima Basin water supply in conjunction with water quality to improve water resources for human consumption, economic productivity, and environmental values within the watershed.

This report reviews recent literature on water markets and water allocation models and provides lessons learned to inform a potential Yakima-specific smart market strategy and structure. Information on successes and failures of various water market methods will assist the Yakima Basin Integrated Plan Workgroup, Executive Committee, and relevant subcommittees in assessing appropriate strategies that may be successfully applied in the Yakima Basin.

2. RESEARCH METHODOLOGY

This report examines contemporary academic journal articles and grey literature evaluating the economic, legal, and policy considerations of formal water markets or water banking in the western United States and relevant international contexts. It includes a thorough review of literature with a focus on Washington State and the Yakima Basin from the last 20 years.

Our research targeted references to either water banks and/or water banking, water markets and/or water marketing, water transfers, water reallocation, or water right exchanges (see Appendix A for a search string listing). We performed our literature search in six databases—Scopus, Hein, Proquest Dissertation, Proquest Agriculture and Environmental Sciences Database, Google, and Google Scholar—to identify relevant articles in legal and academic journals in addition to government and non-governmental reports. We limited our search to reports published after 2008 to focus our review recent findings and recommendations.

We augmented our review of water marketing specific to Washington and Oregon by expanding the qualifying time frame to documents published after 1998 for documents that explicitly mentioned these states. TU and KRD provided additional literature specific to the Yakima Basin that were not produced in our search to be included in our review (these documents are specifically discussed in Chapter 4).

The initial literature search produced 446 documents that met the search criteria, including 44 documents from the expanded search of literature specific to Oregon and Washington. To reduce the amount of literature to consider, we narrowed our search with two rounds of screening. First, we refined the scope to literature focused primarily on Australia, Canada, Chile, and the western United States—areas with legal division of land and water rights and literature on public perception of water markets. This round of screening removed 146 documents from consideration.

The second round of screening was to identify articles that were deemed most relevant to the consideration of the Yakima River Basin Integrated Water Resource Management Plan. Relevance was determined by: 1) discussion of formal water trading, 2) analysis or assessment of performance of instituted water markets, and/or 3) a consideration of the impacts of a government entity's involvement, as a water market user or regulator. This round of screening removed articles that focused on abstract economic theory or hypothetical water markets, only discussed riparian water rights, or evaluated indigenous water rights absent of adjudicated markets. Of the 300 documents initially considered, we identified 89 as the most relevant to include in our in-depth review.

Key Descriptive Characteristics of Literature Reviewed

Our review included 89 articles and of these: 65 mention temporary transfers (73%) of varying length; 37 articles (43%) discuss federal involvement of some kind in water markets; and 38 (43%) mention some other government entity's involvement. Sixty-one percent (61%; 54 documents) mention environmental uses of water, and fifty-two percent (52%; 46 documents) touch upon drought or other climatic variability in the context of water marketing.

3. FINDINGS

Findings from the literature highlight common issues that hinder the administration of water markets, as well as proposed or implemented solutions. This chapter presents our findings in the following sections:

- **Section 3.1** begins with a discussion of transaction costs associated with water markets.
- **Section 3.2** identifies commonalities in environmental, economic, and social externalities.
- **Section 3.3** highlights considerations for valuing water rights and opportunities for improving economic welfare from water trading.
- **Section 3.4** examines studies that assess public perceptions of water markets and case studies of political conflict or opposition.
- **Section 3.5** discusses suggestions from the literature for improving water markets. Solutions presented in the literature generally address transaction costs and externalities identified in sections 3.1 and 3.2 as well as education and governance strategies to address public perception and acceptance of water markets. These recommendations reflect the content of reviewed documents, *not* the views or suggestions of the authors of this report.

3.1 TRANSACTION COSTS

Water markets, like those for any good or service, function best when the friction of trade is minimized. In economic theory, a market system will generate the optimal allocation of a good without regulation if the bargaining process does not significantly distort the market process (Coase, 1960). If the initial endowment of a good is less than perfectly efficient (that is, some amount of the good is consumed by users who value it less than users without endowments), users who value the good less will realize economic gains by selling (or leasing) some or all of their endowment to users who value it more. As a result of this bargaining process, consumption of the good is shifted to more efficient uses without incurring penalties to the original consumers. If the basic conditions of low-cost bargaining are met (i.e. minimal transaction costs), the efficient allocation of a good will be achieved through trading regardless of the initial allocation.

However, water markets struggle to provide suitable bargaining conditions to participants due to the unique nature of the specification of water as a good. As a result, water transfers incur transaction costs that constitute the necessary cost incurred during the trading to meet the legal, administrative, and hydrological requirements for amending the use requirements of water. As such, they are not representative of social value (Grafton et al., 2016) and influence the market similarly to a tax (Regnacq et al., 2016). Transaction costs therefore dampen both the willingness

and ability of potential market participants to trade and represent the most substantial barrier to the development of water markets. However, Hadjigeorgalis (2009) argues that water markets do not necessarily incur greater transaction costs than other water allocation systems due to the integration of private cost-minimizing incentives. In fact, they can significantly improve the overall efficiency of existing allocations when certain market conditions are met.

Transaction costs impede effective water marketing in three ways. First, transaction costs reduce the economic surplus of trading that does occur. Second, the costs discourage entry of new market participants. Finally, the costs encourage water users to engage in unregulated informal transfer arrangements with potentially significant third-party impacts or environmental externalities (Thampapillai, 2009). The following subsections will discuss the three major categories of transaction costs identified in the literature: limited market information, risk and uncertainty, and administrative costs. Taken collectively, these costs provide insight into the relative transferability of water rights and entitlements across users.

3.1.1 Limited Market Information

Market information constitutes data on market activity regarding existing market participants and transactions. For a market to function efficiently, participants must be able to easily identify potential trading partners and judge the value of their assets against prevailing price conditions. Due to the thinly-traded nature of many water markets, however, potential participants often do not have access to sufficient market information to facilitate activity. Lack of market information specifically inhibits water markets by imposing two types of barriers: search costs and lack of price signaling.

Search Costs

Search costs constitute the expense of identifying potential trading partners. Identifying suitable trading partners is often difficult and time-consuming, especially in thinly traded markets (Hadjigeorgalis, 2009; Thampapillai, 2009; Young, 2016). Records of water rights users may be difficult to locate (Borzutsky and Madden, 2013), and potential trading partners are often hesitant to share information on their existing rights for fear of regulatory scrutiny (Cook and Rabotyagov, 2014; Szeptycki et al., 2015; Kenney, 2015). Search costs also tend to increase over geographical distances, and there may be a necessary threshold population of visible trading parties within a locality for a market to be viable (Regnacq et al., 2016). Search costs are also incurred by trading participants due to difficulty finding qualified consulting services to support transfer applications (Purkey and Landry, 2001) and assist navigating trading rules and procedures (Thampapillai, 2009).

Price Signaling

Price signaling occurs when potential market participants gain visibility of past transactions, allowing them to formulate a willingness-to-trade schema on the basis of their own value product

and the potential fairness of a transfer. Price signaling is important because it guides per-unit costs toward equilibrium (at least within a locality) and provides relative valuations to different types of water users across all sectors. Lack of price signaling therefore inhibits price negotiation and constitutes a type of information cost, contributing to higher transaction costs (Kenney, 2015). Price discovery is especially damaging for short-term transfer markets that are only active during drought years due to the high opportunity costs of delays (Janmaat and Rahimova, 2018; Alevy et al., 2010). Price signaling difficulties are further exacerbated in watersheds with limited measurement or adjudication (Szeptycki et al., 2015).

Market Visibility

Many information costs can be mitigated through the public provision (in a physical or online format) of market information by either the regulatory agency or a water banking institution (Jaeger and Doppelt, 2002). Effective information systems for water marketing may include some or all of the following: a geospatial database of water rights; basic locational transfer suitability guides; documentation and explanation of transfer rules and procedures; comprehensive data on historical transactions including unit price, volume, and review process duration; and a forum for interested buyers and sellers.

3.1.2 Risk and Uncertainty

Transaction costs attributable to risk and uncertainty are incurred as a result of limitations on the definition, measurement, enforcement, and protection of existing property rights (Duane and Opperman, 2010). As a result, these costs vary significantly between regions and countries due to differences in the legal administration of water.

Definition of Rights

Notably, risk and uncertainty costs of water trading are substantially higher when subject to seniority-based prior appropriation doctrine than in entitlement-based allocation systems, though costs are further stratified within prior appropriation systems by the extent and effectiveness of existing management infrastructure (see below). Entitlement-based allocation systems generally reduce the risk and uncertainty of trading for a couple of reasons: first, entitlements are derived from a well-defined supply of water; and second, the absence of a seniority system reduces the burden of fulfilling no-injury requirements. Furthermore, entitlement-based systems typically occur in systems with well-developed infrastructure and accurate consumptive use measurements, reducing the potential for adverse environmental impacts due to altered return flows (Taylor, 2016; Dilling et al., 2019; Breviglieri et al., 2018).

Measurement of Rights

Measurement costs are the result of inadequate existing assessment of the extent and availability of water rights to meet trading requirements. Upon submitting a proposed trade for

administrative review, trading participants (particularly sellers) are typically required to demonstrate both the validity of the existing water right and the availability of that existing right for transfer to the regulatory agency (Lovrich and Siemann, 2004). Trading of water rights therefore often necessitates that participants incur substantial fees for legal and hydrological consultants and requires sufficient knowledge of both fields to determine the acceptability of their assessment results for the review process (Purkey and Landry, 2001; Lovrich and Siemann, 2004).

Enforcement and Protection of Rights

Potential market participants often fear that the results of an assessment may lead to a permanent revision of the existing water right if it is found that the right has not been fully utilized under "use it or lose" rules (Cook and Rabotyagov, 2014; Szeptycki et al,, 2015; Kenney, 2015). This lack of protection is especially evident in seniority-based systems because water rights constitute a private use of a public good, not a private good in and of themselves. McCrea et al. (2007) found this fear especially evident in the Yakima River basin where the agency responsible for transfer review had also functioned as plaintiff in the adjudication of rights in the basin. As a result, potential participants may infer an adversarial relationship with the reviewing agency and opt out of trading due to the anticipation of a negative revision to their water right.

Determining the availability of a water right for transfer also requires trade participants to adequately demonstrate that the transfer will not adversely affect the accessibility of third-party senior water rights within the water system. Satisfying the requirements of such "no-injury" rules can be notoriously difficult due to the complexity of assessing altered return flows and the potential for *de minimis* impacts (Nicholas et al., 2016; Hansen et al., 2014; Squillace and McLeod, 2016). Furthermore, measurement costs can be worsened as the result of historically limited water rights enforcement, leading to expensive processing delays if subjected to third-party protest. Such conflicts not only impose an opportunity cost during the extended period of review, but also may result in costly litigation (Grafton, 2011b; Squillace and McLeod, 2016).

As implied above, a major structural factor in the extent of risk and uncertainty costs is the extent of adjudication and conjunctive management within a basin. Both management systems are obviously cost- and time-intensive, but dramatically improve the specification of rights prior to trade (Szeptycki et al., 2015). As a result, comprehensive adjudications in particular provide substantiation of water right validity and transfer suitability at the time of review, and also minimizes the cost of assessing the impacts of altered return flows on third parties (Wheeler et al., 2017).

3.1.3 Administrative Costs

Administrative costs are those incurred by the time and expense of bureaucratic review of proposed trades. These costs are incurred both as a direct expense by the regulatory agency and

as an opportunity cost to the trading parties. Direct costs to regulation of transfers may be considered transaction costs regardless of whether they are covered by fees assessed on the trading parties or imposed as taxpayer burden; in either case they constitute a social cost of the transaction itself. The extent of administrative costs is correlated to the magnitude of review requirements and therefore may be reduced in conjunction with measurement costs (Borzutsky et al, 2013; Clifford et al, 2004; Szeptycki et al, 2015).

Opportunity costs vary greatly: the value of long-term or permanent transfers are relatively insensitive to processing delays, but short-term transfers are often extremely time-sensitive for agricultural and environmental uses under drought conditions (Slaughter and Wiener, 2007; Szeptycki et al., 2015). Moreover, many regulatory agencies face substantial backlogs in their review systems, rendering time-sensitive transfers functionally impossible (Szeptycki et al., 2015). As a result, the value (and therefore activity) of these short-term transfers is strongly associated with a prompt and responsive process for review and approval.

3.2 EXTERNALITIES

Externalities are costs incurred by transactions at the societal level that are not incorporated into the value of the traded asset. Because these costs do not accrue directly to transactional entities or individual third parties, they are often difficult to measure. As a result, potential external effects are often difficult to regulate against. This section will discuss two major categories—economic and environmental—of externality identified in the literature as prevalent in water markets.

3.2.1 Secondary Economic Effects

Opposition to large-scale water reallocation has been voiced in numerous locations due to concerns about potential secondary impacts on rural economies. These cases (discussed below) primarily concern the dislocation of water usage across sufficient geographic distance that it results in a loss of productive capacity in the community of origin. Subsequent impacts are the result of costs incurred beyond the scope of the transaction itself; that is, damages beyond the scope of economic surplus gained or lost as a result of the transfer, as well as any transaction costs.

Varzi and Grigg (2019) find three types of external costs attributable to reduced agricultural productivity: 1) decreased revenue from crop sales; 2) decreased demand for agricultural support industries (e.g. seed and fertilizer); and 3) reduced demand for agricultural labor resulting in declining wages. Nicholas et al. (2016) identify decreasing appraised land values leading to a reduction in the local tax base as a further external cost.

In order to mitigate these effects on rural community, the state of Colorado has gone so far as to propose imposing a one-time fee on out-of-district transfers to compensate for potential degradation of the local economy (Kenney, 2015). Similar termination or exit fees have been integrated into inter-district entitlement trades in Australia with positive results (Waye and Son, 2010; Garrick et al., 2009). Rather than assess fees for short-term inter-district transfers, the state of Victoria has imposed limits on the volume of such transfers as well as the total volume of entitlements that may be held by out-of-district users (Grafton et al., 2009).

These negative economic impacts are predicted as a result of reduced employment in regions that are dependent on agricultural activity for economic welfare. Employment losses may occur directly (through the layoff of farm employees) or indirectly (as a result of reduced viability of agriculture-dependent industry such as process) (Jaeger, 2004). Further impacts could also be incurred in the case of transfer outside of infrastructure-based entitlement systems (such as irrigation districts) when fewer irrigators remain to support the fixed cost of transmission (Waye and Son, 2010).

Empirical assessment of impacts is limited. Gollehon (1999) estimates that net income lost to an agricultural community may be as high as 20 percent of the value of production. However, Varzi and Grigg (2019) find that external costs in the Arkansas River Basin in Colorado due to water transfers existed but were relatively minor. Jaeger (2004), modeling a potential water market in the Klamath Basin of Oregon and California, estimates the impact of a 20% reduction of agricultural water usage will result in a 10% decrease in gross income and employment given that agricultural transfers primarily target lower-value crop uses. Thampapillai (2009) and Grafton et al. (2016) similarly found that Australian entitlement transfers to environmental uses have resulted in limited secondary impacts during drought years given the existing constraints on supply, and further confirmed that transfers primarily originated from low-value crops.

Nevertheless, dry-year productivity reductions in low-value crops may still impact sector-specific dependent industries. Jaeger (2004) posits the example of a potato processing plant whose local supply drops below a threshold level for operations as agricultural water is shifted to other crops (p. 182). Despite minimal losses to total agricultural productivity in the community, the isolated impacts on potato productivity result in layoffs at the processing plant (or, in an extreme scenario, its complete closure). However, the extent and permanence of impacts due to water trading is not clear: Janmaat and Rahimova (2018) identify a functional market for option contracts as an effective tool for mitigating these costs over the short term. Moreover, short-term losses of crop-specific productivity do not necessarily result in long-term damage to dependent industries (Wheeler, 2013a).

3.2.2 Environmental Externalities

Water transactions have the potential to produce a positive externality when the diversion point is transferred downstream. When occurring on a natural body of water, such transfers can result

in a net streamflow improvement over the lineal distance between the original diversion and the new diversion (Jaeger, 2001). Furthermore, if these transfers reduce agricultural activity at the original location, they may also result in a reduction of agricultural and animal waste introduced into the system through return flows, improving habitat quality (Jaeger, 2001).

However, some external costs may accrue to the environment as well. Positive instream effects will be reversed in the case of upstream transfers (Montilla-López et al., 2016). Park (2017) observes that wildlife may be dependent on return flows in addition to stream flows and subsequently impaired by return flow reductions. Similarly, Griffin (2012) argues that transfers from a controlled system such as an irrigation canal may impair downstream irrigators dependent on return flows to a natural body of water. Summarizing these conflicting cost indications, Young (2016) states that potential costs and benefits of locational transfers present a "spatially heterogeneous externality" that must be assessed on a case-by-case basis.

3.3 Valuation and Economic Welfare

Twenty-nine (29) articles in our review mention valuing trade activity and quantifying increases in economic welfare resulting from water transfers. These studies assess the potential for improving economic welfare from water rights transfers, while underscoring the impact they may have on rural, agricultural communities in cases of intersector water transfers between rural and urban users.

It can be difficult to substantiate gains from water trading, but many[1] studies have attempted to do so. Methodologies for determining potential for economic gains from trade vary. One technique of estimating welfare gains is using drought years as a natural experiment, comparing drought year trading activity and economic output against climatically "normal" baseline periods (Broadbent et al., 2014; Janmaat and Rahimova, 2018; Squillace, 2016). These studies observed economic output during years of drought was not proportional to the relative scarcity of water resources, and therefore provides evidence that water is being traded from low- to relatively high-value uses. For example, Wheeler et al. (2013a) estimated that increased trading activity in Australian markets reduced the impact of drought in the southern Murray-Darling Basin from AUD$11.7 to $7 billion between 2006 and 2011.

Another method used in the literature is an assessment of the prices from successful water rights transactions. These prices are an estimate of the buyer's willingness to pay, or the "perceived income that the buyers will derive from utilizing the water in their business ventures (e.g., maintaining municipal supply, developing an industrial site, maintaining a planted crop)" (p. 23;

[1] Clifford et al., 2004; Pease, 2012; Jaeger, 2001; Jaeger et al., 2002; Jaeger, 2004; Burke et al., 2004; Hansen et al., 2014; Holley and Sinclair, 2016; Grafton et al., 2014; Grafton et al., 2016; Wheeler, 2013a; Yoder et al., 2016; Debaere et al., 2014; Broadbent et al., 2014; Janmaat and Rahimova, 2018; Squillace, 2016

Clifford et al., 2004). For example, Hansen et al. (2014) note prices paid for municipal water are higher than the prices paid for irrigation or environmental purposes, suggesting that there are untapped economic benefits of reallocating water to the higher bidder. Jaeger (2004) and Lovrich and Siemann (2004), however, warn that transaction costs and excessive price expectations of sellers are embedded in these prices and difficult to disentangle from the true economic value of water, therefore obfuscating any real capacity for gains from trade (Jaeger, 2004; Lovrich and Siemann, 2004).

Other studies examine the kind of transactions that promote improvement of economic welfare. Nine studies[2] focus on the economic welfare impacts of intersectoral trading (such as transfers from agricultural to municipal use), while several studies[3] discuss how intrasectoral transfers (such as between agricultural users) also generate welfare gains. Intrasectoral transfers can increase economic welfare particularly when economically low-value agricultural water is transferred to relatively higher-value agricultural uses (such as alfalfa or viticulture), which is often observed during droughts or where water resources are most scarce (Szeptycki et al., 2015; Burke et al., 2004). In practice, this can be the result of junior water users obtaining water security from senior rights holders to support capital-intensive perennial crops, such as avocados and grapes in Chile (Alevy et al., 2010).

Welfare gains from trade are predicated on having diverse uses of water in the market and agricultural water uses that are less sensitive to periodic water shortages (Wheeler et al., 2013a; Wheeler et al., 2017; Alevy et al., 2010; Kenney, 2015). During instances of severe drought, water users who maintain permanent crops, such as orchards, tend to monopolize water use to protect their long-term investments (Heard et al., 2017; Grafton et al., 2009; Szeptycki et al., 2015). If the permanent crop is not the highest value use from an economic standpoint, this homogenizing effect of water use may restrict efficient reallocation of water in the market. Alevy et al. (2010) discuss one such instance from a Chilean study by Zegarra (2002) where an extreme drought caused the market trading to grind to a halt at the point when water users engaged in farming permanent crops resisted trading away their water.

Two studies propose making water rights more flexible in trading to further improve potential economic gains from trade. Young (2016) suggests one means of increasing flexibility: enable simultaneous matching of many buyers to many sellers rather than matching a single buyer to a single seller. “Instead of a seller with 100 acre-feet of water having to find a buyer who needs exactly that amount, she can sell to several buyers, each needing different, but smaller quantities. The reverse is also true: a smart market can aggregate many sellers' water rights for a large bidding quantity.” (p. 3) Grafton et al. (2009) found that seasonal and temporary water trading in

[2] Liedner et al., 2011; Pease, 2012; Debaere et al., 2014; Liedner et al., 2011; Heard et al., 2017; Griffin, 2012; Grafton et al., 2011; Hadjigeorgalis et al., 2009; Hadjigeorgalis, 2009
[3] Debaere et al., 2017; Squillace, 2016; Heard et al., 2017; Janmaat and Rahimova, 2018; Broadbent et al., 2014; Scott et al., 2004

the Murray-Darling Basin of Australia offered a safety valve for the farmers who irrigate orchards and vineyards, while also increasing the volume of sales at high water prices.

3.4 Public Perception of Water Markets

Forty-four (44) of the 89 reviewed studies mention public perception of water markets, opposition to water markets, or conflict and political action related to water markets. These studies highlight characteristics that hinder positive perceptions of water markets and trade, and common concerns among stakeholder groups. Several studies highlight factors that promote positive perceptions of water markets as well. These factors are generally the inverse of factors thought to diminish the performance of water markets.

Five[4] studies cited administrative concerns as a characteristic that hindered positive perceptions of water markets or positive relationships among users. Inconsistencies and lack of clarity in the administering water markets often fuel distrust and wariness, as was the case for the Arkansas River Water Bank Pilot Program in Colorado (Lepper and Freeman, 2010). Lepper and Freeman (2010) found that farmers were suspicious of the state's intentions in implementing the program, because the Pilot Water Bank was run by cosmopolitan regulators who were not accountable to the farmers.

A study of Ecology's Washington Water Acquisition Program in the Dungeness, Yakima, and Walla Walla basins conducted by Lovrich and Siemann (2004) found that many interviewees viewed water markets as complicated, bureaucratic, and inconsistent. Users complained of slow processing times, inconsistent rules and lack of transparency. Lengthy delays and lack of responsiveness on the part of Ecology were cited as reasons landowners were discouraged from participating in the program. Multiple focus groups of Yakima landowners convened in 2007 found similar concerns: when asked why they did not participate in Ecology's reverse water right auction of that year, respondents voiced complaints about the complexity of the process, lack of flexible transfer arrangements, and vague program goals as major motivations (Rux, 2007).

Similar administrative concerns were cited by the United States Government Accountability Office (2005) in a study on the United States Bureau of Reclamation's water banking program in the Klamath basin from 2002-2004. The study states that Reclamation was unclear in communicating various management and accounting decisions to users. Additionally, the study stated that Reclamation failed to provide program users with clear information regarding water bank operations. Furthermore, Reclamation's policy of providing users with information upon request resulted in stakeholders receiving conflicting information at different times.

[4] Lepper and Freeman, 2010; Lovrich and Siemann, 2004; United States Government Accountability Office, 2005; Lieberherr, 2011; Wheeler, 2014

Lieberherr (2011) discusses concerns related to bureaucratic and time-intensive processes in the Deschutes Groundwater Mitigation Program that led to frustration among active participants and was cited as a reason why some potential participants didn't engage with the program. Similar concerns were cited by Lepper and Freeman (2010) in Colorado, where lack of clarity and consistency led to a distrust and discouraged users from engaging in water markets. Finally, in the Murray-Darling Basin in Australia, Wheeler (2014) notes that the release of a guide to the MDB Plan calling for an increase in environmental water holdings resulted in unrest among water users due to the secrecy associated with the Guide's release.

Other studies underscore general distrust of markets and commoditization of water (Wheeler et al., 2017; Nikolakis and Grafton, 2009), a mistrust of government involvement in water markets (Wheeler et al., 2013; Lepper and Freeman, 2010; Rux, 2007), and misgivings among agricultural communities, with a perception that they have nothing to gain and everything to lose, even in the context of voluntary transactions (Conrad et al., 2017; Jaeger and Doppelt, 2002). Some studies found that cities were reluctant to transfer water out of agricultural communities due to a widespread perception that this disrupts rural communities and is politically charged. (Debaere et al., 2014; Duane and Opperman, 2010).

A common theme in these studies was that non-economic factors generated common concerns among stakeholder groups and hindered positive perceptions of water markets. One study of environmental flow transactions in the U.S. noted that irrigator participation was impacted by several non-economic factors including social pressures, concerns regarding impacts to irrigation districts or rural communities, and a lack of trust (Lane-Miller et al., 2013). Cook and Rabotyagov (2014) echo this finding, stating that irrigators do not make simple profit maximizing decisions, but instead incorporate the cultural value of rural lifestyle into considerations of water transfers. Participation by irrigators may hinge upon whether the buyer of their water right is another irrigator or a growing town, or if the transaction is facilitated by an entity they trust.

Thampapillai (2009) found similar concerns in a study of water trading in the Murray-Darling Basin in Australia. Community members in this study were concerned about permanent transfers negatively impacting agricultural communities. The study found evidence of social pressure to avoid out-of-district transfers. Concerns regarding out-of-district transfers were echoed in two studies conducted by Wheeler et al. (2013a, 2017) in the Murray-Darling Basin in Australia as well. Here, the authors discuss distrust of the redistribution of water entitlements among irrigation communities in addition to a preference for within district transfers. Several other studies cite irrigator concerns about potential negative impacts of market participation on their own communities, or else highlight social pressures within communities, irrigation districts or canal companies to not engage in transfers (Nicholas et al., 2016; Hanak and Stryjewski, 2012; Libecap et al., 2011; Hadjigeorgalis, 2009; Jaeger, 2004). In this same vein, a study in the Okanagan Basin in Canada found that farmers expressed a preference for intrasectoral agricultural transfers over intersectoral transfers to new uses.

A few[5] studies discussed equity concerns in water markets. Holley and Sinclair (2016) find that 67% of indigenous respondents disagreed with the assertion that all parties were being treated equally and fairly under the water management regime in New South Wales, Australia, compared to 40% of non-indigenous respondents. In a study conducted in the Deschutes Basin, equity concerns were framed around differences between big water users and smaller water users. Lieberherr (2011) notes that many users in the Deschutes Groundwater Mitigation Program felt that bigger water users (such as golf courses) weren't paying their fair share or were being wasteful, which negatively impacted their perception of the program.

Potential negative secondary effects of water transfers on rural economies constitute a major concern for potential water market participants. Studies highlighted community concerns with transferring water from agricultural to other uses, including concerns related to loss of the agricultural economy and associated infrastructure, as well as fear of population loss within rural communities (Loch et al., 2013; Lovrich and Siemann, 2004). One study specifically highlighted community concern regarding transferring water from "traditional" consumptive uses to instream uses (Grafton et al., 2009). Similar user concerns included loss of flexibility to respond to changes in weather or market access as a result of permanent or long-term leases (Lovrick and Siemann, 2004).

Several studies reference the cultural stigma associated with fallowing agricultural land and how this stigma has increased the popularity of conserved water acquisitions for streamflow augmentation purposes (Debaere et al., 2014; Garrick et al., 2009). Wheeler et al. (2013b) points to evidence that Australian agricultural communities are more willing to engage in transfers of conserved agricultural water. The authors note that one-fifth of irrigators who stated that they would be uninterested in selling their water entitlements also stated that they would be interested in alternative trading arrangements. Furthermore, 40% of irrigators who showed only slight interest in selling their water entitlements expressed interest in alternative trading arrangements. However, Kenney (2015) notes that water constituencies disagree on whether alternative agricultural transfer methods (ATMs) such as the sale of conserved water avoids or accelerates the dry-up of agricultural lands.

Factors identified as promoting positive perceptions of water markets and improved willingness to participate address the elements that lead to opposition to water markets: credibility and trust. Lovrich and Siemann (2004) specifically mention that interviewees stressed the importance of using credible intermediary organizations, such as a private non-profit (e.g. Washington Water Trust) or non-regulatory government agency (e.g. conservation districts), to facilitate participation. Additionally, both Lovrick and Siemann (2004) and Lane-Miller et al. (2013) discuss the importance of tailoring the design and management of a program to local conditions

[5] Holley and Sinclair, 2016; Lieberherr, 201; Wheeler et al., (2013b)

of each watershed area, and messaging success stories or testimonials to help promote positive perceptions of water transfers.

3.5 Suggestions Provided by the Literature for Improving Water Markets

The literature in our review contains various suggestions for improving the performance and public perception of water markets. Commonly noted as "recommendations" in the literature, these ideas address provisions to minimize barriers to trading activity such as transaction costs, negative economic impacts on agricultural communities, and technical issues related to measurement, monitoring, and enforcement.

3.5.1 Promoting Temporary Transfers

Five[6] articles in our review recommend that water market administrators promote some form of temporary transfer over permanent transfers. Referencing the growing need to transfer agricultural water to other uses in the west, MacDonnell and Rice (2008) discuss the importance of easing the requirements of temporary transfers in order to provide flexibility to farmers and minimize economic externalities on rural agricultural communities. Szeptycki et al.'s (2015) review of state laws relating to environmental water transfers finds that temporary transfers promote water market participation (especially in conjunction with a streamlined review process).

Several[7] articles specifically recommend the use of dry-year option contracts or split-season transfers to provide greater flexibility to agricultural water users. Jaeger and Doppelt's 2002 examination of two case studies from Washington (Salmon Creek in the Okanogan River Basin) and Oregon (Upper Klamath River Basin) argues that contingent dry-year option contracts for instream uses should be developed in places where the value of instream water only exceeds its out-of-stream value during drought years. This type of system would avoid frequent renegotiation of temporary leases.

One such contract was implemented in the Oregon portion of the Walla Walla River Basin in 1998. Under this agreement, the Oregon Water Trust agreed to pay an individual irrigator growing spring-irrigated crops an initial one-time payment over a 10-year period for an option to divert the irrigation water to instream uses in dry years (Jaeger and Doppelt, 2002). The amount of the initial payment was based on projections of the number of dry years likely to occur over the 10-year period, as well as the volume and value of foregone production. Jaeger and Doppelt

[6] Jaeger and Doppelt, 2002; MacDonnell et al., 2008; Szeptycki et al., 2015; Squillace, 2013; Squillace, 2016.
[7] Jaeger and Doppelt, 2002; Squillace, 2016; Borzutzky and Madden, 2013.

(2002) also identify out-of-stream option contracts as an important tool for situations “where the value of water in one use or the other is uncertain or fluctuates from year to year” (p. 16).

In “Marketing Conserved Water,” Squillace and McLeod (2016) note that the frequency of dry-year option contracts for municipal uses are sometimes restricted due to the risk that a prolonged drought could take agricultural land out of production for multiple consecutive years. In order to mitigate this risk to farmers while providing municipal users with greater security, Squillace and McLeod recommend that dry-year option contracts be used to transfer conserved agricultural water (via rotational fallowing, deficit irrigation, or crop switching) as an alternative to the permanent transfer of agricultural water rights.

Split-season transfers can also offer a way to minimize conflict between users by capitalizing on the fluctuations in the marginal value of water for various uses over the course of the irrigation season (Jaeger and Doppelt, 2002). Jaeger and Doppelt (2002) argue that this strategy is especially useful for areas where water storage does not exist and irrigators are able to shift their irrigation schedule earlier in the season, leaving more water for instream uses later in the season when flows are lower. For example, in the Upper Klamath River Basin, irrigators growing grains and pasture were able to irrigate prior to the start of curtailments introduced by a 2001 Federal Klamath Reclamation Project. This approach resulted in normal yields on 17,000 acres without additional irrigation later in the season, mitigating economic damage from lost agricultural production (Jaeger and Doppelt, 2002).

3.5.2 Transfer Process and Market Visibility

A common theme in the literature is the need for a centralized market authority to establish consistent standards for water application approval processes and disseminate market and price information. High levels of uncertainty due to incomplete market information present a major barrier to efficient water markets; incomplete or inconsistent price data inhibits the ability of water users to effectively manage water resources to adapt to drought and other climate-induced scarcity (Jaeger and Doppelt, 2002; Loch et al., 2013; Zuo et al., 2014).

A centralized website or other publicly visible platform can help mitigate this uncertainty by providing transparent market information including transaction data (price and volume), climate modeling, forecasted water availability, allocation information (if applicable), and water market activity to date (Doherty and Smith, 2012). Montilla-López et al. (2016) examine water markets worldwide and recommend that administrators provide as much information as possible to the public including prices and trading volumes, parties involved, and the terms of transactions.

A study by the U.S. Government Accountability Office (GAO) found that the Bureau of Reclamation failed to communicate key information related to the operation and status of the Klamath Water Bank, confusing stakeholders and undermining the bank’s legitimacy and efficacy. The GAO recommended the creation of a centralized website or publication of

biweekly press releases to explain the rationale of management decisions and keep water users informed of significant events (United States Government Accountability Office, 2005).

Similarly, Loch et al. (2013) cite poor price information and lack of transparency in allocation announcements in Australia's Murray-Darling Basin as a constraint within that market. Jaeger and Doppelt (2002) note that price information can be distinguished between market transactions consistent with a seller's willingness-to-pay price and those that reflect idiosyncratic willingness-to-pay prices (such as agricultural lifestyle valuation).

As a caution to publishing price information, however, Young (2016) notes that "confidentiality of price information is one of the most underappreciated aspects of trading" (p. 5). Young (2016) found that farmers in Nebraska were hesitant to divulge sensitive personal financial information as a condition of participating in the local water market. However, the operation of a smart market by a neutral private third-party sharing limited price information (price ranges instead of exact prices) with the public protected confidentiality and encouraged trading (Young, 2016).

Some opportunity costs related to lengthy transfer approval processes can be defrayed by establishing a priority system for application processing wherein time-sensitive transfers jump to the top of the queue (Lovrich and Siemann, 2004). However, priority systems can also create other issues: in the Walla Walla River Basin, for example, Lovrich and Siemann (2004) note that the required priority for trust water right change applications interfered with processing other rights. Lovrich and Siemann (2004) recommend that the Washington State Department of Ecology develop a flexible approach to application processing that strikes a balance between Trust Water Right Program applications and other change applications.

Administrative costs can be further reduced by either expanding the scope (volume or duration) of each transfer or streamlining the approval process of short-term transfers (Jaeger and Doppelt, 2002). Expanding the scope of transfers minimizes transaction costs by increasing the welfare gains from trade relative to the fixed costs of transfer (Jaeger and Doppelt, 2002).

Streamlined approval can be implemented in multiple ways. Many jurisdictions relax the requirements of no-injury rules for seasonal and one-year transfers, especially under drought conditions (Jaeger and Doppelt, 2002; Hansen et al., 2014). For example, Oregon employs an expedited process for reviewing short-term transfers, reviewing leases of less than five years based on paper rights and allowing transactions to be revoked after the fact if they are found to negatively affect other users (Szeptycki et al., 2015). Subsequently, providing a simplified renewal process for temporary transfers (rather than process each iteration as a new transaction) can dramatically reduce the time and expense of annual review (Jaeger, 2002).

3.5.3 Establishing Consistent Standards

Several[8] articles emphasize the importance of establishing consistent evaluation standards for the validity and availability of a water right for transfer as well as the importance of communicating these standards transparently to the public. Important standards include consistent methodologies for measuring consumptive availability of a given water right as well as standardized evapotranspiration rates that incorporate crop type, soil type, and regional considerations. These are especially important for markets in conserved agricultural water (Jaeger and Doppelt, 2002; Kenney, 2015).

Setting consistent and transparent standards for measuring consumptive use also mitigates uncertainty for buyers and sellers which promotes the functioning of a healthy water market (Squillace, 2016). In Colorado, Kenney (2015) recommends that water market administrators standardize methods for calculating water savings from transfers of conserved agricultural water in a way that would guarantee that their approval would also satisfy the no-injury rule.

The technical challenges involved in measuring consumptive use can add considerable time and expense to the approval of a water right transfer, suggesting the need for better technology to measure the amount of transferable water in a given transaction (Szeptycki et al., 2015). Jones and Colby (2012) review measurement, monitoring, and enforcement strategies for temporary transfers of agricultural water conserved through rotational fallowing programs. The authors examine methods for measuring consumptive use including water savings, water delivery-based measurement, traditional evapotranspiration calculation, and remote sensing of evapotranspiration.

Jones and Colby (2012) find that traditional evapotranspiration methods are accurate and cost-effective if crop coefficients used in a region are current, but recommend using satellite-assisted estimators if crop coefficients are outdated. In contrast, the report finds that water delivery measurement is cost efficient but less accurate. For transfers of conserved water, Squillace (2016) and Kenney (2015) recommend a policy of reducing the volume available for transfer by 10% to account for uncertainties in calculating changes in consumptive use.

3.5.4 Education and Outreach

Closely related to the establishment of consistent and transparent transfer rules is the need to educate the public about water market processes. Five articles in our review provide recommendations for specific education and outreach activities to influence public perception and promote common understanding of the benefits of water markets. The recommendations are:

[8] Grafton et al., 2009; Jones and Colby, 2012; Szeptycki et al., 2015.

- Public meetings to inform stakeholders about water market processes, inform participants about water acquisition efforts, answer questions from community members to clarify rules and procedures, and address basin-wide economic impacts of transfers (Purkey and Landry, 2001; Doherty and Smith, 2012);
- Education geared specifically toward creating realistic price expectations in the community, such as mock water trading workshops (Clifford et al., 2004);
- Frequent and accessible public presentations (Jaeger and Doppelt, 2002); and
- Messaging focused on the benefits of transfers to agricultural users (Lovrich and Siemann, 2004).

3.5.5 Collaboration and Governance

Four[9] articles recommend including key community representatives and stakeholders as a part of the institutional water market planning process in order to improve acceptability for potential market participants. Jaeger and Doppelt (2002) identify the ability to establish strong collaborative relationships with stakeholders as important in basins throughout the Pacific Northwest where some irrigation districts may be reluctant to work with NGOs or government agencies. Additionally, Dilling et al. (2019) and O'Donnell et al. (2010) recommend the creation of a conflict resolution mechanism to reduce transaction costs.

Loch et al. (2013) and Young (2016) discuss the importance of avoiding conflicts of interest in the case of government-run water markets to prevent erosion of public trust. For example, a government agency administering a water market while simultaneously participating as a buyer or seller in the market will gain insider price information that creates a conflict of interest. In such cases, Young (2016) recommends relegating financial administration of the water market to a third party.

3.5.6 Monitoring and Enforcement

In the face of increasing strain on water resources due to more frequent droughts and the intensifying effects of climate change, implementing standard and predictable methods for monitoring and enforcing water transfers is crucial to ensure proper water accounting and program accountability (Jones and Colby, 2012; Jaeger and Doppelt, 2002). Review costs may also be expedited through the use of assessment tools that do not require on-site monitoring (Szeptycki et al., 2015).

Jones and Colby (2012) recommend using satellite-based methods for monitoring purposes for rotational fallowing programs as opposed to site visits, especially if fields in the area are large enough to access at no cost as Landsat images—"as long as fields are monitored far enough into

[9] Jaeger and Doppelt, 2002; Clifford et al., 2004; O'Donnell et al. (2010); Doherty and Smith, 2012.

the growing season for the difference between weeds and crops to be apparent, this approach would be cost effective, require minimum staff time, and provide a history of fallowing compliance given that images are archived" (44).

Jones and Colby (2012) note that the implementation of remote sensing technology for monitoring and enforcement would require substantial involvement from irrigators, suggesting that rotational fallowing programs should emphasize the benefits of remote sensing technology for irrigators, including real-time data on crop-water interactions leading to improved irrigation scheduling and higher crop yields. Additionally, the authors also recommend that program agencies pursue cost-sharing agreements between the agricultural and non-profit sector or government sectors to offset the high cost of remote sensing technology.

As an alternative to imposing fines on irrigators, Jones and Colby (2012) point out that compliance rewards may actually increase compliance rates in agricultural water conservation programs. Finally, Jones and Colby (2012) suggest that targeted monitoring and employing a variety of monitoring and enforcement methods may help to encourage compliance while keeping costs down.

3.5.7 Inter-District and Trans-Basin Trades

Recommendations from the literature on transfer rules for trans-basin trades are largely focused on Australian water markets. Recommendations are mixed, demonstrating the necessary balance between facilitating transfers and preventing negative externalities, and indicating that transfer rules should be tailored to the local, social and hydrological context of each region. Several authors recommend the removal of trade restrictions in order to promote water transfers (Grafton et al., 2009; Loch et al., 2013), while others emphasize that transfer rules should be structured to minimize negative environmental impacts (MacDonnell and Rice, 2008; Waye and Son, 2010; Doherty and Smith, 2012).

For example, the State of Victoria in Australia set a 4% cap on out-of-irrigation-district trades which is designed to protect the economic interests of agricultural communities (Grafton et al., 2009). Grafton et al. (2009) advocate for the removal of such inter-district trading restrictions that benefit a particular group, arguing that they could be detrimental to the public interest and prevent environmental water transactions from taking place[10]. However, Waye and Son (2010) argue that although removing the 4% rule in Victoria would make more water available for environmental uses, it would encourage a more opportunistic market which would be less likely to incorporate the full cost of third party or environmental externalities.

[10] The Australian Competition & Consumer Commission ruled to phase out the 4% cap on out of district trades in the State of Victoria starting in 2014.

Loch et al. (2013) identify trade restrictions on inter-regional trade in the Murray-Darling Basin in Australia as a barrier to maximizing gains from trade for buyers/sellers and argue for their removal. In contrast, MacDonnell and Rice (2008) argue that out-of-basin transfers in the western United States should be subject to additional requirements including a no net environmental degradation standard, and should only be approved after the applicant has demonstrated that existing supplies are being used efficiently and there are no better alternative supplies.

Four articles[11] in our review suggest mitigating environmental and social externalities on rural agricultural communities through measures such as a mandatory formal commitment to land restoration from water right buyers (Squillace, 2015), community mitigation funds (Clifford et al., 2004, Doherty and Smith, 2012, MacDonnell and Rice, 2008), revegetation and noxious weed management programs, or improvements to infrastructure (Doherty and Smith, 2012).

3.5.8 Financing and Fees

Three[12] articles in our review address financing models for supporting water markets. Two articles recommend a cost-based pricing model to cover operational and management costs and avoid hidden subsidies (O'Donnell et al.; Montilla-López et al., 2016). In addition, Doherty and Smith (2012) propose a real estate transfer or development tax as a potential financing option.

[11] Clifford et al., 2004; Doherty and Smith, 2012; MacDonnell and Rice, 2008; Squillace, 2015.
[12] O'Donnell et al.; Montilla-López et al., 2016; Doherty and Smith, 2012.

4. FINDINGS IN WASHINGTON STATE LITERATURE

Within our literature sample, we identified a subset of documents that identified and discussed findings within Washington State and the Yakima River Basin. Many themes from these documents echo the findings from the larger sample of literature, while others are more regionally specific. This chapter will discuss findings sourced from (and therefore applicable to) Washington State and the Yakima River Basin within the context of the thematic elements of our literature sample identified above. This subset of the literature sample includes nine[13] documents.

4.1 TRANSACTION COSTS

McCrea et al.'s (2007) technical report on market-based reallocation of water resources in the Yakima Basin identifies similar administrative and market information transaction costs as our sample of global literature. McCrea et al. (2007) find that processing time is a significant obstacle to market transfers and recommend expanding the scope of the priority processing system for change applications. However, the report also finds that the Yakima Transfer Working Group has reduced transaction costs by providing proactive technical assistance to market participants. The authors also emphasize the importance of outreach and education and making information widely available to the public in order to foster trust and encourage market participation (McCrea et al., 2007).

In addition, several authors highlight the importance of other factors in the Yakima including adjudication and legal complexity:

- Completion of comprehensive adjudication should reduce measurement and enforcement costs and associated transactional risk (Welch et al., 2013; McCrea et al., 2007).
- Legal pluralism and jurisdictional complexity require transfers to meet a higher legal threshold for approval than in many other regions (Welch et al., 2013).

4.2 EXTERNALITIES

Similar to themes from the global literature that highlight concerns over negative effects of transactions on local economies, a report to the Washington State Legislature (Clifford, 2012)

[13] Clifford, 2012; Clifford, 2006; Clifford, 2004; Graham and Montgomery, 2011; McCrea et al., 2007; Niemi, 2011; Roza, 2016; Rux, 2007; Welch et al., 2013.

points to negative economic externalities of water transfers on communities in northeast Washington. Like other authors who recommend promoting transfers of conserved agricultural water in order to protect the economic interests of rural agricultural communities (Squillace and McLeod, 2016), Clifford cites MacDonnell and Rice's 2008 report which recommends the formation of rotational fallowing pools in Washington State to mitigate the local effects of water transfers. Clifford's report further encourages regulatory agencies, agricultural groups, and environmental groups to promote their use to stakeholders (Clifford, 2012).

4.3 Public Perception

Welch et al.'s 2013 situation analysis of market-based water reallocation in the Yakima basin finds that a market institution with a well-defined purpose may facilitate participation. However, a top-down approach to market creation (defined and empowered by government agencies) may deter participation when users perceive that reallocations prioritize marketwide results over their individual or community interests (Welch et al., 2013). This finding relates to the recommendations of several authors (Jaeger and Doppelt, 2002; Clifford et al., 2004; O'Donnell et al., 2010; Doherty and Smith, 2012) in the broader literature review who emphasize the importance of collaboration with local representatives and groups in market design to promote the legitimacy of markets.

Findings from McCrea et al.'s 2007 report suggest that social capital may be generated by increasing the visibility of past and current transfers within the markets. Potential market participants will be encouraged to pursue trading if they trust the consistency of process and outcome across the body of market transactions. This echoes the theme from several authors in the larger literature sample that emphasizes the importance of establishing consistent transfer processes and standards (Grafton et al., 2009; Jones and Colby, 2012; Szeptycki et al., 2015).

Finally, McCrea et al. (2007) find that Yakima stakeholders have demonstrated a lack of trust in the Washington Department of Ecology as a market regulator due to its past role as plaintiff in water rights adjudication in the basin.

4.4 Valuation and Economic Welfare

Niemi et al. (2011) studied net economic effects on the agricultural sector under several drought-year scenarios. They find that the Yakima Integrated Plan baseline trading scenario (transfers summing 30,000 acre-feet, primarily inter-district) has the potential to reduce economic losses of severe drought by $20 million. Moreover, unrestricted trading with active participation has the potential to fully offset net economic losses of severe drought.

4.5 Suggestions in Washington Literature for Improving Water Markets

Suggestions for improving water transfers in the Yakima River Basin broadly discuss process and fee standardization across districts as well as multiple alternative water market structures.

Welch et al. (2013) propose the creation of a joint committee to manage all water transfers within the Yakima River Basin to improve the transfer process. The authors identify three primary responsibilities for this committee necessary to facilitate a healthy water market: 1) registry services to validate users' water rights and standardize entitlements across irrigation districts; 2) transaction management to regulate the transfer process in accordance with transaction rules and standardize transaction fees; and 3) shared reduction management to establish use preferences during drought periods. The authors assert that the creation of such a joint committee will simultaneously reduce administrative costs associated with transfer as well as improve willingness to participate through a stakeholder-inclusive approval process.

McCrea et al. (2007) discuss several alternative water marketing systems in the context of the Yakima River basin:

- *Water market using existing authority*: a water market administered by a private non-profit functioning as a clearinghouse entity. The administering organization publishes information on location, use, and availability of interested sellers and conducts outreach to potential buyers and other stakeholders about market opportunities. Transfer approval would remain under the authority of existing Ecology processes.
- *Open water market*: a water market administered by a private non-profit functioning as both clearinghouse and broker. The administering organization publishes market information but also seeks actively to match potential buyers and sellers. Transfer approval would remain under the authority of existing Ecology processes.
- *Water banking using existing trust water rights program*: the existing Trust Water Rights Program functions as a water bank to interested buyers and sellers within the basin. Participants transfer rights into and out of the bank (rather than transact with other private entities in a market setting). Water rights remain protected from relinquishment as long as they remain in trust.
- *Non-regulatory water bank*: similar to the previous alternative but featuring a newly created bank administered by either a private non-profit or non-regulatory government agency. Prices can be either set by the administering organization or negotiated on a case-by-case basis.
- *Drought-year transfers outside of irrigation districts*: inter-district transfers are relaxed to allow up to 30% of district supply to be transferred elsewhere during drought years. Individual users petition for temporary transfer at a set price subject to approval by both the district of origin and the district of final use.

- *Irrigation district bank*: individual irrigation districts function as a water bank during drought and non-drought years. Each district will solicit sale offer from its members at a fixed price and negotiate leases to purchasing members or to outside districts.

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6. APPENDIX A – DATABASE SEARCH STRINGS

Below is a list of the seven search strings used in our initial literature search, which was limited to reports published after 2008.

1. "water bank" OR "water banks" OR "water banking" OR "groundwater bank" OR "groundwater banks" OR "water supply bank" OR "water supply banks" OR ("rental pool" AND "water") OR "water lease bank"
2. "drought bank" OR "drought banks" OR "augmentation bank" OR "augmentation banks" OR "water trust"
3. ("water market" OR "water markets" OR "water marketing") AND NOT ("water bottle" OR "bottle")
4. ("water transfer" OR "water transfers" OR "water right transfer" OR "water rights transfer" OR "water rights transfers") AND voluntary
5. ("water reallocation" OR "water right reallocation" OR "water rights reallocation" OR "water right allocation" OR "water rights allocation") AND voluntary
6. "water exchange" OR "water right exchange" OR "water rights exchange" AND voluntary

We expanded the time horizon of our search to capture additional reports that focused on Oregon and Washington state. Below are the modified search strings that we used:

1. "water bank" OR "water banks" OR "water banking" OR "groundwater bank" OR "groundwater banks" OR "water supply bank" OR "water supply banks" OR ("rental pool" AND "water") OR "water lease bank" AND ("Oregon" OR "Washington")
2. "drought bank" OR "drought banks" OR "augmentation bank" OR "augmentation banks" OR "water trust" AND ("Oregon" OR "Washington")
3. ("water market" OR "water markets" OR "water marketing") AND NOT ("water bottle" OR "bottle") AND ("Oregon" OR "Washington")
4. ("water transfer" OR "water transfers" OR "water right transfer" OR "water rights transfer" OR "water rights transfers") AND voluntary AND ("Oregon" OR "Washington")
5. ("water reallocation" OR "water right reallocation" OR "water rights reallocation" OR "water right allocation" OR "water rights allocation") AND voluntary AND ("Oregon" OR "Washington")
6. "water exchange" OR "water right exchange" OR "water rights exchange" AND voluntary AND ("Oregon" OR "Washington")

7. APPENDIX B - SUMMARY OF INITIAL LITERATURE SEARCH

	SEARCH STRING					
DATABASE	1. "Water bank…"	2. "Drought bank…"	3. "Water market…"	4. "Water transfer…"	5. "Water reallocation…"	6. "Water exchange…"
Google						
Results returned	191	4	200	190	179	189
Results reviewed	191	4	130	100	70	30
Source for further review	17	0	10	7	1	0
Google Scholar						
Results returned	3,610	1,420	14,300	3,670	578	2,370
Results reviewed	150	100	300	100	100	100
Source for further review	45	26	108	25	36	1
Hein						
Results returned	231	130	583	256	56	6
Results reviewed	100	50	100	100	56	6
Source for further review	20	3	18	9	3	0

	Search String					
Database	1. “Water bank…”	2. “Drought bank…”	3. “Water market…”	4. “Water transfer…”	5. “Water reallocation…”	6. “Water exchange…”
Scopus						
Results returned	12	1	69	2	1	159
Results reviewed	12	1	50	2	1	100
Source for further review	2	0	8	0	0	1
Proquest Dissertation						
Results returned	109	335	1,054	8	3	3,151
Results reviewed	90	50	100	8	3	50
Source for further review	15	0	5	2	0	0
Proquest Ag & Envs						
Results returned	192	161	1,041	12	44	15
Results reviewed	120	161	20	12	44	15
Source for further review	14	0	23	0	3	0

Western Water Law:
Case Study Review of Transfer Processes

Agreement No. *WRYBIP-2019-KittRD-00005*

Prepared by
Noah Wentzel

WASHINGTON
Water Right Transfers via Ecology
Statutory Authority: RCW 90.03.255 to 90.03.380

Water right transfers in Washington are regulated by the Department of Ecology (ECY). No distinction is made in the transfer process between permanent and temporary transfers.

Transfer applicants are encouraged to arrange a pre-application consultation with ECY staff to review the pertinent water right(s) and assess potential barriers to transfer. Following submission of a completed application, the transfer applicant is required to publish a legal notice of the proposed change in a prominent local newspaper and submit an affidavit of publication to ECY.

ECY will then review and evaluate the transfer application. The evaluation criteria are validity, injury, enlargement, and compatibility with public interest. An additional evaluation criterion includes any comment or opposition arising during the simultaneous public comment period. During the review process, ECY also collects any additional documentation required to demonstrate that the transfer satisfies evaluation criteria and may undertake (at staff discretion) field or technical investigations of the existing right to verify application conditions.

Following the review period, ECY typically publishes a draft final Report of Examination (ROE) detailing the application evaluation and the decision to approve or reject the transfer. The draft final ROE is then available for public comment for 30 days. ECY staff then address any comments received and make corresponding changes and/or remove the “draft” status from the final ROE.

An approved application then receives a superseding permit for the change project. Once the applicant completes the change project and ECY completes a Proof Examination, a new certificate or claim is issued for the transferred right.

Water Right Transfers via Ecology (WA)				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Pre-application Consultation	Applicant	ECY	*N/A*[1]	*N/A*
Submit Application	Applicant	ECY	*N/A*	$50 plus $0.50 per 0.01 cfs plus $1 per ac-ft. (max. $12,500)
Publish legal notice and submit affidavit	Applicant	Local newspaper; ECY	14 days from ECY notification; 30-day public comment period	Applicant's expense
Application Review	ECY	*N/A*	*N/A*	*N/A*
Submit Report of Examination	Applicant	ECY	30 days	*N/A*
Circulate Report of Examination	ECY	*N/A*	30 days	*N/A*
Change approval and issuance of superseding permit	ECY	*N/A*	30-day appeal period	*N/A*
Complete change project	Applicant	*N/A*	3 years	*N/A*
Proof Examination	ECY	*N/A*	Immediately following change notification	*N/A*
Issuance of new certificate	ECY	*N/A*	Immediate	*N/A*

Transfers via Water Conservancy Boards
Statutory Authority: RCW 90.80.070 to 90.80.100

Applications for water right transfers may also be submitted to a local water conservancy board where they exist. Although final approval for transfer under this process remains under the authority of ECY, this process was instituted to streamline review and comment periods by delegating authority for public comment and draft decision-making to the local conservancy board authority, thereby removing any initial waiting period due to processing backlogs.

[1] No agent, well-defined action deadline, or applicability

Once an application has been submitted, the conservancy board may choose whether or not to accept review of the application; if the application is rejected, the applicant must reapply directly with ECY. Following the board's review of the application (on the criteria of validity, injury, enlargement, and public interest) and public feedback, the board may choose to hold a public hearing on the transfer. The conservancy board will then hold an approval vote, and a majority approval decision is then submitted to ECY for final approval.

Following the board vote, the final steps for completing are the same as the standard process described above: the applicant receives a superseding permit for the change from ECY, completes the transfer project, then receives the newly issued certificate or claim.

A similar process for transfers is utilized in the Yakima River Basin under the guidance of the Water Transfer Working Group, a voluntary technical committee composed of basin stakeholders and water managers. A detailed framework and description of Yakima Basin transfers is being developed through a related effort and will be appended to this document.

Water Conservancy Board Transfers				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Application submission	Applicant	Water conservancy board	*N/A*	Subject to individual water conservancy board rules
Application acceptance	Water conservancy board	Applicant	*N/A*	*N/A*
Deliberation	Water conservancy board	Public	Subject to conservancy board rules	Water conservancy board's expense
Vote	Water conservancy board	*N/A*	*N/A*	*N/A*
Submit record of decision	Water conservancy board	ECY	30 day comment period	*N/A*
Approval and publication of final Report of Examination	ECY	Public	30 days	*N/A*
Complete change project	Applicant	*N/A*	3 years	*N/A*
Proof Examination	ECY	Applicant	Immediately following change notification	*N/A*
Issuance of new certificate	ECY	Applicant	Immediate	*N/A*

Trust Water Rights Program
Statutory Authority: 90.38.040, 90.42.110 to 90.42.130, 90.03.380

The Trust Water Rights Program (TWRP) in Washington is authorized to function as water banking authority. In this program, water rights are acquired by ECY through purchase or lease under the transfer process described above (90.03.380) to supplement instream flows and are protected from relinquishment or cancellation for the term of the lease. Additionally, the application must "identify reasonably foreseeable future temporary or permanent beneficial uses" for the water right if it is transferred by ECY to a third party. Each right acquired by ECY is issued a new certificate

Leased water may then be sublet by ECY to applicants seeking water rights on a temporary basis provided the transfer does not violate the lease agreement between the original water right holder and ECY and fulfills a beneficial use identified by the original water right holder at the time of

the initial TWRP lease. Third-party leases executed through the TWRP retain their original priority date prior to initial transfer into the trust.

The department is required to publicize proposed water banking activities through TWRP to pertinent governments (federal, local, and tribal), conservation groups, agricultural organizations, developers, and other pertinent local entities. ECY decisions to transfer leased TWRP water may be appealed to the pollution control hearings board or a superior court.

Note that water rights may be submitted to the TWRP as either a lease/purchase or an uncompensated donation. However, donated are accepted automatically and do not receive departmental review for extent and validity and are therefore ineligible for transfer to a third party.

IDAHO
Water Right Transfers
Statutory Authority: Idaho Code 42-222, 42-222A, 42-248

Water right transfers in Idaho are regulated by the Department of Water Resources (IDWR). No distinction is made in the transfer process between permanent and temporary transfers.

Following the initial submission of the application, the applicant must give public notice of the proposed change in a local newspaper. Comments and statements of protest from third parties must be received by IDWR within ten days of the final publication of notice. Applications are then evaluated by the department on the criteria of transfer authority, water right validity, enlargement of use, local public interest, reasonable standards of diversion efficiency, and any impacts on the local agricultural base and/or economy.

Once the evaluation is complete, IDWR staff then prepare a draft memorandum of the decision and issue an approval decision, which the applicant may contest. IDWR must then give public notice of the decision. If the transfer has been approved and there is no substantive opposition or appeal justifying a hearing, IDWR then issues an approval permit for the change.

Following a declaration of drought by the governor, temporary change applications enter an expedited review process. The standard public comment period and publication of findings requirements are waived, and the IDWR director may immediately approve a proposed transfer if no information is available to demonstrate that it will injure existing water rights.

IDWR notably provides significant support tools for composing transfer applications through its website. Historical consumptive use data for irrigation rights is publicly available through the infrared satellite-monitoring tool METRIC, and pre-qualified transfer maps can be generated through IDWR water rights GIS tool.

For water right transfer examples in Idaho, see "Transfer Examples" under the Water Rights section of the IDWR website.[2]

[2] "Transfer Examples," *Idaho Department of Water Resources.* 12/9/19. https://idwr.idaho.gov/water-rights/transfers/examples.html

Idaho Water Right Transfers				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Application submission	Applicant	IDWR	*N/A*	Variable. minimum $225; graduated based on volume/rate
Initial processing	IDWR	*N/A*	*N/A*	
Public notice	IDWR	*N/A*	Public comment deadline 10 days after final publication	IDWR expense
Request for additional information	IDWR	Applicant	*N/A*	*N/A*
Administrative, hydrological, legal review	IDWR	*N/A*	*N/A*	*N/A*
Preparation of staff memorandum	IDWR	*N/A*	*N/A*	*N/A*
Approval	IDWR	*N/A*	*N/A*	*N/A*
Public notice of decision	IDWR	*N/A*	*N/A*	*N/A*
Issuance of approval document	IDWR	*N/A*	*N/A*	*N/A*

Water Supply Bank and Local Rental Pools
Statutory Authority: Idaho Code 42-1761 to 42-1766

The primary mechanism for marketing temporary water right transfers in Idaho is the statewide Water Supply Bank (WSB) and affiliated local water rental pools. The WSB solicits leases of existing water rights for deposit in the bank up to a maximum term of five years. Lessors to the WSB are required to forego entirely the use of that water right for the term of the lease even if the right remains unused by the bank to guarantee that rights cannot be simultaneously exercised by lessor and lessee. Proposed leases to the WSB are evaluated for validity, authority to transfer, compatibility with public interest, probability of/suitability for rental, and availability of WSB funds.

Water users seeking temporary water rights then apply annually to the WSB to rent water from the pool supply at a price set by the WSB board. Applications are assigned priority based on the date they are received. Further criteria for evaluating rental applications include injury to third-party rights, enlargement of use, availability of existing rental supplies, hydraulic connection to existing rental supplies, and local public interest.

The same minimum lease and rental processes apply to local rental pools as the WSB, although local pools may impose additional terms and conditions at their discretion. Local pools also set rental prices within their territory.

Applicants rent water from the WSB or local pools are also authorized to couple their application with that of a new supply lease. Provided the rental meets transfer requirements, the rental application receives priority for that supply lease. Coupled applications are also permitted to privately set the water rental price rather than use the price set by the WSB or local pool authority.

WSB Lease Acquisition				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Application submission	Applicant	WSB	Ongoing	$250-500
Review and request for additional information	WSB	*N/A*	Per negotiated terms	*N/A*
Approval	WSB Board	Applicant	*N/A*	*N/A*
Relinquishment of original appropriation	Applicant	*N/A*	*N/A*	*N/A*

WSB Rentals				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Application submission	Applicant	*N/A*	*N/A*	None
Priority assignment	WSB	*N/A*	Immediate	*N/A*
Processing, review, availability matching	WSB	*N/A*	Ongoing after irrigation season	*N/A*
Approval decision	WSB	Applicant	Due March 1	*N/A*
Late application submissions and processing	Applicant, WSB	*N/A*	Ongoing throughout irrigation season	*N/A*

OREGON

Permanent Water Right Transfers

Statutory Authority: ORS 540.510 to 540.585

Water right transfers in Oregon are regulated by the Water Resources Department (OWRD). Permanent water right transfers provide the standard process for transfers within the state.

Following the submission of a transfer application, OWRD publishes notice of the proposed transfer in its weekly bulletin, initiating a 30-day public comment period. Following an initial review, OWRD returns the application to the applicant with a draft preliminary determination. The applicant then has 30 days to update the application address any issues and concerns raised. OWRD then publishes the preliminary determination in its weekly bulletin and circulates it to any commenters, and any protests of the determination must be filed within 30 days of the final publication date of the preliminary determination. If no substantive protest is presented, OWRD issues a final transfer order as well as a notice of cancellation of any appurtenant supplemental rights. Once the change has been completed, a proposed certificate is issued. The applicant then has 60 days request a reconsideration of certificate contents. Otherwise, a final certificate is issued for the new right.

Permanent Water Right Transfers (OR)				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Application submission	Applicant	OWRD	*N/A*	Variable; base fee $1160
Public notice	OWRD	Public	30-day comment period	OWRD expense
Posting of preliminary determination	OWRD	Applicant, public	30-day protest period	*N/A*
Issuance of proposed certificate	OWRD	Applicant	60 days	*N/A*
Issuance of new certificate	OWRD	Applicant	*N/A*	*N/A*

Temporary Water Right Transfers

Statutory Authority: ORS 540.523

The primary difference between temporary and permanent transfer processes in Oregon is the waiver of the certification by a certified water right examiner (CWRE) for transfer application maps. However, these transfers are limited to a maximum term of five years, and transfer authorization remains subject to cancellation if evidence of injury to third-party water rights is demonstrated to OWRD.

The temporary transfer process is further streamlined following the governor's declaration of drought by eliminating public notice and comment period requirements.

Temporary Water Right Transfers – Drought (OR)				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Application submission	Applicant	OWRD	*N/A*	Variable; base fee $1160
Posting of preliminary determination	OWRD	Public	ASAP	*N/A*
Issuance of permit	OWRD	Applicant	ASAP	*N/A*

To view water right transfer data in Oregon, see the OWRD Transfer Information Query tool.[3]

Intradistrict Water Transfers
Statutory Authority: ORS 540.570 to 540.585

Oregon statute provides a mechanism for water users to transfer water rights within the geographic boundaries of an irrigation district through a simplified process. Applicants submit transfer applications to the district for review, not OWRD. The district then publishes the proposed transfer to all potentially affected landowners and, if approved, submits the petition for change to OWRD. Approval requires written permission from all affected landowners. Provided that the proposed transfer is statutorily compliant and does not enlarge either the use or irrigated acreage of the right, petitions receive expedited approval.

[3] "Transfers Information Query," *Oregon Water Resources Department.* 12/9/19. https://apps.wrd.state.or.us/apps/wr/wrinfo/wr_query_transfer.aspx?name_last=&name_company=

Intradistrict Water Transfers (OR)				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee**
Request submission	Applicant	District	*N/A*	Per district rules
District notice	District	Affected landowners	*N/A*	*N/A*
District review of request	District		*N/A*	*N/A*
Transfer Petition	District	OWRD	Per district rules	*N/A*
Public notice	OWRD	Public	30 days	OWRD expense
Permit approval	OWRD	District, Applicant	*N/A*	*N/A*

COLORADO
Water Court Transfers
Statutory Authority: CRS 37-92-302

The Colorado Water Courts are the primary mechanism for evaluating water right changes and transfers in the state. There is no distinct process or expedited procedure for temporary transfers within the water court framework.

Applicants seeking to transfer a water right file a change application with the water clerk for their regional water court decision and file a "resume" description of the proposed change for publication in the court notice. Following submission, the applicant must notify all potentially affected landowners of the proposed change within 14 days and publish the transfer resume in a local newspaper. The division water judge then assigns the application to a water referee for review and evaluation. The water referee then consults with an engineer from the Department of Water Resources (CDWR), who then has 35 days to submit a technical evaluation of the proposed transfer.

Concurrently, third parties may file statements of opposition with the water referee for two months following the final publication of the proposed transfer. Following the public comment period, the water referee has 63 days to deliver a determination, but may also extend the review period for another 63 days if needed. If no statements of opposition have been filed, the applicant then files a proposed ruling and decree to the water referee for review. If approved, a certificate is issued for the new water right.

If statements of opposition *have* been filed and the water referee concludes they bear substantive claims, the proposed change is then referred back to the water judge for court proceedings.

To view water right transaction data from water court decisions, see the CDWR Water Right – Transactions page in the Colorado Information Marketplace.[4] For an example decree, see *Concerning the Application for Water Rights of the City of Trinidad.*[5]

[4] "DWR Water Right – Transactions," *Colorado Information Marketplace.* 12/9/19. https://data.colorado.gov/Water/DWR-Water-Right-Transactions/i55n-9sba/data
[5] "Concerning the Application for Water Rights of the City of Trinidad," *Colorado Department of Natural Resources.* 12/9/19. https://dnrweblink.state.co.us/dwr/DocView.aspx?id=1925242

Water Court Transfers (CO)				
Task	**Responsible Party**	**To Whom**	**Action Deadline**	**Fee/Cost**
Application submission	Applicant	*N/A*	*N/A*	*N/A*
Public notice	Applicant	Affected landowners, water clerk, local newspaper	14 days from application submission	*N/A*
Opposition statement filing period	Anyone	Water clerk	Two months	*N/A*
Review	Water referee	*N/A*	*N/A*	*N/A*
Engineer's report	CDWR	*N/A*	35 days from referral	*N/A*
Ruling	Water referee	*N/A*	63 days from close of opposition statement filing	*N/A*
Submission and approval of final ruling	Applicant, water referee	*N/A*	*N/A*	*N/A*

Interruptible Water Supply Agreements
Statutory Authority: CRS 37-92-309

Following the publication of the Statewide Water Supply Initiative (SWSI) in 2002, water planners and legislators began developing tools to support the Alternative Agricultural Transfer Methods (ATMs) program with the specific goal of promoting mechanisms for transferring agricultural water to new uses without resulting in permanent land fallowing. One of the most significant of these ATM programs is the Interruptible Water Supply Agreement (IWSA), which was given statutory authority in 2003. Although the IWSA has not been regularly employed since their creation, it is currently the basis for the Catlin Ditch rotational fallowing project in the Lower Arkansas Basin.

IWSAs function as option transfer agreements. Contracting parties submit an IWSA proposal to CDWR as well as written notice to the correlated notification subscriber list maintained by the department. The applicant must then submit a written technical report (prepared by a professional engineer or other authorized specialist) to CDWR that includes evaluations of historical consumptive use, return flow dynamics, potential for third-party injury, and any necessary conditions to prevent injury. Following a 35-day public comment period (and a

hearing, if deemed necessary by the state engineer), CDWR may immediately issue a final determination.

Once an IWSA has been approved, the applicant must notify all affiliated and commenting parties of their intention to exercise the use option for a given year by March 1. Additionally, no right (or parcel) option can be exercised more than three times in any ten-year period. However, in the case of rotational fallowing projects (such as Catlin Ditch), options may be assigned to individual land parcels to allow a rotating subsection of options to be exercised annually. No water right or parcel may be included as a supply option for more than one IWSA. However, option holders may "stack" IWSA options in order to provide multiple alternate water supplies.

Substitute Water Supply Plans

Statutory Authority: CRS 37-92-308

Colorado law also provides some recourse for water right users to seek temporary change authorization from CDWR without a water court decree through Substitute Water Supply Plans provided a demonstrable need exists for the accelerated timeline.

If a transfer plan submitted to CDWR corresponds to an existing change application in the water court that has not yet received a decree, the applicant must provide notification of the proposed substitute plan to anyone who has filed a statement of opposition in the pending water court decision. CDWR then reviews the substitute plan proposal on the criteria of injury, mitigation of any out-of-priority impacts, water quality impact, and compliance with interstate compact obligations. Following a 30-day public comment period, CDWR may then approve the temporary change for a maximum term of one year. Following the expiration of the term, applicants may seek renewal of existing temporary changes for additional one-year terms up to a total five years.

If a transfer plan submitted to CDWR *does not* correspond to an existing change application in the water court, public notice must be given to *all* potentially affected landowners. The process is otherwise the same as above.

If a plan submitted to CDWR constitutes a response to an emergency situation (such as extreme drought), no notice or comment period is required. However, temporary changes so approved have a maximum term of only 91 days.

PROCESS COMPARISON

Water Right Transfers

Water right transfer mechanisms are generally similar in Washington, Oregon, and Idaho. All three require similar standards of documentation supporting authorization for the applicant to alter an existing right, and all three applications initiate departmental review of the right for validity, potential injury, and potential enlargement of use.

Idaho, however, also requires an evaluation of potential external effects on communities and local economies, and furthermore requires that the applying individual or entity be a resident within the state. Meanwhile, Oregon allows a lower standard of proof of non-injury for

temporary transfers: all three states generally require applicants to demonstrate (with supporting documentation) that transfers *will not* result in injury, but temporary transfers in Oregon only require documentation that no evidence exists to indicate potential for injury.

All three states maintain some requirement of certified water right examiner (CWRE) preparation of transfer maps. However, Oregon allows this requirement to be waived for temporary transfers. In Idaho, the extent of recent adjudications and availability of IDWR-sanctioned mapping and monitoring resources allows applicants to generate maps without consulting a CWRE but may impose this requirement during review if the initial map is deficient.

The water court system in Colorado provides a substantial contrast to the other three states. The extent of review, notice, and comment periods is initially greater than in the other states, even for short-term transfers. Moreover, all of these periods may be extended at the discretion of water court officials.

Water Exchanges

The Washington TWRP and Idaho WSB perform similar functions of brokering temporary transfers by leasing existing rights and providing protection from relinquishment for instream flow use. However, the TWRP operates on a case-by-case demand basis via the existing ECY transfer process, whereas the WSB operates an active annual market for single-season rentals.

The IWSA system in Colorado is superficially similar but operates on the basis of option leasing without a centralized brokerage; as a result, the original water right holder may continue to exercise their right during irrigation seasons when the option has not been exercised. IWSAs and substitute water supply agreements are primarily a mechanism to minimize exposure to water court processes for high-priority transfer alternatives to “buy-and-dry” purchases.

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WASHINGTON STATUTES	
STATUTE	**DESCRIPTION**
90.03.250	Appropriation procedure—Application for permit—Temporary permit.
90.03.255	Applications for water right, transfer, or change—Consideration of water impoundment or other resource management technique.
90.03.260	Appropriation procedure—Application—Contents.
90.03.265	Appropriation procedure—Cost-reimbursement agreement for expedited review of application—Adoption of rules.
90.03.270	Appropriation procedure—Record of application.
90.03.280	Appropriation procedure—Notice.
90.03.290	Appropriation procedure—Department to investigate—Preliminary permit—Findings and action on application.
90.03.300	Appropriation procedure—Diversion of water for out-of-state use—Reciprocity.
90.03.310	Appropriation procedure—Assignability of permit or application.
90.03.320	Appropriation procedure—Construction work.
90.03.330	Appropriation procedure—Water right certificate.
90.03.340	Appropriation procedure—Effective date of water right.
90.03.345	Establishment of reservations of water for certain purposes and minimum flows or levels as constituting appropriations with priority dates.
90.03.370	Reservoir permits—Secondary permits—Expedited processing—Underground artificial storage and recovery project standards and rules—Exemptions—Report to the legislature.
90.03.380	Right to water attaches to land—Transfer or change in point of diversion—Transfer of rights from one district to another—Priority of water rights applications—Exemption for small irrigation impoundments—Electronic notice of an application for an interbasin water rights transfer.
90.03.383	Interties—Findings—Definitions—Review and approval.
90.03.386	Coordination of approval procedures for compliance and consistency with approved water system plan.
90.03.390	Temporary changes—Emergency interties—Rotation in use.
90.03.395	Change of point of diversion to downstream intake structure—Intent.
90.03.397	Department may approve change of the point of diversion prescribed in a permit to appropriate surface water—Requirements.

90.03.470	Schedule of fees.
90.03.471	Disposition of fees.
90.03.570	Change or transfer of an unperfected surface water right for municipal water supply purposes.
90.03.615	Calculating annual consumptive quantity.
90.03.655	Expedited processing of applications—On department's own volition—Notice—Fees.
90.03.660	Expedited processing of applications—Notice to tribal governments.
90.03.665	Certified water right examiners—Fees—Rules.
90.14.010	Purpose.
90.14.020	Legislative declaration.
90.14.031	Definitions.
90.14.041	Claim of right to withdraw, divert or use ground or surface waters—Filing statement of claim required—Exemptions.
90.14.043	Claim of right to withdraw, divert or use ground or surface waters—Claim upon certification by board—Procedure—Cut-off date for accepting petitions.
90.14.044	Existing water rights not impaired.
90.14.051	Statement of claim—Contents—Short form.
90.14.061	Statement of claim—Filing procedure—Processing of claim—Fee.
90.14.065	Statement of claim—Amendment—Surface water right claim change or transfer—Review of department of ecology's determination.
90.14.068	Statement of claim—New filing period.
90.14.071	Failure to file claim waives and relinquishes right.
90.14.081	Filing of claim not deemed adjudication of right—Prima facie evidence.
90.14.091	Definitions—Water rights notice—Form.
90.14.101	Notice of chapter provisions—How given—Requirements.
90.14.111	Water rights claims registry.
90.14.121	Penalty for overstating claim.
90.14.130	Reversion of rights to state due to nonuse—Notice by order—Relinquishment determinations—Appeal.
90.14.140	"Sufficient cause" for nonuse defined—Rights exempted.
90.14.150	Rights arising from permit to withdraw public waters not affected—Extensions.
90.14.160	Relinquishment of right for abandonment or failure to beneficially use without sufficient cause—Prior rights acquired through appropriation, custom or general adjudication.

90.14.170	Relinquishment of right for abandonment or failure to beneficially use without sufficient cause—Rights acquired due to ownership of land abutting stream, lake, or watercourse.
90.14.180	Relinquishment of right for abandonment or failure to beneficially use without sufficient cause—Future rights acquired through appropriation.
90.14.190	Water resources decisions—Appeals—Attorneys' fees.
90.14.200	Implementation and enforcement of chapter—Proceedings under RCW 90.14.130 deemed adjudicative—Application of RCW sections to specific proceedings.
90.14.210	Chapter applies to all rights to withdraw groundwaters.
90.14.215	Chapter not applicable to trust water rights under chapter 90.38 or 90.42 RCW.
90.14.220	No rights to be acquired by prescription or adverse use.
90.14.230	Rules and regulations.
90.14.240	Water rights tracking system account.
90.14.900	Effective date—1967 c 233.
90.14.910	Severability—1967 c 233.
90.38.005	Findings—Purpose.
90.38.010	Definitions.
90.38.020	Acquisition or donation of trust water rights.
90.38.030	Water conservation projects—Contracts for financial assistance.
90.38.040	Trust water rights program.
90.38.050	Rules.
90.38.060	Integrated water resource management plan.
90.38.070	Yakima integrated plan implementation account.
90.38.080	Yakima integrated plan implementation taxable bond account.
90.38.090	Yakima integrated plan implementation revenue recovery account.
90.38.100	Report to the legislature and governor.
90.38.110	Construction of a water supply project—Prior review by the state of Washington water research center.
90.38.120	Legislative intent—Cost to implement the integrated plan.
90.38.130	Authorization to purchase land—Management and disposal of land.
90.38.900	Existing policies not replaced.
90.38.901	Transfer of rights between irrigation districts not intended.
90.38.902	Existing rights not impaired.
90.42.005	Policy—Findings
90.42.10	Findings—Intent

90.42.20	Definitions
90.42.30	Contracts to finance water conservation projects—Public benefits—Trust water rights
90.42.40	Trust water rights program—Water right certificate—Notice of creation or modification
90.42.50	Guidelines governing trust water rights—Submission of guidelines to joint select committee
90.42.60	Chapter 43.83B RCW or RCW 43.83.340 not replaced or amended
90.42.70	Involuntary impairment of existing water rights not authorized
90.42.80	Trust water rights—Acquisition, donation, exercise, and transfer—Appropriation required for expenditure of funds
90.42.90	Jurisdictional authorities not altered
90.42.100	Water banking
90.42.110	Water banking—Application to transfer water rights
90.42.120	Water banking—Transfer of water rights—Requirements—Appeals
90.42.130	Water banking—Input from affected entities
90.42.135	Limitations of act—2003 c 144
90.42.138	Construction—2003 c 144
90.42.150	Recovery of department's costs associated with water service contracts with federal agencies
90.42.160	Adoption of rules
90.42.170	Water banking—Department must maintain information on its web site
90.80.005	Findings.
90.80.010	Definitions.
90.80.020	Water conservancy boards—Creation.
90.80.030	Petition for board creation—Required information—Approval or denial—Description of training requirements.
90.80.035	Water conservancy boards for water resource inventory areas—Multicounty water conservancy boards—Petition for creation.
90.80.040	Rules—Minimum training requirements and continuing education.
90.80.050	Corporate powers—Board composition—Members' terms, expenses—Alternates—Eligibility to be appointed.
90.80.055	Additional board powers.
90.80.057	Quorum.
90.80.060	Board powers—Funding.

90.80.065	Dissolution of board.
90.80.070	Applications for water transfers—Notice—Record of decision—Review—Alternate serving as commissioner.
90.80.080	Records of decision—Transmittal to department and others—Internet posting—Review.
90.80.090	Appeals from director's decisions.
90.80.100	Damages arising from records of decisions on transfers—Immunity.
90.80.110	Approval of interties.
90.80.120	Conflicts of interest.
90.80.130	Application of open public meetings act.
90.80.135	Application of public records act.
90.80.140	Transfers approved under chapter 90.03 or 90.44 RCW not affected.
90.80.150	Information required to be maintained on the department's web site.
90.92.010	Findings.
90.92.020	Definitions.
90.92.030	Establishing a water management board.
90.92.040	Composition of board—Members' terms—Policy advisory group—Conflicts of interest.
90.92.050	Board's authorities, duties, and responsibilities.
90.92.060	Report to the legislature.
90.92.070	Water banking.
90.92.080	Local water plan—Board to adopt guidelines and criteria for filing, review, and approval—Annual reports—Term.
90.92.090	Local water plan—Public notice period—Other requirements.
90.92.100	Appeal—Review of a claim of impairment.
90.92.110	Local water plan—Expiration—Making elements of the local water plan permanent.
90.92.120	Local water plan—Status of water rights.
90.92.130	Location of pilot program.

IDAHO STATUTES	
STATUTE	**DESCRIPTION**
42-101	Nature of property in water.
42-108	Change in point of diversion, place of use, period of use, or nature of use — application of act.
42-108B	Leasing of water under established rights — notice — appeal.
42-202	Application to appropriate water — contents — filing fees — disposition of fees — record of receipts.
42-202A	Temporary approval — application — criteria — exceptions.
42-203A	Notice upon receipt of application — protest — hearing and findings — appeals.
42-206	Residence a requisite for issuance.
42-207	Sale, transfer, assignment or mortgage of permit.
42-219	Issuance of license — priority.
42-220	Effect of license.
42-221	Fees of department.
42-222	Change in point of diversion, place of use, period of use, or nature of use of water under established rights — forfeiture and extension — appeals.
42-222A	Temporary changes during drought conditions.
42-223	Exceptions or defenses to forfeiture.
42-240	Application for right to exchange water — filing fee — notice — protest — hearing — approval or denial — appeal.
42-248	Notification of change in ownership of a water right or change of address of a water right owner — notice of action affecting a water right.
42-1425	Accomplished transfers
42-1761	Water supply bank created
42-1762	Rules and regulations — acquisition of water rights.
42-1763	Rentals from bank — approval by director.
42-1763B	Interim authority for rental of water to augment flows for listed anadromous fish.
42-1764	Substitution for transfer proceeding — rights not subject to forfeiture — no dedication of rights.
42-1765	Local committees — rental of stored water — apportionment of rental proceeds.
42-1765A	Lemhi river basin — local rental committee
42-1766	Appeals procedure for water right holders.

42-1767	Approval of projects — authority of water users to contract with board — authorizing the board's acquisition of interest in projects.

IDAHO ADMINISTRATIVE CODE		
Water Supply Bank		
Section	Rule	DESCRIPTION
37.02.03	0	LEGAL AUTHORITY (RULE 0)
37.02.04	1	TITLE AND SCOPE (RULE 1)
37.02.05	2	WRITTEN INTERPRETATIONS (RULE 2)
37.02.06	4	INCORPORATION BY REFERENCE (RULE 4)
37.02.07	5	OFFICE – OFFICE HOURS – MAILING ADDRESS -- STREET ADDRESS -- WEBSITE (RULE 5)
37.02.08	6	PUBLIC RECORDS ACT COMPLIANCE (RULE 6)
37.02.09	10	DEFINITIONS (RULE 10)
37.02.10	25	ACQUISITION OF WATER RIGHTS FOR THE BOARD'S WATER SUPPLY BANK (RULE 25)
37.02.11	30	SALE OR RENTAL OF WATER RIGHTS FROM THE BOARD'S WATER SUPPLY BANK (RULE 30)
37.02.12	35	HANDLING OF MONEY ASSOCIATED WITH THE BOARD'S WATER SUPPLY BANK (RULE 35)
37.02.13	40	APPOINTMENT OF LOCAL RENTAL POOL COMMITTEES (RULE 40)

OREGON STATUTES	
STATUTE	**DESCRIPTION**
§ 540.505	Definitions
§ 540.510	Appurtenancy of water to premises
§ 540.520	Application for change of use, place of use or point of diversion
§ 540.523	Temporary transfer of water right or permit
§ 540.524	Substitution of supplemental water right from ground water source for primary water right from surface water source
§ 540.525	Installation of fish screening or by-pass device as prerequisite for transfer of point of diversion
§ 540.530	Order authorizing change of use, place of use or point of diversion
§ 540.531	Transfer of surface water point of diversion to ground water
§ 540.532	Request for change in point of diversion to reflect historical use
§ 540.533	Application for exchange of water
§ 540.535	Notice of application for exchange
§ 540.537	Order allowing exchange
§ 540.539	Exchange subject to beneficial use requirements
§ 540.541	Delivery and use of water under exchange
§ 540.543	Regulation of headgates when water provided by exchange
§ 540.545	Transfer of water rights following county acquisition of land
§ 540.560	Order changing description of land to which water right is appurtenant
§ 540.570	Temporary transfers within districts
§ 540.572	Application of certificated water elsewhere within district
§ 540.574	Petition for approval of transfer
§ 540.576	Notice of petition
§ 540.578	Filing of protest
§ 540.580	Permanent transfer of place of use of water within district
§ 540.585	Temporary transfers within Deschutes River Basin
§ 540.587	Report on implementation of temporary transfer provisions
§ 540.589	Ratification of prior transfer of water rights to irrigation district

OREGON ADMINISTRATIVE RULES	
Rule	Description
690-019-0010	Purpose of Rules
690-019-0020	Definitions
690-019-0030	Duration of Drought Declaration
690-019-0040	Emergency Water Use Permit
690-019-0050	Incomplete Applications
690-019-0055	Temporary Drought Transfers
690-019-0058	Temporary Drought Instream Leases
690-019-0059	Temporary Substitution of Supplemental Ground Water Right for Surface Water Primary Right
690-019-0060	Potential Liability
690-019-0070	Preference of Use, Human Consumption and Livestock
690-019-0080	Option or Agreement for Use of Existing Right
690-019-0085	Renewal Process for Drought Water Use Authorizations
690-019-0090	Requirement for Conservation and Curtailment Plans
690-019-0100	Schedule of Fees
690-019-0105	Fee Refund
690-380-0010	Purpose
690-380-0090	Applicability
690-380-0100	Definitions
690-380-2000	Types of Permanent Transfers
690-380-2110	Change in Point of Diversion or Point of Appropriation
690-380-2120	Change in Point of Diversion to Reflect Historical Use
690-380-2130	Change from a Surface Water Point of Diversion to a Ground Water Appropriation
690-380-2200	Changes in Place of Use
690-380-2240	Layered Water Rights and Certificates of Registration
690-380-2250	Transfer of Supplemental Water Right or Permit
690-380-2260	Exchanges of Water
690-380-2300	Changes in Character of Use
690-380-2320	Transfer from Supplemental Use to Primary Use
690-380-2330	Substitution of Supplemental Ground Water Right for Primary Surface Water Right
690-380-2340	Specific-to-General Industrial Water Use Change
690-380-2410	Municipal Water Rights

690-380-2420	Notice of Merger, Consolidation or Formation of a Water Authority
690-380-2430	Acquisition of Water Rights by a Water Authority
690-380-3000	Application for Transfer
690-380-3050	Additional Application Requirements
690-380-3100	Map Requirements
690-380-3200	District May Submit Application for Water Users
690-380-3220	Separate Application Required for Each Water Right
690-380-3400	Waiver of Fees
690-380-3410	Waiver of Mapping Requirements
690-380-4000	Request for Comments
690-380-4010	Preliminary Determination
690-380-4020	Notice of Preliminary Determination
690-380-4030	Protests and Requests for Hearings
690-380-4200	Hearings
690-380-5000	Approval of Transfers
690-380-5030	Approval of Injurious Transfers
690-380-5040	Affidavits of Consent
690-380-5050	Consent to Injury of Instream Water Rights
690-380-5060	Fish Screening and By-Pass Devices
690-380-5100	Compatibility with Acknowledged Comprehensive Plans
690-380-5110	Original Right Terminated
690-380-5120	Multiple Primary Water Rights on the Same Lands
690-380-5130	Assignment or Change of Ownership
690-380-5140	Time for Completion
690-380-6010	Failure to Complete a Transfer as Grounds for Cancellation
690-380-6020	Extension of Time
690-380-6030	Proof Of Use; Noncompliance
690-380-6040	Proof of Completion of Change
690-380-6050	Waiver of Proof of Completion
690-380-6060	Petition for Reconsideration
690-380-8000	Temporary Transfers
690-380-8002	Temporary Transfer Applications under OAR 690-380-8000(1)
690-380-8004	Temporary Transfer Applications under OAR 690-380-8000(2)
690-380-8010	Seasonal Use
690-380-8020	Supplemental Water Rights
690-380-9000	Clarification of Water Rights
690-385-0010	Purpose

690-385-0100	Definitions
690-385-2000	Standard Requirements for Application for Transfer
690-385-2200	Standard Map Requirements
690-385-3000	District Temporary Transfer Criteria Renumbered from 690-021-0020
690-385-3100	Types of District Temporary Transfers
690-385-3110	Temporary Change in Place of Use
690-385-3120	Temporary Change in Type of Use of a Water Right to Store Water
690-385-3130	Temporary Change in Type of Use from a Primary Right to a Supplemental Right
690-385-3140	Temporary Change in Point of Diversion or Appropriation
690-385-3145	Temporary Change in Point of Diversion in Response to an Emergency
690-385-3150	Temporary Change from Surface Water Point of Diversion to Ground Water Appropriation
690-385-3200	District Temporary Transfer Applications
690-385-3300	District Temporary Transfer Application Map Requirements
690-385-3400	District Temporary Transfer Application Notice and Review
690-385-3500	District Temporary Transfer Approval and Final Orders
690-385-3520	Fish Screening Devices
690-385-3600	Appeal of a Final Order Approving a District Temporary Transfer
690-385-4000	District Permanent Transfer Criteria
690-385-4100	Notice of District Permanent Transfer
690-385-4200	District Permanent Transfer Applications
690-385-4300	District Permanent Transfer Application Map Requirements
690-385-4400	District Permanent Transfer Application Notice and Review
690-385-4500	District Permanent Transfer Approval and Final Orders
690-385-4580	Original Right Terminated by Final Order
690-385-4600	Protests and Requests for Hearings
690-385-4700	Hearings
690-385-5000	District Permanent Transfer of Water Right for Nonuse Criteria
690-385-5100	Notice of Nonuse of Water Right and Intent to Transfer Pursuant to ORS 540.572
690-385-5200	District Permanent Transfer of Water Right for Nonuse Applications
690-385-5300	District Permanent Transfer of Water Right for Nonuse Application Map Requirements
690-385-5400	Notice of Filing District Permanent Transfer of Water Right for Nonuse Application

690-385-5500	District Permanent Transfer of Water Right for Nonuse Application Notice and Review
690-385-5600	District Permanent Transfer of Water Right for Nonuse Approval and Final Orders
690-385-5680	Original Right Terminated by Final Order
690-385-5700	Protests and Requests for Hearings
690-385-5800	Hearings
690-385-5900	Time Period to Process Permanent Transfer Application Exempt from Forfeiture
690-385-6000	Miscellaneous Provisions: Multiple Primary Water Rights on the Same Lands
690-385-7000	Completion and Perfection of Transferred Rights: Time for Completion
690-385-7100	Completion and Perfection of Transferred Rights: Failure to Complete a Transfer as Grounds for Cancellation
690-385-7200	Completion and Perfection of Transferred Rights: Extension of the Time Limits
690-385-7400	Completion and Perfection of Transferred Rights: Proof of Use; Noncompliance
690-385-7600	Completion and Perfection of Transferred Rights: Proof of Completion of Change
690-385-7800	Completion and Perfection of Transferred Rights: Request for Reconsideration
690-505-0000	Upper Deschutes Basin
690-505-0010	Middle Deschutes River Basin
690-505-0020	Lower Deschutes River Basin
690-505-0030	Upper Crooked River Basin
690-505-0040	Lower Crooked River Basin
690-505-0050	Lower Main Stem Deschutes River
690-505-0400	Ground Water Classification
690-505-0500	Ground Water Appropriations within the Deschutes Ground Water Study Area
690-505-0600	Deschutes Basin Groundwater Mitigation Rules: Purpose and Applicability of Ground Water Mitigation Rules
690-505-0605	Deschutes Basin Groundwater Mitigation Rules: Definitions
690-505-0610	Deschutes Basin Groundwater Mitigation Rules: Mitigation Obligation and Mitigation Standards

690-505-0615	Deschutes Basin Groundwater Mitigation Rules: Notice of Mitigation Obligation
690-505-0620	Deschutes Basin Groundwater Mitigation Rules: Ground Water Permit and Final Order Conditions
690-505-0625	Deschutes Basin Groundwater Mitigation Rules: Municipal and Quasi-municipal Ground Water Permit Applications
690-505-0630	Deschutes Basin Groundwater Mitigation Rules: Additional Findings of Department When Mitigation is Provided

COLORADO	
STATUTE	**DESCRIPTION**
37-92-102	Legislative declaration - basic tenets of Colorado water law
37-92-103	Definitions
37-92-201	Water divisions
37-92-202	Division engineers
37-92-203	Water judges - jurisdiction
37-92-204	Water clerks - duties
37-92-301	Administration and distribution of waters
37-92-302	Applications for water rights or changes of such rights - plans for augmentation
37-92-303	Rulings by the referee
37-92-304	Proceedings by the water judge
37-92-305	Standards with respect to rulings of the referee and decisions of the water judge - definitions
37-92-306	Priorities junior to prior awards - when
37-92-306.1	Relation back of priority date
37-92-308	Substitute water supply plans - special procedures for review - water adjudication cash fund - legislative declaration - repeal
37-92-309	Interruptible water supply agreements - special review procedures - rules - water adjudication cash fund - legislative declaration - definitions
37-92-310	Colorado water rights protection act - short title - legislative declaration - limitation on actions

Colorado		
Colorado Administrative Code		
Section	Rule	Description
2 CCR 402-12	12.1	Title
3 CCR 402-12	12.2	Scope and Purpose.
4 CCR 402-12	12.3	Definitions
5 CCR 402-12	12.4	Delegation of Administration of Water Bank
6 CCR 402-12	12.5	Limitations on the Water Bank.
7 CCR 402-12	12.6	Procedures for Placing Water into the Water Bank.
8 CCR 402-12	12.7	Listing and Bidding Process.
9 CCR 402-12	12.8	Transactional Procedures.
10 CCR 402-12	12.9	Expedited Transaction Procedures for Certain Water Rights
11 CCR 402-12	12.1	Quantification Procedures for Water to be Released from the Bank.
12 CCR 402-12	12.11	Procedures for Delivering Water from Storage Facilities.
13 CCR 402-12	12.12	Reporting Requirements.
14 CCR 402-12	12.13	Water Bank Time Limitation.
15 CCR 402-12	12.15	Effective Dates.
2 CCR 402-15	15.1	Title
3 CCR 402-15	15.2	Authority
4 CCR 402-15	15.3	Scope and Purpose
5 CCR 402-15	15.4	Definitions
6 CCR 402-15	15.5	General Rules
7 CCR 402-15	15.6	Fees
8 CCR 402-15	15.7	Review and Approval Guidelines
9 CCR 402-15	15.8	Engineering Reports
10 CCR 402-15	15.9	Administration, Accounting, and Reporting
11 CCR 402-15	15.1	Variances
12 CCR 402-15	15.11	Severability
13 CCR 402-15	15.12	Revisions
14 CCR 402-15	15.13	Statement of Basis and Purpose Incorporated by Reference
15 CCR 402-15	15.14	Effective Date

Water Court Rules	
1	Appearances
2	Filing and Service Procedure
3	Applications for Water Rights
4	Amendments or Corrections
5	Withdrawal of Application or Other Pleading
6	Referral to Referee, Case Management, Rulings, and Decrees
7	Intervention
8	Briefs
9	Transfer of Conditional Water Right and Change of Address
10	Exhibits
11	Pre-Trial Procedure, Case management, Disclosure, and Simplification of Issues
12	Procedure Regarding Decennial Abandonment Lists

S2.2: GIS Database

The project team required a geospatial database to assist with water rights analysis and market simulations. Compilation of the "GIS database" was completed by staff from Jacobs Engineering. The document explains the process completed to compile the relevant data and associated appendices for updating/processing data.

Date: June 13, 2022
Project name: Yakima Basin Water Rights Geospatial Analysis
Project no: W3X78410

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Purpose

Trout Unlimited and the Kittitas Reclamation District requested a geographic information spatial (geospatial) database to use for water rights analyses and data evaluation to develop a Yakima Basin Smart Market strategy for a water market. Jacobs Engineering provided technical expertise and developed the database in coordination with project partners. The purpose of this technical memorandum is to describe: (1) the steps taken to develop the database; (2) data incorporated into the database; (3) an evaluation of the data; (4) and lessons learned.

This memo was created by Peter Barney, GIS Professional Associate for Jacobs Engineering Group, with input from staff from Trout Unlimited and ERA Economics.

Database Development

Spatial data were identified and downloaded from multiple sources to create a geodatabase (GDB). Data types gathered include water rights, hydrologic, land ownership, jurisdictional, water supply company, planted crop, soils, wetland , land use, and fish hatchery. Some data were readily available for download, others available upon request, and others created by GIS staff.

The goal was to compile all potential data to develop a robust database to meet TU and KRD needs. After compilation and initial database development, TU and KRD staff reviewed the data and provided input on further data manipulations/processing. The initial process was a review followed by a “clip” and removal of unnecessary portions of data or entire datasets. The specific processes to attain the final dataset will likely change as the original data providers change the available data (e.g., county parcel data may be reformatted) and/or mapping software is changed (e.g., ESRI ceases supporting older ArcMap versions).

Data Sources:

Geographic Water Information System (GWIS) data are provided as a GDB which will remain separate from the other data in order to preserve the relations between its spatial and tabular data. GWIS data is available for download from the Washington State Department of Ecology website (https://fortress.wa.gov/ecy/gispublic/DataDownload/wr/GWIS_Data/). A guide to the download and processing of the GWIS system are included in Appendices A and B.

Water Delivery Districts:

1. Benton Irrigation District data are provided via download from Benton County Geographic Information Systems., https://bentonco.maps.arcgis.com/apps/webappviewer/index.html?id=428dcedbce17467b841844e8908bf3e7, Accessed 2019.
2. Ellensburg Irrigation District data are provided by Kittitas Reclamation District 7/2019.
3. Kennewick Irrigation District data are provided via download from Kennewick Irrigation District https://www.kid.org/
4. Kittitas Irrigation District data are provided by Kittitas Reclamation District 11/2019.
5. Roza Irrigation District data are provided by Yakima County GIS, 10/2019. http://www.co.yakima.wa.us/gis
6. Sunnyside Valley Irrigation District data are provided via download from Sunnyside Valley Irrigation District. http://www.svid.org/projects.htm. Accessed 11/2019.
7. Yakima Tieton Irrigation District data are acquired directly from Yakima Tieton Irrigation District 11/2019. Justin Wies wies@ytid.net
8. Fish hatchery data are provided via download Pacific States Marine Fisheries Commission. Columbia Basin Fish Facilities. https://www.arcgis.com/home/item.html?id=2381a6f4edb2474e860950c38088c819. Accessed 11/2019.
9. Columbia River Instream Atlas data are acquired directly from WA Department of Fish and Wildlife 11/2019. Gombert, Dale W (DFW) <Dale.Gombert@dfw.wa.gov>
10. Land Use data are provided by via download from Washington Department of Ecology. State of Washington Department of Ecology GIS Data https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data. Accessed 11/2019.
11. Crop data are provided via download from Washington State Department of Agriculture Natural Resource Assessment Section. https://agr.wa.gov/departments/land-and-water/natural-resouces/agricultural-land-use. Accessed 11/2019.
12. Benton County parcel data are provided via download from Benton County. https://bentonco.maps.arcgis.com/apps/webappviewer/index.html?id=428dcedbce17467b841844e8908bf3e7. Accessed 11/2019.
13. Kittitas County parcel data are provided via download from Kittitas County. https://data-kitcogis.opendata.arcgis.com/datasets/tax-parcels/data?geometry=-120.813%2C47.146%2C-120.552%2C47.187. Accessed 11/2019.
14. Klickitat County parcel data are acquired directly from Klickitat County with permission. Kim Gleason - kimg@klickitatcounty.org

15. Yakima County parcel data are provided via download from Yakima County. Yakima County, WA – Open Data. https://gis-yakimacounty.opendata.arcgis.com/. Accessed 11/2019.
16. Public Land Survey Sections data are available via download from Washington Geospatial Open Data Portal. https://geo.wa.gov/datasets/ae861d2304da4d099e0f7841fcbfa860_7?geometry=-121.460%2C46.465%2C-119.374%2C46.795. Accessed 11/2019.
17. National Hydrology Data are available via download from USGS. https://www.usgs.gov/core-science-systems/ngp/national-hydrography. Accessed 11/2019.
18. Rivermile data are created in GIS.
19. Washington State Department of Ecology Dam location data are available via download. https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data. Accessed 11/2019.
20. WDFW Dam data are available via download from the Washington Department of Fish and Wildlife. https://data-wdfw.opendata.arcgis.com/. Accessed 2020.
21. Reservoir data are provided by Kittitas Reclamation District.
22. WA DNR Water Body and Water Course data are provided by Washington State Department of Natural Resources, Forest Practices Division. https://data-wadnr.opendata.arcgis.com/. Accessed 11/2019.
23. USGS WDFW River Miles data are provided via download from the Washington State Department of Ecology. https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data. Accesses 11/2019.
24. Stream Gages for Baseflow data are provided via download from the Washington State Department of Ecology. https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data. Accessed 11/2019.
25. Water Diversions ECY NHD data are provided via download from the Washington State Department of Ecology. https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data. Accessed 11/2019.
26. National Hydrology Data are provided via download from USGS. https://www.usgs.gov/core-science-systems/ngp/national-hydrography. Accessed 11/2019.
27. National Wetland Inventory Data are provided via download from US Fish and Wildlife Service. https://www.fws.gov/wetlands/data/Data-Download.html. Accessed 11/2019.
28. National Watershed Boundary Dataset are provided via download from the Washington State Department of Ecology. https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data. Accessed 11/2019.

29. Yakima adjudication subbasin boundaries are provided via download from the Washington State Department of Ecology. https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data. Accessed 1/2020.
30. SSURGO Soils data are provided via download from United States Department of Agriculture. https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. Accessed 1/2020.
31. County Boundaries are provided via download by U.S. Census Bureau. https://www.census.gov/geographies/mapping-files/time-series/geo/cartographic-boundary.html. Accessed 11/2019.
32. LiDAR data are provided by Washington Department of Natural Resources and Federal Emergency Planning Agency.

Database Update Process

Periodically, the spatial and tabular GIS data will need to updated. Database update timing will depend on the planned data use frequency. For example, if the database will be used only in drought years, then an annual update in late winter or early spring (when water conditions are known with more certainty) would be necessary. Parcel and crop GIS data should be downloaded directly from the source (see above) and swapped out with the existing data. GWIS data will be downloaded directly from the source (see above) and will require significant processing, detailed in Appendices A and B.

Data Review

Data were qualitatively evaluated for the general format, accessibility, usability (for specific analyses), quality/completeness, and the update schedule. The evaluation was kept qualitative and simple due to the amount and differences of data used.

Data category scores are one (1) through five (5). One is considered a low score and indicative of data with significant issues or concerns in that category. Five is a high score and indicative of data that lacks issues or concerns in that category. If data was no used for analytical purposes, then scores of N/A (not applicable) are listed. The categories scored are:

Format. Whether the data available in a geospatially compatible format or required processing to use in the database.

Accessibility. Whether the data is freely and readily available for public access.

Usability. Whether the data requires significant processing to use the information.

Completeness. Whether the data provides all the potentially needed information in one dataset or requires subsets.

Updating. Whether the data is frequently updated to reflect on-the-ground changes. For data that must be requested from an agency, a score of 1 will be assessed.

Data Source	Format	Accessibility	Usability	Completeness	Updating
1	5	5	5	3	3
2	5	1	5	5	1
3	5	1	5	5	1
4	5	1	5	5	1
5	5	1	5	5	1
6	5	5	5	5	3
7	5	1	5	5	1
8	5	5	5	5	4
9	5	1	5	5	1
10	5	5	5	5	2
11	5	5	4	5	3
12	5	5	5	5	5
13	5	5	5	5	5
14	5	1	5	5	1
15	5	5	5	5	3
16	5	5	4	5	5
17	5	5	3	5	4
18	n/a	n/a	n/a	n/a	n/a
19	5	5	5	4	3
20	5	5	5	4	Unknown

Data Source	Format	Accessibility	Usability	Completeness	Updating
21	5	1	5	4	1
22	5	5	5	5	Unknown
23	5	5	3	4	4
24	5	5	5	4	3
25	5	5	5	5	3
26	5	5	5	5	4
27	5	5	4	5	4
28	5	5	5	5	4
29	5	5	5	5	4
30	5	5	3	5	4
31	5	5	5	5	5
32	5	1	1	1	3

Lessons Learned

Data Downloads and Processing

A significant drawback of the GWIS for our use is the lack of ability to connect each Diversion Point to a list of owners in a single table. The Diversion Points must be queried one (or more) at a time in GIS to access tables of the Places of Use and water rights documents. The process is a bit painstaking and can easily become frustrating to even a GIS professional. To further complicate the procedure, GWIS data is updated frequently at frequent intervals which requires an arduous download and processing task to be performed in order to keep the system up to date.

Acquiring and maintaining up-to-date data is tedious. Data gathering will always be necessary to conduct this study, but there are some solutions which would alleviate the difficulties of the process.

As more the more data are hosted through ESRI ArcGIS Online on servers or in the cloud, data gathering becomes slightly easier. For some data layers, simply connecting to a hosted feature layer in ArcMap or in ArcGIS Pro is satisfactory. A benefit of this technique is the data will

automatically update whenever the source data is updated. One can save the time of periodic downloads. These data can be displayed, analyzed, and queried but not edited. For editing, a local copy must be exported, but the process is quicker that downloading directly from a website.

Another solution – for data not hosted in ArcGIS Online – is to create a contract with the agencies that provide the data. A preset data deliverable, either periodically or each time the data are updated, could further simplify the data acquisition process.

Finally, during the course of the project, it became apparent that much of the acquired data was not useful or necessary to the study. Much time would be saved by paring down the data list to just what is necessary to maintain or recreate the study.

Usability and Data Quality/Quantity

The resulting database was primarly used by Trout Unlimited's contractor, ERA Economics LLC, for water rights analyses.

Recommendations

This project was completed using ESRI ArcGIS Desktop software. ESRI has released a new GIS software, ArcGIS Pro, and will stop supporting ArcGIS Desktop in 2026. Because this project is expected to be an ongoing effort which will be handed over to the client, it will need to be moved over to ArcGIS Pro at some point.

Data needed for ongoing database use should be periodically reviewed for applicability. Data deemed "unnecessary" should be removed from the data update list.

Appendix A.

Guide to download and process a new set of GWIS data from the WA Dept. of Ecology

A. Download GWIS data

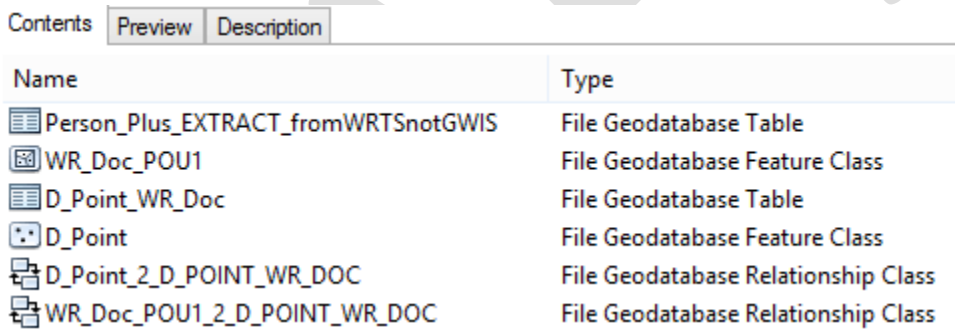
Go to: https://fortress.wa.gov/ecy/gispublic/DataDownload/wr/GWIS_Data/

Download the GWIS_SDEexport.zip

Archive a non-modified version of the data.

B. Clip the data to the Yakima Basin

1. **In ArcCatalog**, your downloaded data GDB should look like this:



   a. Create a new Relationship Class in the GDB to connect the POU feature class to the Person plus EXTRACT from WRTS not GWIS table. This will be necessary later in the procedure. See screenshots below.

   Name: WR_Doc_2_Person_Plus_EXTRACT

   Origin: WR_Doc_POU1

   Destination is Person_Plus_EXTRACT_fromWRTSnotGWIS

   Type: Simple

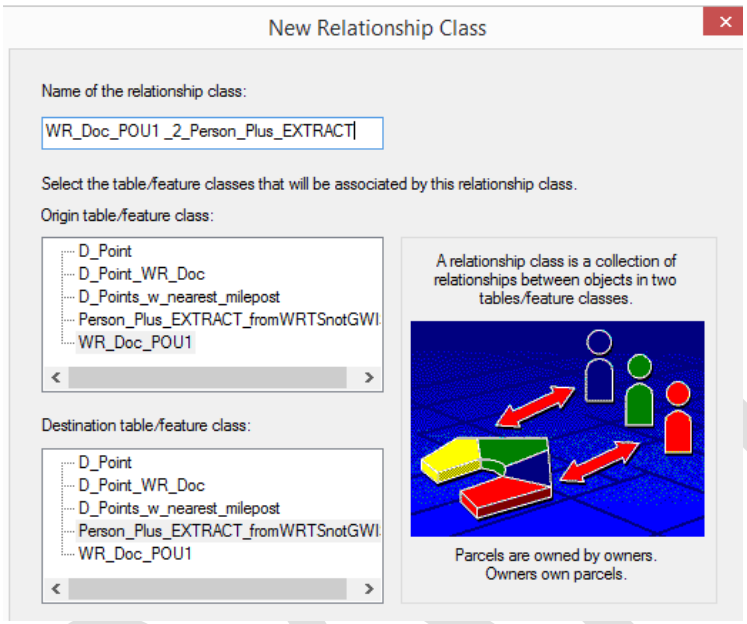
   Rename the label for the relationship as it is traversed from Origin to Destination to "Person_Plus_EXTRACT"

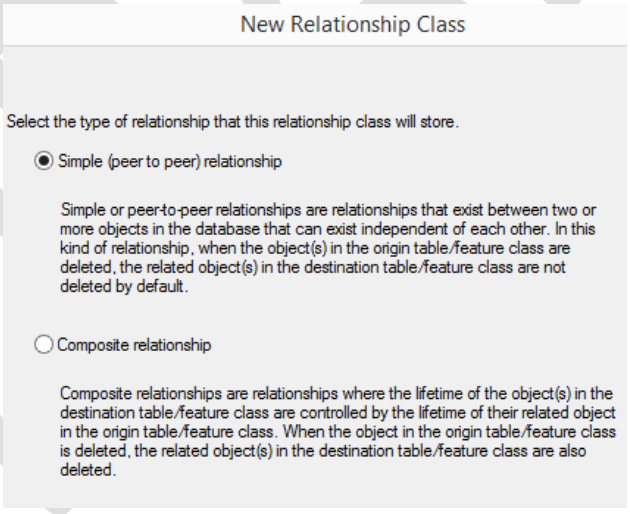
   Cardinality: 1 – M (One to Many)

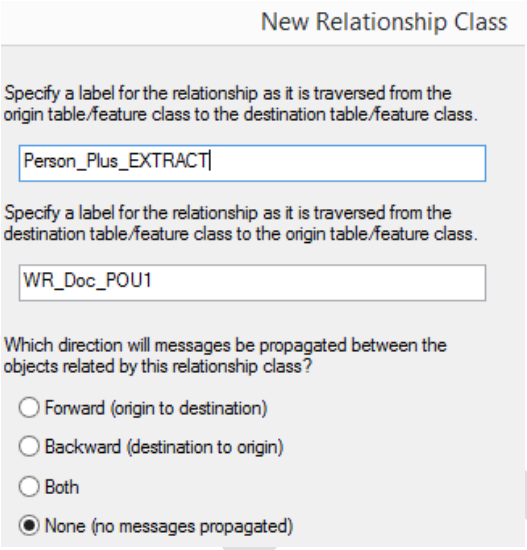
   Do not add attributes

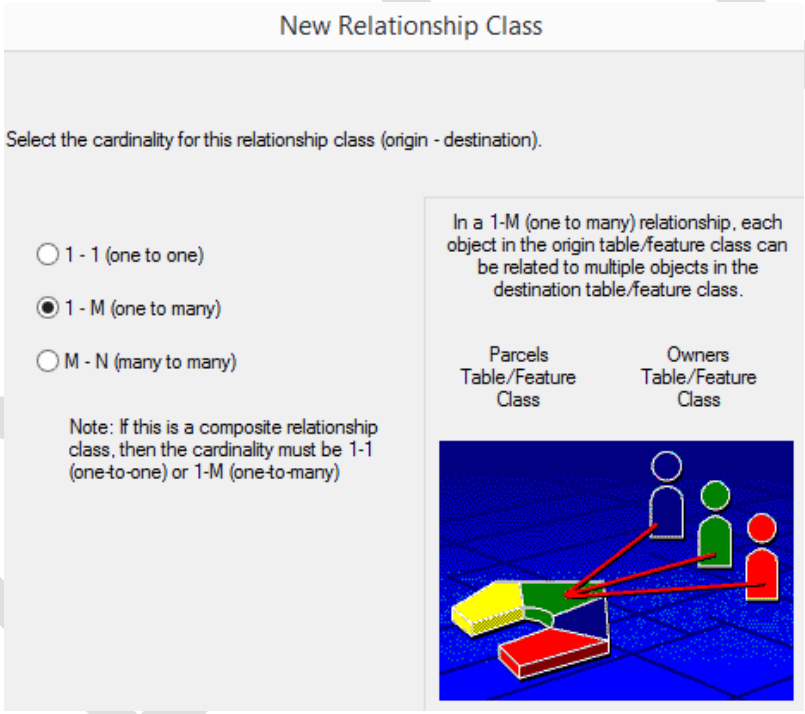
Set both primary and foreign key to WR_DOC_ID. This should be in the drop down.

Finish







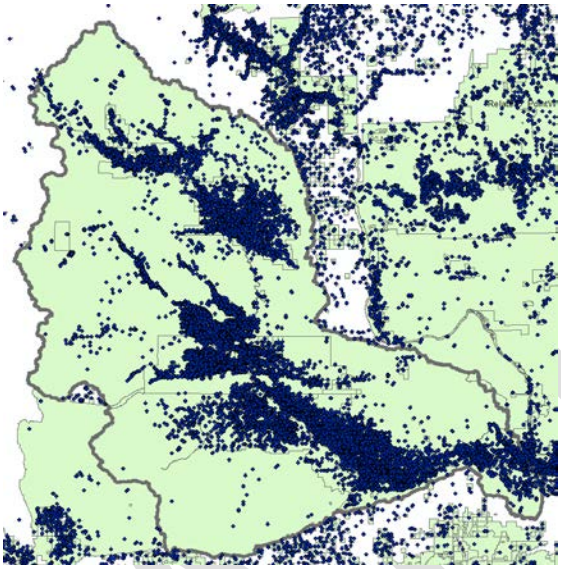


2. In ArcMap: delete extraneous D Points

a. Add four layers to an MXD:
Person_Plus_EXTRACT_fromWRTSnotGWIS (Table)
WR_Doc_POU1 (Polygon)

D_Point_WR_Doc (Table)
D_Point (Point)

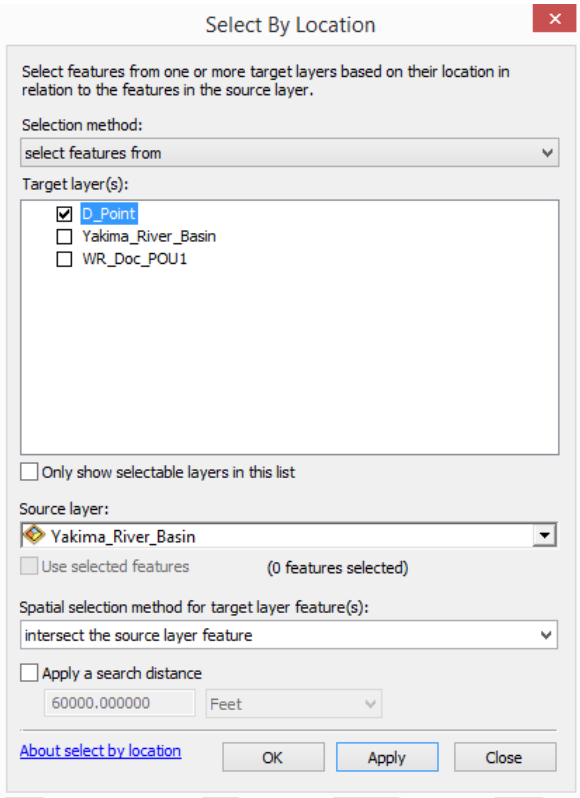
b. Add the Yakima_River_Basin layer and zoom to it:



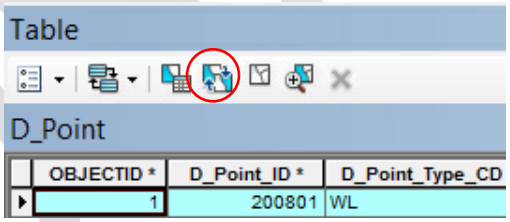
c. Start an editing session on the D_Point layer.

d. Go to the Selection tab and choose Select by Location:

Select feature from D_Point that intersect the Yakima_River_Basin source layer.



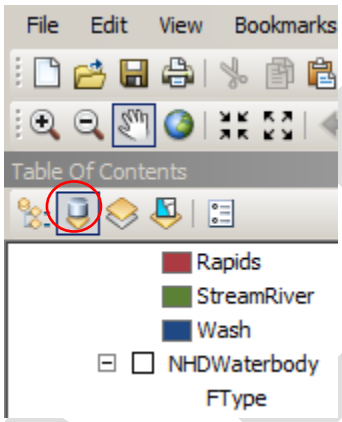
e. Open the table for the D_Point layer. You should find that roughly 21500 of roughly 157000 records are selected. Switch the selection using the button circled below.



f. This will select all of the D points that fall outside of the Yakima Basin. Delete them.

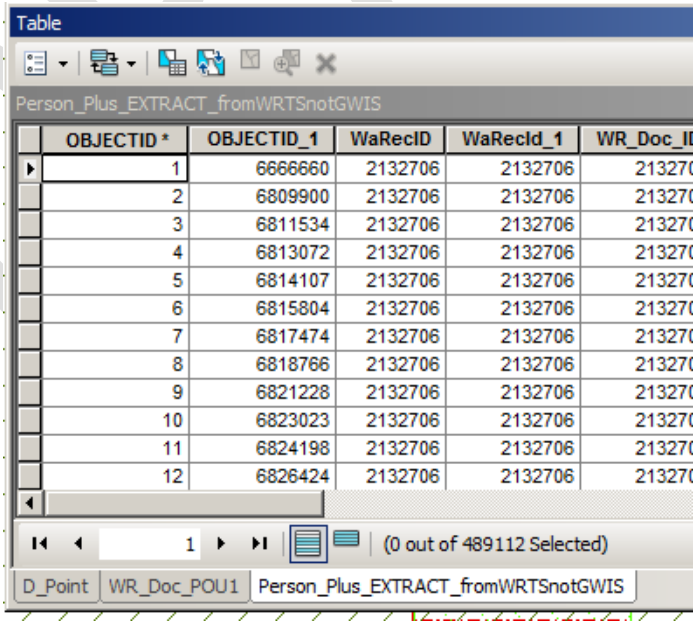
3. **In ArcMap, delete extraneous records from the POU layer and the two tables:**

   a. Put the table of contents into List by Source view:



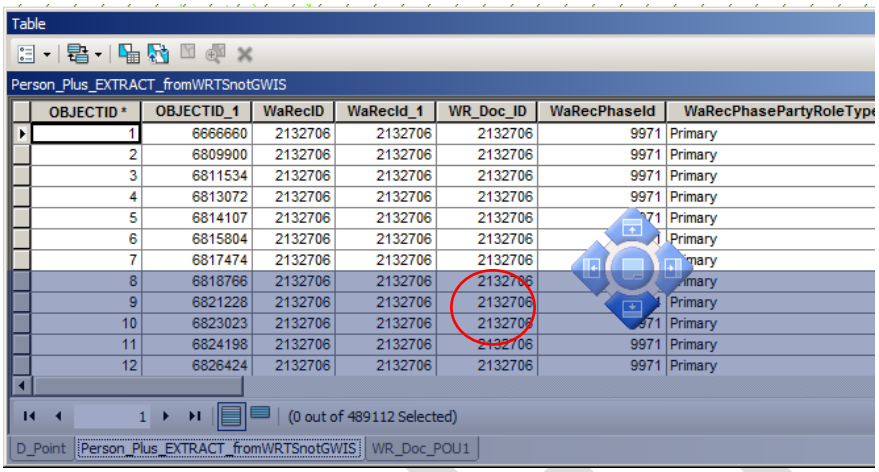
   b. Open the attribute tables for the D_Point layer and the WR_Doc_POU1 layer and the Person_Plus_EXTRACT_fromWRTSnotGWIS and the D_Point_WR_Doc tables from the table of contents.

   The tables will open as four tabs in the same window:

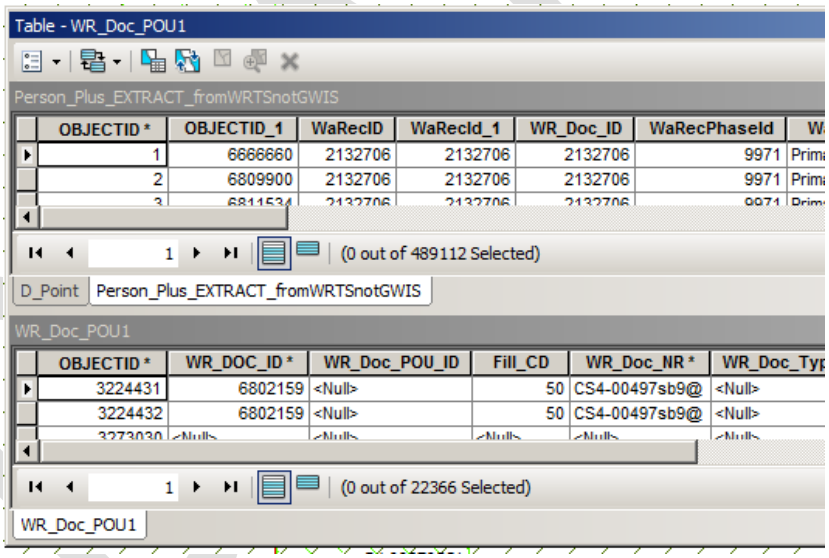


c. Stack the tables on top of eachother.

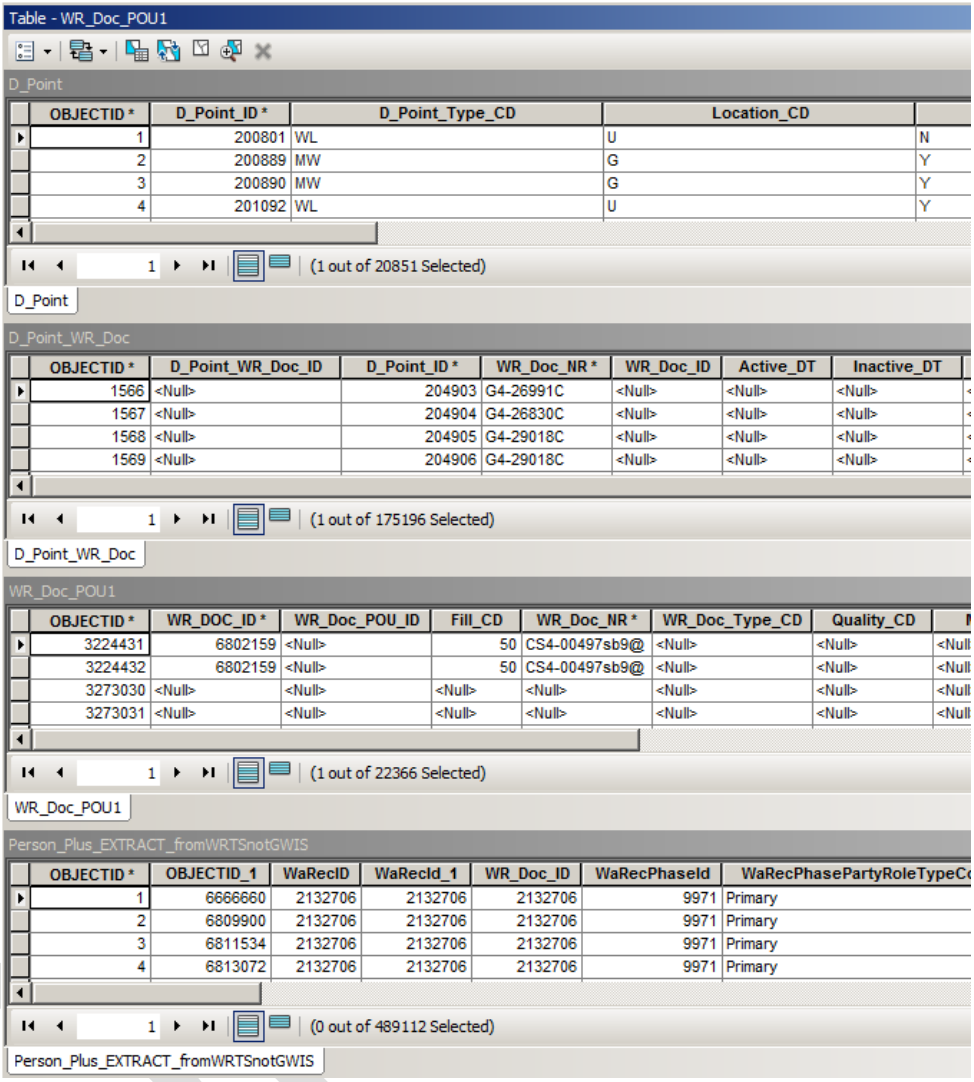
i. Click and hold the WR_Doc_POU1 tab, continue holding the click as you drag over the blue down arrow, then release:



This will split the window into two tables:

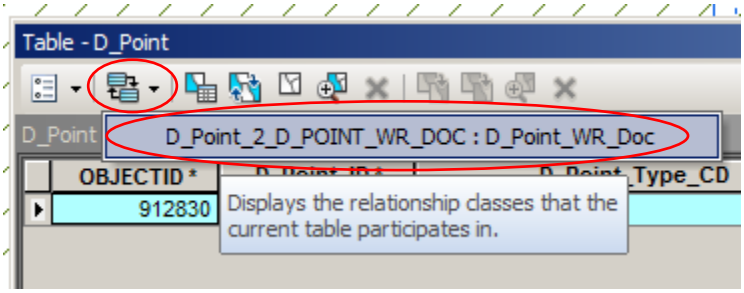


ii. Do the same for the Person_Plus_EXTRACT_fromWRTSnot_GWIS tab and D_Point_WR_Doc tabs and resize the table window. Now the four tables are stacked in one window:



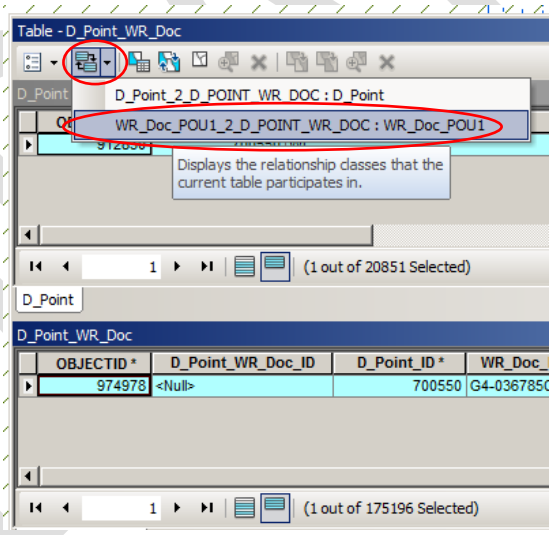
d. Switch the selection on the D_Point table to select all of the records.

Make sure the D_Point table is activated by clicking its header; the header will turn from grey to blue. Click the dropdown for the Related Tables icon and click on the option “D_Point_2_D_POINT_WR_DOC : D_Point_WR_Doc.”



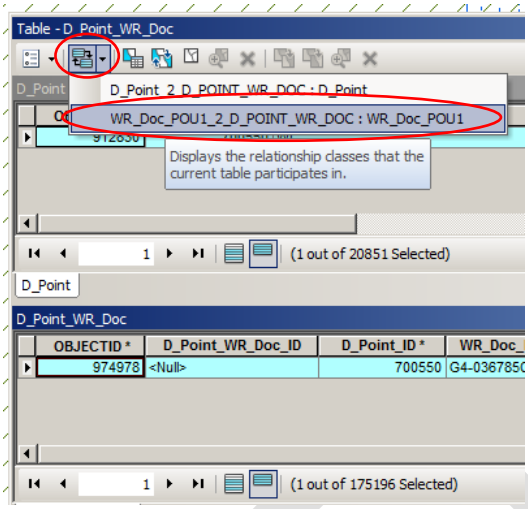
Now you will see many records in the D_Point_WR_Doc table (~21600) are now selected. Click the header of the D_Point_WR_Doc table to activate it. Switch the selection so all of the extraneous records are selected. (To be safe, you can activate the D_Point table momentarily to clear the selection so you don't accidentally delete D Points, then re-activate the D_Point_WR_Doc.) Delete them. ArcMap will run for a long time on this processing step and several others. Save edits.

e. Activate the D_Point_WR_Doc table by clicking on its header. Switch the selection so all records are selected. Again click the dropdown for the Related Tables icon and choose WR_Doc_POU1_2_D_POINT_WR_DOC : WR_Doc_POU1.

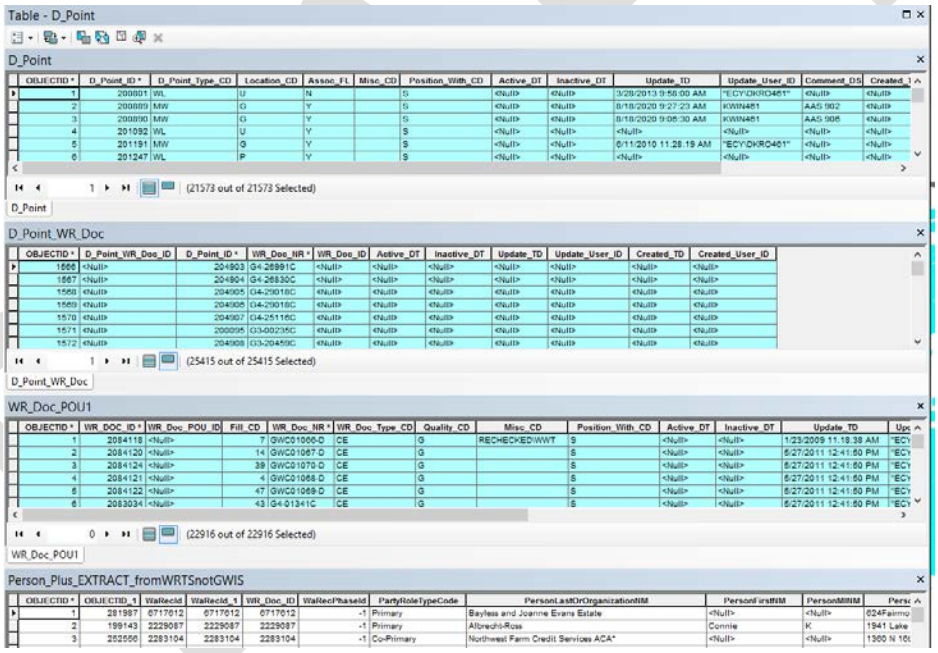


This will select ~23000 of ~156600. Again, switch the selection and delete the extraneous data, being careful not to delete the D_Point_WR_Doc data.

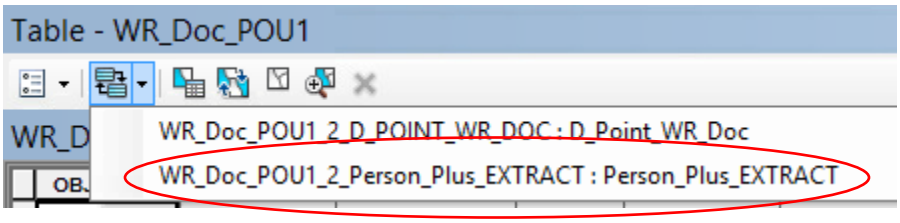
f. Activate the D_Point_WR_Doc table by clicking on its header. Again click the dropdown for the Related Tables icon and choose WR_Doc_POU1_2_D_POINT_WR_DOC : WR_Doc_POU1.



Now you will see a single (or multiple) record selected in the WR_Doc_POU1 table and the polygon for the Place of Use associated with the selected D Point will also be selected:



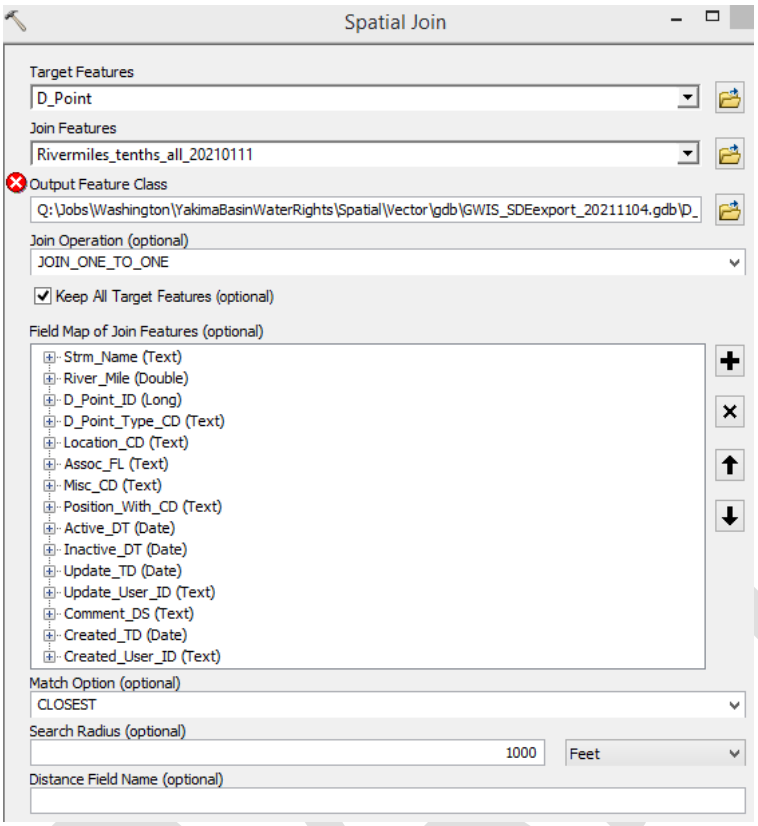
g. Activate the WR_Doc_POU1 table. Again, click the dropdown for the Relate Tables dropdown. This time choose WR_Doc_POU1_2_Person_Plus_EXTRACT.



Activate the Person_Plus_EXTRACT_fromWRTSnotGWIS table. Switch the selection and delete the extraneous records.

The data are now clean and the relationships are set up to relate a D Point to its POU!!! At this point you can use the Guide to Use GWIS in GIS document to analyze the data.

4. **In Arcmap, add river mile markers to the D Points:**
   - **a.** Add the Rivermiles_tenths_all layer to the MXD.
   - **b.** Use the Spatial Join tool to join the nearest river mile point to each D Point. Use the "Closest" technique and choose a logical search distance (1000 ft). Save it in your GWIS gdb. This will create a new D Point layer that has two extra fields in the attribute table: Stream Name and River Mile.
   - **c.** You will not be able to use the new layer for the D point-to-POU relationship process. Keep the other D Points layer in your MXD for use in GWIS.

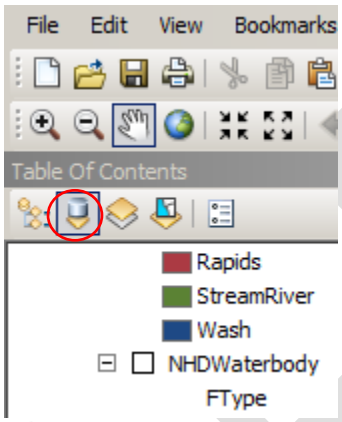


You will not be able to use the newly created layer for the D point-to-POU relationship process. It will only be used for other analysis. Keep the other D Points layer in your MXD for use in GWIS.

Appendix B.

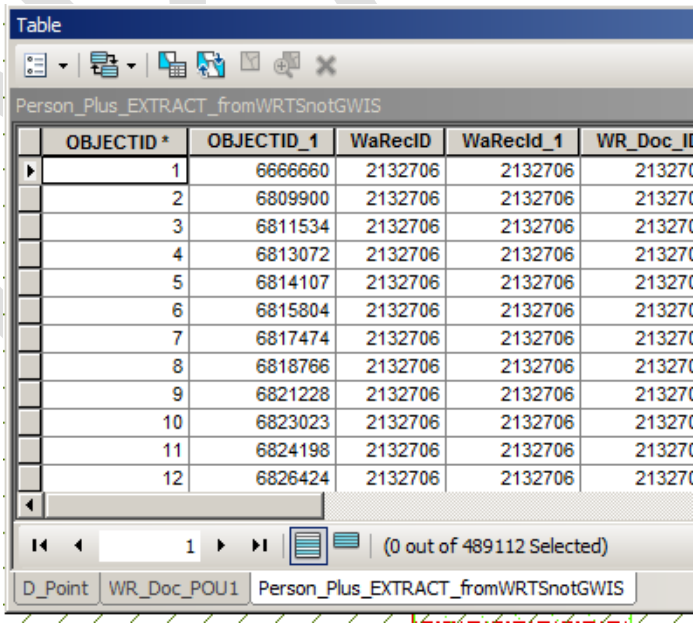
Guide to activate GWIS relations (D-Point, Place of Use, WRTS) in GIS

1. Open Yakima_Basin_Water_Rights mxd
2. Put the table of contents into List by Source view:

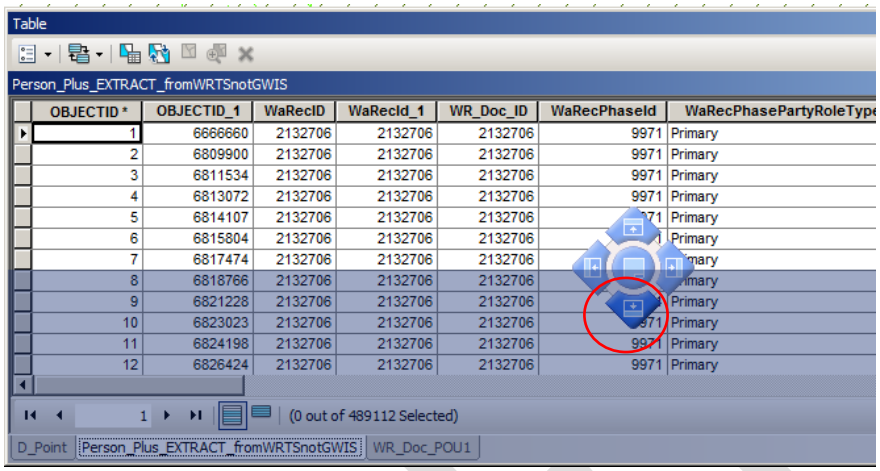


3. Open the attribute tables for the D_Point layer and the WR_Doc_POU1 layer and the Person_Plus_EXTRACT_fromWRTSnotGWIS and the D_Point_WR_Doc tables from the table of contents.

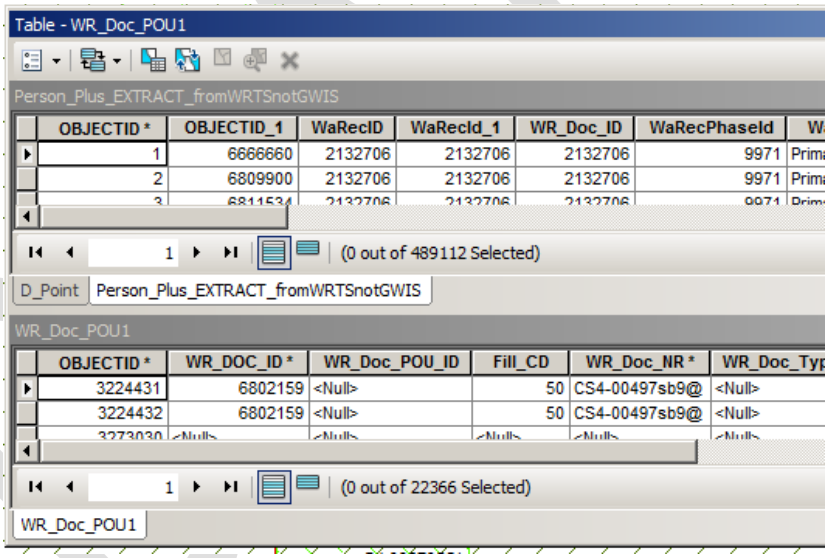
   The tables will open as four tabs in the same window:



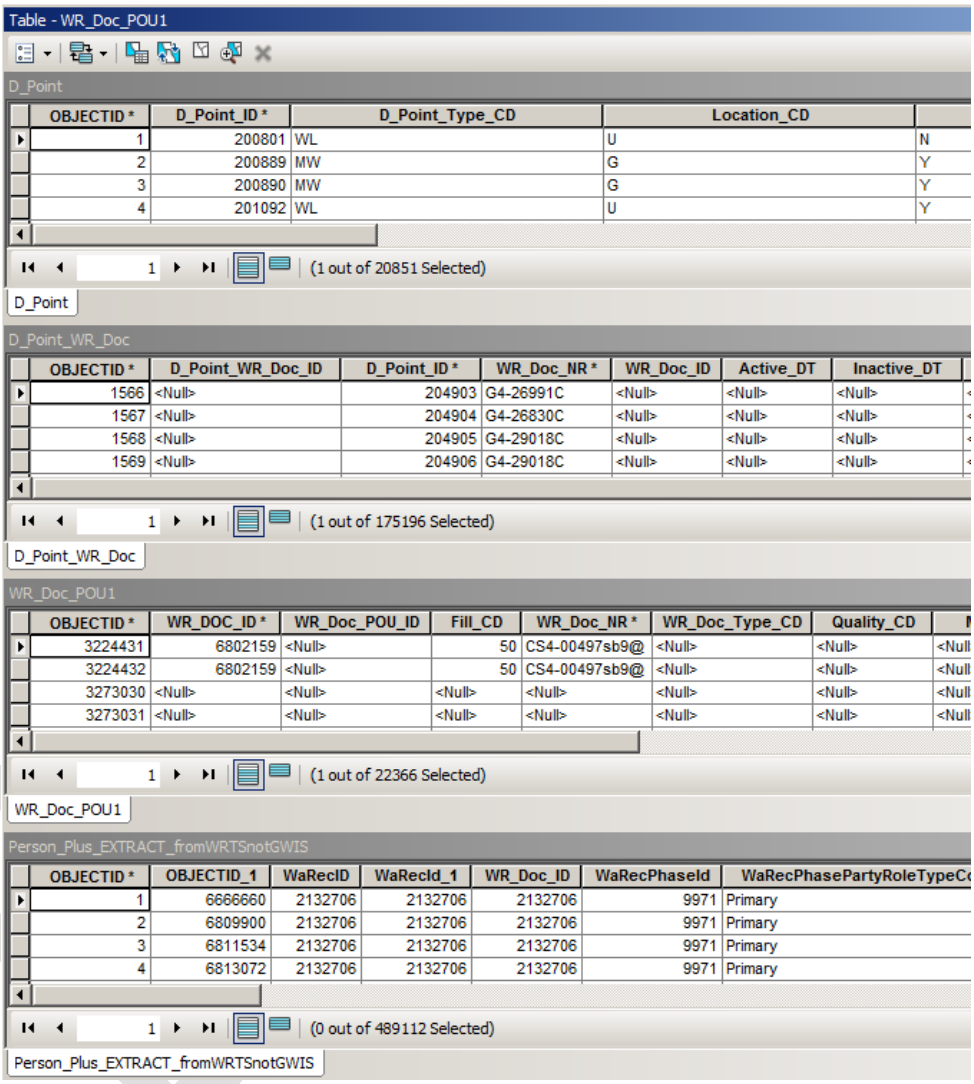
4. Stack the tables on top of eachother.
   a. Click and hold the WR_Doc_POU1 tab, continue holding the click as you drag over the blue down arrow, then release:



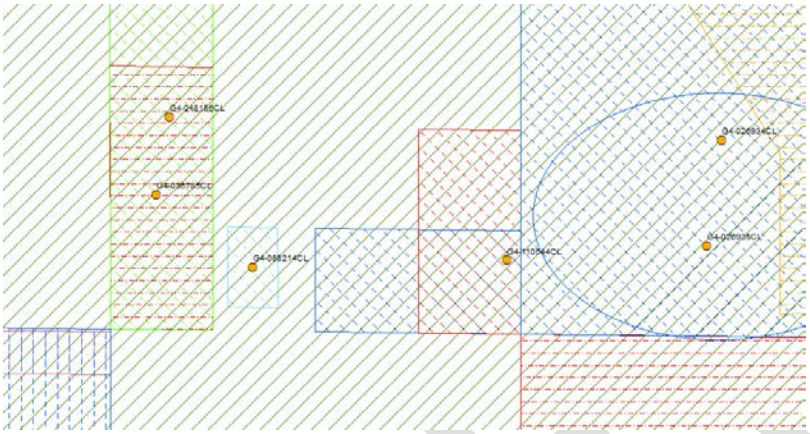
This will split the window into two tables:



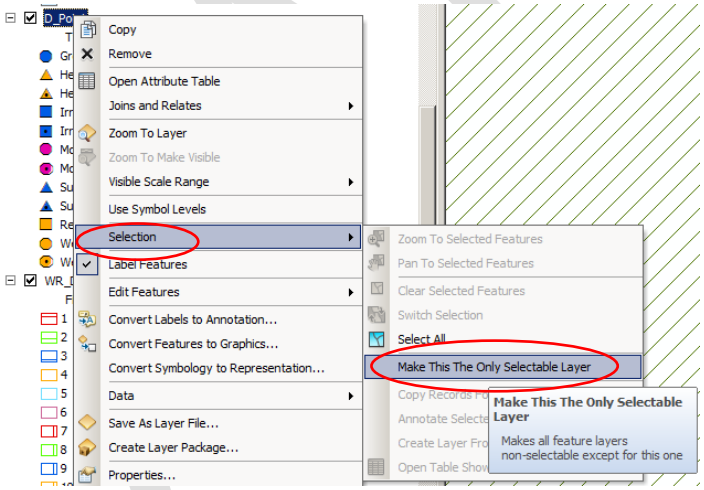
b. Do the same for the Person_Plus_EXTRACT_fromWRTSnot_GWIS tab and D_Point_WR_Doc tabs and resize the table window. Now the four tables are stacked in one window:



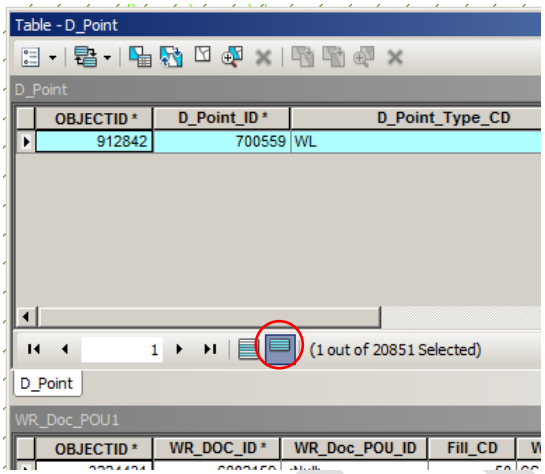
5. Zoom in tight on your area of interest:



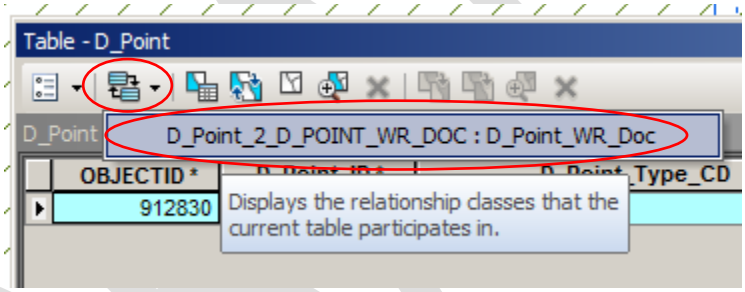
6. Right click the D_point layer in the TOC and make it the only selectable layer:



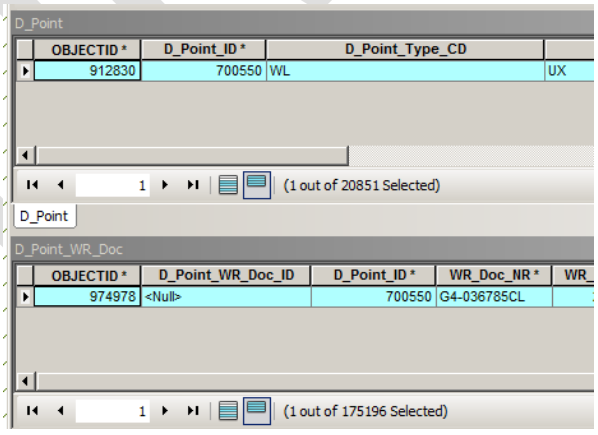
7. Select the D Point that you are interested in. In all four tables, click the icon to “show selected records.” This will get rid of all records except for the selected point:



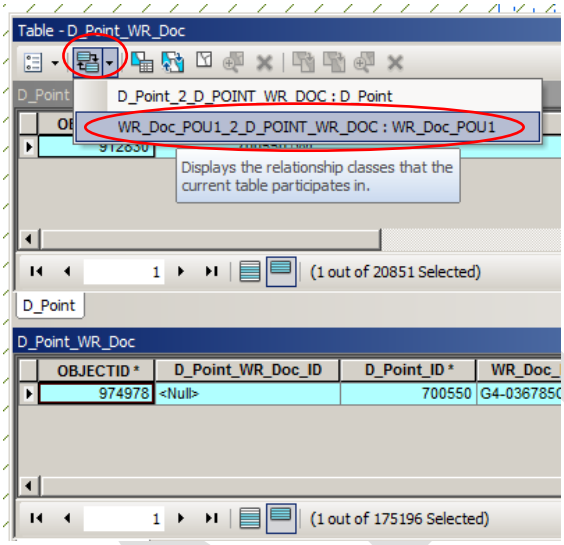
8. Make sure the D_Point table is activated by clicking its header; the header will turn from grey to blue. Click the dropdown for the Related Tables icon and click on the option "D_Point_2_D_POINT_WR_DOC : D_Point_WR_Doc."



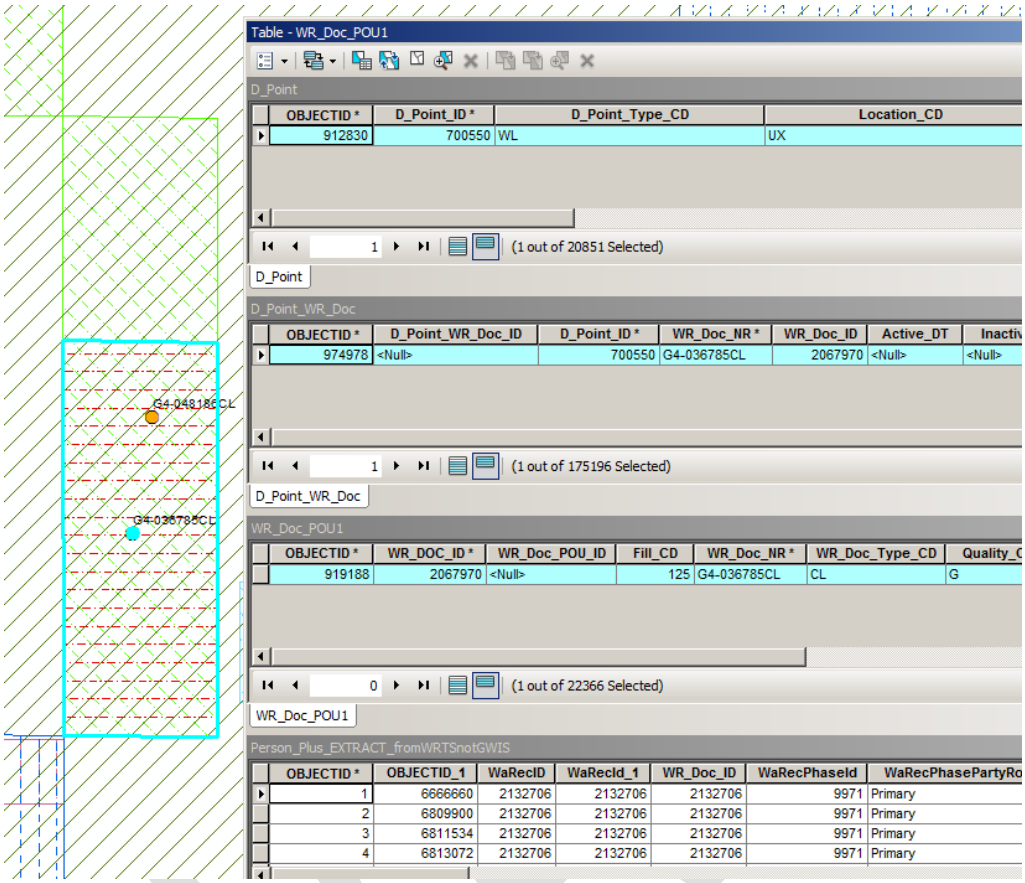
Now you will see a single (or multiple) selected record in the D_Point_WR_Doc table:



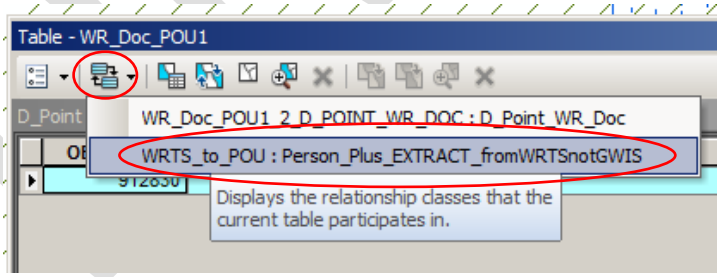
9. Activate the D_Point_WR_Doc table by clicking on its header. Again click the dropdown for the Related Tables icon and choose WR_Doc_POU1_2_D_POINT_WR_DOC : WR_Doc_POU1.



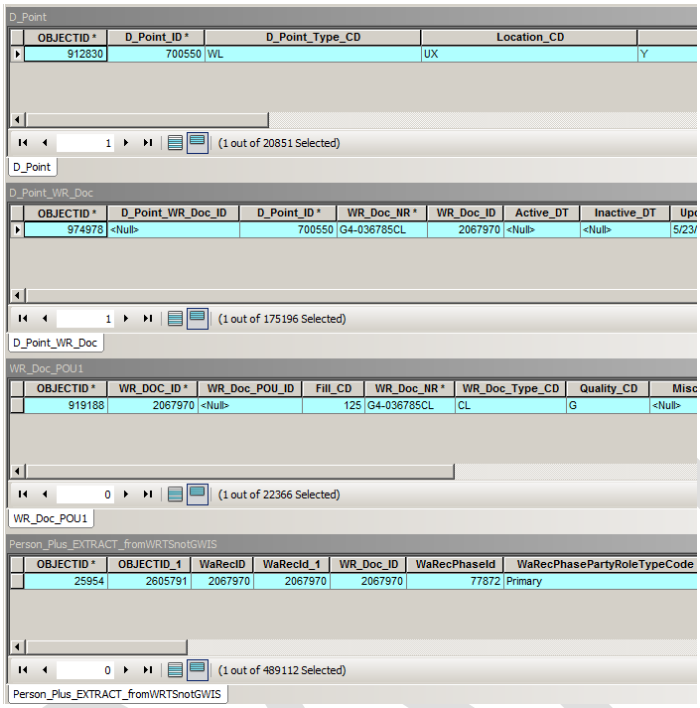
Now you will see a single (or multiple) record selected in the WR_Doc_POU1 table and the polygon for the Place of Use associated with the selected D Point will also be selected:



10. Activate the WR_Doc_POU1 table by clicking its header. Click the Related Tables dropdown and choose WRTS_to_POU : Person_Plus_EXTRACT_fromWRTSnotGWIS.



You will see a single (or multiple) record highlighted in the Person_Plus_Extract_fromWRTSnotGWIS table. All relationships are now completed:

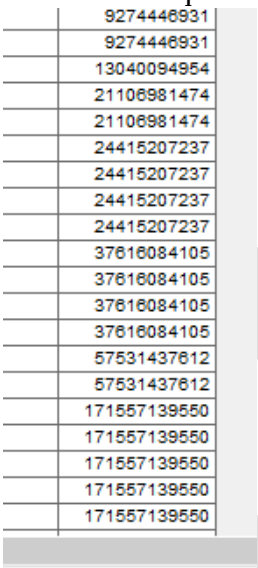


At this point you can view all information available on a single D Point and its Place or Places of Use. If you want to look at a new point, you will unselect the current selection  and select a new point. You will have to re-activate, or push, each relationship through again.

NOTE:

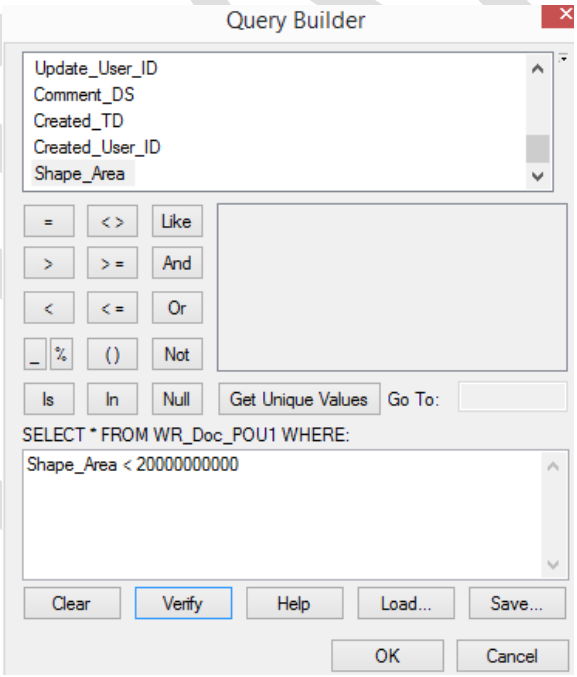
There are several very large POUs, including some that cover the entire basin. When you are visually searching through the POU data or trying to select a specific POU polygon, it can be frustrating to see many overlapping polygons or get 10 extraneous POUs every time you try to select one. In order to prevent this frustration, you can set a definition query on the POU layer to filter out the largest POUs. The Shape_Area field in the attribute table gives the square footage of each POU. A definition query on Shape_Area allows you to block out all of the largest POUs.

1. Open the attribute table and sort it by the Shape_Area field (just double-click the header). Scroll to the bottom to get an idea of the square footage of the largest POUs:



9274446931
9274446931
13040094954
21106981474
21106981474
24415207237
24415207237
24415207237
24415207237
37616084105
37616084105
37616084105
37616084105
57531437612
57531437612
171557139550
171557139550
171557139550
171557139550
171557139550

2. Open the properties for the POU layer and go to the Definition Query tab. Create a query to remove the largest POUs. Pick the appropriate number of square feet to remove the POUs that are not needed in your analysis.



3. Be sure you delete the definition query when you are done.

S2.3: Streamflow Needs

A key part of evaluating the potential for multi-benefit markets was the identification of streams in need of flow improvements. This technical work was completed by TU staff in close coordination with ERA Economics and with technical assistance from experts at the Washington Department of Fish and Wildlife.

To: Yakima Water Market Strategy Development Project

From: Trout Unlimited

Date: June 2022

Re: *Instream Flow Needs and Water Rights*

Purpose:
To provide instream flow needs information to aide in creation of a Yakima Basin Smart Market water market strategy that improves water transfer efficiency and availability. Note, "instream flow" and "streamflow" are used interchangeably.

Background:
The Yakima Basin is home to over 2000 surface water rights. Many of these water rights are from tributaries to the Yakima or Naches Rivers. Transfers of these rights are possible but subject to specific transfer rules. These rules, generally speaking, may help improve streamflows through market-based water transfers.

At the project outset, the "Instream Flow Needs" section was contemplated as a complete subbasin flow analyses to quantify, identify, and interpret instream amounts and needs by stream based on water demands and historical flow rates. This approach included identification of opportunities for alternative flow supplementation that could impact environmental market demand for water. The approach also was to make use of existing instream flow data and analysis where possible.

After conferring with streamflow and water rights technical experts from the Washington Department of Fish and Wildlife (produced the Columbia River Instream Atlas) and Yakama Nation, a revised approach was identified to better illustrate the role of market-based transfers on streamflow needs. As such, the quantitative step is still included as a summary of the total water rights certificated in each subbasin and then what percentage of those rights are designated for instream flow.

Additionally, the quantification of instream flow means is less critical than understanding that the ultimate goal is restoration of normative flow levels plus an amount to be determined. This is arguably the most reasonable way to address streamflow needs while accounting for uncertainty, like climate change, landscape development changes, and market conditions.

Identifying Streamflow Needs:
Streams in the Yakima Basin experience insufficient amounts or significantly altered timing of instream flows. These changes create numerous locations where streamflow was identified as a limiting factor to fish populations.

Instream flow is a limiting factor for fish recovery in multiple plans and analyses. These include the: 2009 Yakima Steelhead Recovery Plan (YSRP) as incorporated in the 2009 Mid-Columbia Steelhead Recovery Plan; 2012 Yakima Bull Trout Action Plan; YBIP technical analyses and plans (multiple years); 2004 Northwest Power & Conservation Council's Yakima Subbasin Plan and 2004 Supplement; 2001 Yakima Limiting Factors Analysis; WA Dept. of Fish & Wildlife's (WDFW) Columbia River Instream Atlas (CRIA) (2011, 2016); and WA Dept. of Ecology's (Ecology) Water Acquisition Program report (2003); The 2004 Subbasin Plan Supplement identifies low flows as one of the limiting factors to address first; this is pragmatic and logical conclusion because without water there is no fish habitat.

Yakima planning documents identify a need for normative flows in the absence of specific flow targets or rules, especially in tributaries. With a "*biological objective. . .to restore this watershed sufficiently to support self-sustaining and harvestable populations of indigenous fish. . . [,]"* (2004 Supplement, p. 15) The specific reach of stream that requires flow improvements can vary significantly on local conditions. For certain water right transfers or permits (e.g. domestic wells) a detailed analysis may be required to identify gaining and losing stream reaches. For most surface water transfers, such a detailed analysis is not necessary. Rather, a simplified approach is less intensive and assumes that a downstream move is typically positive and allowable.

The simplified approach helps to advance the work of restoring natural flow conditions in streams with surface water rights on them. A more complex approach is to identify streams with water rights, then an identification of the flow specific reaches followed by an analysis of local hydrogeologic and annual water year (supply) conditions with instream flow transfer considerations. This approach would identify the very specific locations where flow is "needed" and other areas where flow is potentially "less needed." However, this approach requires significant resources and may still conclude that water is needed wherever water rights are diverted. As such, the simplified approach is most useful for the market strategy development.

We may reasonably conclude that any stream with either a surface water right or in a subbasin with a groundwater right may benefit from transfers that improve streamflows. This effectively amounts to all named streams in the Yakima Basin and additional unnamed streams, springs, ponds, or similar sources.

The amount of water that any given stream would need to improve streamflows is that amount that is being removed from the system. Removal could be via consumptive use through irrigation, stockwater, or domestic uses. Removal could also be from non-consumptive uses that mimic consumptive uses because the non-consumptive water does not return to the stream or it does not return to the original POD.

Given these factors, the need amounts, locations, and timing for instream flow is logically the amount necessary to restore the natural flow conditions. Whether the amount will ever be enough for market participants or restoration practitioners to conclude "enough is instream" is a question that only time can answer. Setting a numerical value for "enough" is a very imprecise practice because the streams may be in such condition that returning to natural functions may be limited because the hydrology is too impacted and needs additional water to achieve full restoration.

Appendix 1 contains tables of the surface water rights for the Yakima Basin. The majority of tables are separated by adjudication subbasin. Additional tables demonstrate the amount of water rights with a purpose of use as "instream flow".

We did not consider and specifically excluded from the market strategy analysis water rights (both district and non-district) on the Yakama Nation reservation. The Yakama Nation reservation water rights are the subject of complicated treaty, congressional and Yakama Nation water code laws, rules and regulations. As a result, Yakama Reservation water rights are not subject to being transferred and traded in a market-based setting such as the smart market.

Market-Based Transfer Impacts on Streamflow:
In Washington State, approaches to streamflow improvements vary based on local conditions; however, the approaches universally include market-based water right transfers where possible. Market-based transfers are an integral part (past, present, and future) of improving streamflows in the Yakima Basin. For market-based transfers, this conclusion means that the transfer cannot expand the water right in any way absent some action (like flow supplementation) that prevents an adverse change to flow.

There are several known market participants that are helping restore streamflow. These participants include Trout Unlimited, the Washington Water Trust, WA Department of Ecology, US Bureau of Reclamation, Yakima, Kittitas, and Benton Counties, and Yakama Nation. Additionally, given the conclusion about what is needed for streamflow, any transfer that improves flow in a stream reach would also, though possible as an ancillary part of a market-based transfer, would be a market participant for streamflow.

The last point offers examples of places where the Smart Market could match streamflow restoration practitioners with other buyers or sellers of water rights. For example, suppose Party A wants to buy water from B but there is a valuation difference. This could be a time when an environmental buyer could offer to contribute to the transaction to bridge the valuation gap and ensure the instream flow benefits accrue.

Streamflow Supplementation Impacts on Streamflow Needs:
Streamflow supplementation is an action that helps maintain stream ecosystems in Upper Yakima River tributaries in the absence of full acquisition of water rights for these streams. In addition to most upper Yakima River tributaries, there are several streams (e.g., Ahtanum Creek, Cowiche Creek, Wenas Creek) where streamflow supplementation has been considered and may be feasible but impractical under current conditions.

Streams currently receiving supplemental water to improve flows are limited to those intersecting the Kittitas Reclamation District canal system. Tucker, Big, Little, Tillman, Taneum, and Manastash Creeks all receive varying amounts of flow. Each stream, excluding Tillman Creek, has a surface water right from it and suffers from impaired seasonal streamflows. As such, the supplemental flows serve to maintain or restore the stream ecosystem in the absence of acquisition/retirement of all water rights for each stream.

The supplementation is not a complete replacement for natural flows; however, it is the best option available to recover fish and ensure a healthy stream ecosystem. As such, supplementation is acknowledged for its extremely high value but is not treated as a replacement in the context of identifying streamflow needs.

Drought Impacts on Streamflow Needs:
Natural drought conditions for streams on the eastern slope of the Cascade Mountains have occurred about 1 in every 5 years since 2000. The natural conditions are typically triggered when normal water supply is less than 75% and there is there is a risk of undue hardship to water users and uses. In a formal drought year, Yakima Basin streams will meet these conditions.

However, in the Yakima Basin streams may also be subject to unnatural drought conditions due to surface water rights that reduce the water supply for out-of-stream uses. In years where a formal drought declaration is not made, many Yakima Basin streams may experience conditions that are significantly worse due to more than 25% of the water supply being removed and a hardship risk is present to water users, like fish and wildlife (or state held Trust Water Rights for instream flow).

Market-based transfers have provided streamflow relief in some streams, like Manastash Creek and the Teanaway River. Water right transactions have restored a portion of the natural flow and, in some streams, may have restored flow to remove the unnatural drought conditions (if drought is 75% water supply, then <25% of the flow can be removed and still be above drought level).

Yakima River conditions are controlled by reservoir operations to a large degree. This may limit the presence of drought conditions in the mainstem river. Regardless, market-based transfers do impact Yakima mainstem conditions in drought years (e.g. Sunnyside to Roza).

Market-based transfers during drought years are ultimately correlated to the drought declarations. If the declaration is early and sufficient time (and funding) is available to practitioners, then temporary transfers may be developed to improve streamflow conditions on a single year basis. However, if the declaration comes late in the year (e.g. 2021) then funding may be limited and the practitioners may lack adequate time to develop significant flow projects.

Assuming drought conditions (natural or unnatural) occur at a high frequency in many Yakima Basin streams and that market-based transfers can improve streamflows when timing and funding align, then it is imperative that the market can react quickly to transfer requests.

Streamflow Needs Summary:
Streamflow needs for development of the Smart Market were simplified due to the number of streams and water rights. Project partners, in close coordination with technical experts from WDFW, determined that streams identified in the CRIA are suitable for Smart Market strategy development.

Table 1 identifies those streams identified in the CRIA *and* streams that are the first named source for surface water rights according to Ecology's Water Rights Tracking System. Six streams—Burbank Creek, Crystal Creek, Peterson Creek, Spex Arth Creek, Tillman Creek, and

the Little Naches River—are identified in the CRIA and are not the first source for any water rights and, as such, these six streams may have streamflow needs that cannot be addressed through a water market.

Table 1. The cumulative face value of the Qi (cfs) exceeds 16,000 for nearly 1,500 water rights in 37 streams identified in the CRIA.

Stream Name (First Source Listed)	Sum of Qi (cfs)	Number of Water Rights
Ahtanum Creek	5.74	51
Big Creek	7.90	16
Bumping River	0.01	2
Caribou Creek	53.33	21
Cherry Creek	8.41	6
Cle Elum River	6.00	3
Coleman Creek	57.48	44
Cooke Creek	33.50	45
Cowiche Creek	4.27	19
Currier Creek	39.02	14
Dry Creek	26.87	52
First Creek	16.98	15
Gold Creek	202.01	5
Little Creek	4.58	8
Manastash Creek	91.79	103
Mercer Creek	2.31	3
Naches River	1,381.89	153
Naneum Creek	92.62	92
North Fork Ahtanum Creek	8.88	39
North Fork Teanaway River	5.37	15
Park Creek	22.01	9
Parke Creek	12.23	7
Rattlesnake Creek	5.02	17
Reecer Creek	24.48	21
Schnebly Creek	13.17	16
South Fork Cowiche Creek	20.09	38
Swauk Creek	13.15	17
Taneum Creek	126.33	15
Teanaway River	30.83	108
Tieton River	347.41	8
Tucker Creek	0.30	1
Wenas Creek	51.41	93
Whiskey Creek	13.75	10
Wide Hollow Creek	29.12	22
Williams Creek	27.46	23
Wilson Creek	82.77	68
Yakima River	12,939.24	270

Totals	15,807.72	1,449

Table 1 totals the Qi for water rights from each stream. The face value of the Qi may vary during the year. The data used are from the WRTS and this provides the highest value of Qi for each right during the period of use. As such, the actual total of the water rights' Qi may be lower.
Table 2. Data from the 2016 CRIA was used to create a relative score for "flow for fish". This information was developed to aid smart market simulations for the larger Yakima Water Market Strategy development. A "low" value merely means that flow restoration is of more importance in other places before that particular location. A "low" score does not mean flow restoration is not desirable. Methods for this analysis are available in Appendix 2.

CRIA_ID	ReachName	FshSco2016	FshBin2016	HabSco2016	HabBin2016	FloSco2016	FloBin2016	Combined	Flow for Fish 3 = low 2 = med 1 = high
3701	Lower Yakima River (Reach 1)	341	3	9.6	2	16	0	3,2,0	3
3702	Lower Yakima River (Reach 2)	341	3	7.5	2	14	0	3,2,0	3
3703	Lower Yakima River (Reach 3)	341	3	12.6	2	16	0	3,2,0	3
3704	Lower Yakima River (Reach 4)	397	3	15.8	3	14	0	3,3,0	3
3705	Lower Yakima River (Reach 5)	373	3	14.9	3	17	0	3,3,0	3
3709	Ahtanum Creek	316	3	10.1	2	12	0	3,2,0	2
3710	North Fork Ahtanum Creek	209	2	13.8	2	10	0	2,2,0	2
3711	Wide Hollow Creek	163	2	4.0	1	7	0	2,1,0	3
3801	Naches River (Reach 1)	330	3	10.6	2	15	0	3,2,0	2
3802	Naches River (Reach 2)	263	3	14.8	3	12	0	3,3,0	1
3803	Cowiche Creek	151	2	11.0	2	9	0	2,2,0	1
3804	South Fork Cowiche Creek	110	1	17.0	3	9	0	1,3,0	1
3805	Tieton River	241	3	8.6	1	14	0	3,1,0	2
3806	Rattlesnake Creek	231	3	15.0	3	18	0	3,3,0	2
3807	Gold Creek	196	2	13.3	2	13	0	2,2,0	2
3808	Little Naches River	217	2	18.0	3	9	0	2,3,0	2
3809	Bumping River	141	2	19.0	3	14	0	2,3,0	2
3901	Upper Yakima River (Reach 1)	306	3	7.9	1	17	0	3,1,0	2
3902	Upper Yakima River (Reach 2)	216	3	13.2	2	17	0	3,2,0	3
3903	Upper Yakima River (Reach 3)	212	3	14.8	2	15	0	3,2,0	2
3904	Upper Yakima River (Reach 4)	211	3	19.2	3	15	0	3,3,0	2
3905	Upper Yakima River (Reach 5)	277	3	18.2	3	14	0	3,3,0	3
3906	Wenas Creek	128	2	3.2	1	14	0	2,1,0	2
3907	Burbank Creek	72	1	6.0	1	7	0	1,1,0	3
3908	Wilson Creek	128	2	2.2	1	13	0	2,1,0	2
3909	Cherry Creek	128	2	3.0	1	10	0	2,1,0	3
3910	Park Creek	128	2	3.3	1	6	0	2,1,0	1

3911	Cooke Creek	128	2	2.8	1	11	0	2,1,0	1
3912	Caribou Creek	128	2	2.3	1	10	0	2,1,0	1
3913	Naneum Creek	128	2	1.3	1	9	0	2,1,0	1
3914	Coleman Creek	128	2	2.0	1	11	0	2,1,0	3
3915	Schnebly Creek	72	1	2.1	1	11	0	1,1,0	3
3916	Mercer Creek	86	1	2.0	1	6	0	1,1,0	1
3917	Reecer Creek	128	2	4.4	1	11	0	2,1,0	2
3918	Whiskey Creek	72	1	1.0	1	6	0	1,1,0	1
3919	Currier Creek	86	1	4.4	1	11	0	1,1,0	2
3920	Manastash Creek	114	2	9.7	2	18	0	2,2,0	1
3921	Dry Creek	72	1	2.1	1	6	0	1,1,0	2
3922	Taneum Creek	128	2	10.6	2	11	0	2,2,0	1
3923	Swauk Creek	131	2	12.1	2	9	0	2,2,0	1
3924	First Creek	36	1	15.7	2	12	0	1,2,0	1
3925	Williams Creek	93	1	11.4	2	11	0	1,2,0	1
3926	Teanaway River	252	3	13.6	2	12	0	3,2,0	1
3927	North Fork Teanaway River	239	3	16.5	3	16	0	3,3,0	1
3928	Cle Elum River	211	3	18.7	3	13	0	3,3,0	2
3929	Big Creek	191	2	14.3	2	9	0	2,2,0	1
3930	Little Creek	130	2	11.8	2	16	0	2,2,0	1
3931	Crystal Creek	24	1	9.2	2	10	0	1,2,0	2
3932	Tillman Creek	60	1	10.0	2	9	0	1,2,0	3
3933	Spex Arth Creek	0	1	8.8	1	12	0	1,1,0	3
3934	Peterson Creek	60	1	17.6	3	12	0	1,3,0	2
3935	Fowler Creek	0	1	12.8	2	13	0	1,2,0	2
3936	Tucker Creek	60	1	11.0	2	12	0	1,2,0	1
39xx	MF Teanaway River								1
39xx	WF Teanaway River								1

A comparison of the streams with a purpose of use listed as “instream flow” to the total Qi from the same streams helps to identify the remaining streamflow needs. For some rights, Table 2, the sole purpose of use is instream flow but for others instream flow is one of the purposes of use (e.g., instream flow, conveyance). For these multi-purpose water rights, the instream flow amount may be realized but the stream also ultimately experiences an impact from the other part of the authorized use.

Table 2. Seventeen (17) of the 41 streams with surface water rights have rights with “instream flow” (IF) identified as a purpose of use; however, despite instream flow rights the streamflow needs are evident if the reader compares the “Max IF Qi” (maximum instream flow Qi) to the “Total Qi” (total Qi awarded—includes instream flow—from Table 1).

CRIA Streams with Instream Flow Purposes of Use	Max. IF Qi	Total Qi	Divertable	Number of IF Rights

			Qi	
Big Creek	**3.38**	**7.90**	**4.58**	**10**
Instream Flow	1.53			2
Instream Flow, Mitigation	1.85			8
Coleman Creek	**0.43**	**57.48**	**57.05**	**1**
Instream Flow	0.43			1
Cowiche Creek	**1.02**	**4.27**	**3.25**	**2**
Instream Flow	1.02			2
Currier Creek	**3.00**	**39.02**	**36.02**	**1**
Instream Flow, Mitigation	3.00			1
First Creek	**12.05**	**16.98**	**4.93**	**12**
Instream Flow	7.53			5
Instream Flow, Mitigation	4.52			7
Manastash Creek	**16.21**	**91.79**	**75.58**	**20**
Instream Flow	16.21			20
Naches River	**450.38**	**1,381.89**	**931.51**	**2**
Instream Flow	0.38			1
Instream Flow, Conveyance	450.00			1
Naneum Creek	**0.26**	**92.62**	**92.36**	**1**
Instream Flow	0.26			1
Reecer Creek	**3.37**	**24.48**	**21.11**	**4**
Instream Flow, Mitigation	3.37			4
Schnebly Creek	**0.02**	**13.17**	**13.15**	**1**
Instream Flow	0.02			1
South Fork Cowiche Creek	**6.61**	**20.09**	**13.48**	**13**
Instream Flow	6.61			13
Swauk Creek	**2.01**	**13.15**	**11.14**	**4**
Instream Flow	2.01			4
Taneum Creek	**41.19**	**126.33**	**85.14**	**5**
Instream Flow	39.83			2
Instream Flow, Mitigation	1.36			3
Teanaway River	**15.07**	**30.83**	**15.76**	**48**
Instream Flow	12.40			31
Instream Flow, Mitigation	2.67			17
Wenas Creek	**0.87**	**51.41**	**50.54**	**1**
Instream Flow	0.87			1
Whiskey Creek	**0.31**	**13.75**	**13.44**	**1**
Instream Flow, Mitigation	0.31			1
Yakima River	**786.15**	**12,939.24**	**12,153.09**	**21**
Instream Flow	54.08			9
Instream Flow, Irrigation	724.10			1
Instream Flow, Mitigation	7.97			11
Grand Total	**1,342.33**	**14,924.40**	**13,582.07**	**147**

Conclusion

Yakima Basin water rights are significant. The authorized diversionary quantities far exceeds the available streamflows in most streams. This over-appropriation results in flow impaired streams, though the extent of flow impairments likely fluctuates during any given year and is subject to annual weather conditions. The simplest approach to streamflow needs for any given stream is a restoration of the natural hydrograph where possible. However, in most streams, natural hydrograph restoration is unlikely and restoration of something as near to natural may be the most realistic goal.

Appendix 1. Water Right Data Tables.
Summary data may result in over-estimating diversionary water amounts (cfs). The potential overestimates results from complex "winter" stockwater use periods with different water amounts for each period.

One way to simplify whether the overestimate exists is to look for a seemingly high Qi associated with a stockwater purpose of use. For example, Williams Creek (Swauk Creek subbasin) has 18.1 cfs of water rights with 'irrigation, stockwater' purposes of use. The value is significantly higher relative to water rights with purposes of uses of 'irrigation' only or 'irrigation, stockwater, conveyance'. The differences may indicate a closer evaluation of the water rights may help identify the timing of streamflow needs.

Please note, in some subbasins there are sources listed as "NA" or "blank." These results require further analysis of the underlying data to correct inaccuracies.

Table 1. The total instantaneous (Qi) authorized diversions for each Adjudication Subbasin based on the constraints of data from the WRTS. Note, Qi value is rounded to two decimal places. Note, the Ahtanum Creek (Subbasin 23) includes water rights authorized for use within and outside the Yakama Reservation, as such, the rights included here are limited to those with a period of use ending on July 10—a defining characteristic of privately owned water rights authorized for use outside the Yakama Reservation.

Adjudication Subbasin	Sum of Qi	Count of Rights
01 Cle Elum Lake	8.92	16
02 Easton	22.68	49
03 Teanaway River	48.81	168
04 Swauk Creek	71.43	78
05 Elk Heights	27.47	55
06 Taneum Creek	142.39	19
07 Reecer Creek	215.00	119
08 Thorp	78.55	57
09 Wilson-Naneum	254.73	269
10 Kittitas	147.70	166
11 Manastash	101.57	124
12 Shushuskin Canyon	38.13	12
13 Umtanum Creek	0.19	2
14 Roza Creek	10.62	2
15 Wenas Creek	75.69	132
16 Upper Naches	448.08	124
17 Tieton	1.08	14
18 Cowiche Creek	29.26	77
19 Lower Naches	699.67	96
20 Selah	23.32	1
21 Burbank	8.45	7
22 Wide Hollow	31.60	33
23 Ahtanum Creek*	38.02	277

24 Moxee	8.89	33
26 Granger	24.42	9
28 Sunnyside	5.43	15
29 Mabton-Prosser	3.55	5
30 Hanford	82.66	24
31 Richland	108.41	41
FN Federal Reserved (Non-Tribal)	8.11	30
MC Major Claimants	10245.58	156
Grand Total	**13237.57**	**2260**

Table 2. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 01 Cle Elum Lake.

First Source Listed	Sum of Qi	Count of Rights
Big Boulder Creek	0.03	2
Cle Elum River	3.00	1
Domerie Creek	3.23	2
Spring Creek	0.21	2
Unnamed Spring	0.19	7
Unnamed Stream	0.03	1
Yakima River	2.23	1
Grand Total	**8.92**	**16**

Table 3. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 02 Easton.

First Source Listed	Sum of Qi	Count of Rights
Big Creek	7.90	16
Cabin Creek	0.17	1
Fowler Creek	1.78	3
Little Creek	4.58	8
Nelson Creek	0.34	1
Roaring Creek	0.07	1
Thetis Creek	0.03	1
Tombstone Creek	0.04	1
Tucker Creek	0.30	1
Unnamed Pond	1.72	1
Unnamed Spring	2.31	12
Unnamed Stream	3.45	3
Grand Total	**22.68**	**49**

Table 4. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 03 Teanaway. (Bold values for each source indicate a source / purpose of use total.)

First Source Listed	Sum of Qi	Count of Rights
03 Teanaway River	**48.81**	**168**

Bussoli Spring	0.03	1
Groundwater	1.54	4
Indian Creek	0.60	1
Mack Creek	2.32	1
Mason Creek	0.45	2
Middle Fork Teanaway River	1.02	11
NA	1.95	3
North Fork Teanaway River	5.37	15
Storey Creek	0.25	1
Storey Creek	0.56	3
Teanaway River	30.81	107
Unnamed Creek	0.16	3
Unnamed Pond	1.80	2
Unnamed Spring	0.20	10
Unnamed Stream	0.64	2
West Fork Teanaway River	1.10	2
Grand Total	**48.81**	**168**

Table 5. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 04 Swauk Creek. (Bold values for each source indicate a source / purpose of use total.)

First Source Listed	Sum of Qi	Count of Rights
Deer Creek	0.60	1
Dunford Spring	0.10	1
First Creek	16.98	15
Groundwater	0.06	1
Mccallum Spring	0.05	1
NA	1.50	1
Price Creek	2.00	1
Pump House Spring	0.00	1
Swauk Creek	13.12	16
Unnamed Spring	0.15	8
Unnamed Stream	0.70	4
Wildcat Gulch	0.03	1
Williams Creek	27.46	23
Yakima River	8.70	4
Grand Total	**71.43**	**78**

Table 6. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 05 Elk Heights. (Bold values for each source indicate a source / purpose of use total.)

First Source Listed	Sum of Qi	Count of Rights
Indian John Spring	0.01	1
Iron Mountain Creek	2.00	2

Pressy Creek	0.02	1
Unnamed Creek	0.80	1
Unnamed Spring	1.10	9
Unnamed Stream	5.74	11
Unnamed Stream	0.75	1
Yakima River	17.05	29
Grand Total	**27.47**	**55**

Table 7. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 06 Taneum Creek.

First Source Listed	Sum of Qi	Count of Rights
Groundwater	0.02	1
Taneum Creek	126.25	14
Unnamed Spring	0.01	1
Yakima River	16.11	3
Grand Total	**142.39**	**19**

Table 8. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 07 Reecer Creek.

First Source Listed	Sum of Qi	Count of Rights
Currier Creek	31.97	13
Dry Creek	21.72	9
Groundwater	0.10	1
Jones Creek	9.95	6
NA	0.07	1
Reecer Creek	24.48	21
Thomas Creek	1.50	1
Unnamed Pond	6.87	3
Unnamed Spring	0.57	6
Unnamed Stream	3.00	2
Yakima River	114.77	56
Grand Total	**215.00**	**119**

Table 9. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 08 Thorp.

First Source Listed	Sum of Qi	Count of Rights
Coleman Canyon Creek	0.32	1
Fogey Creek	10.20	4
Hatfield Canyon Creek	0.53	2
Joe Watt Creek	0.50	1
NA	1.14	2
Robinson Creek	28.49	11
Sheep Pasture Creek	1.00	1
Unnamed Pond	0.04	1

Unnamed Spring	2.72	16
Yakima River	33.62	18
Grand Total	**78.55**	**57**

Table 10. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 09 Wilson-Naneum.

First Source Listed	Sum of Qi	Count of Rights
Boulder Creek	0.01	1
Dot Creek	0.02	2
Dry Creek	4.79	42
High Creek	0.01	1
Leonard Spring	0.01	1
Little Wilson Creek	2.30	1
Lyle Creek	9.14	13
Mercer Creek	2.31	3
NA	1.46	2
Naneum Creek	75.10	91
Pearson Creek	0.01	1
Spring Creek	5.03	5
Swift Creek	0.02	2
Taylor Creek	1.60	2
Unnamed Spring	0.34	8
Unnamed Stream	2.41	6
Whiskey Creek	13.75	10
Wilson Creek	82.75	67
Yakima River	53.68	11
Grand Total	**254.73**	**269**

Table 11. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 10 Kittitas.

First Source Listed	Sum of Qi	Count of Rights
Caribou Creek	23.33	20
Cherry Creek	8.41	6
Coleman Creek	32.48	43
Cooke Creek	33.50	45
NA	3.33	2
Park Creek	22.01	9
Parke Creek	4.36	6
Schnebly Canyon Creek	0.01	1
Schnebly Creek	13.17	16
Spring Creek	1.30	1
Unnamed Spring	1.21	13
Unnamed Stream	1.14	2
Warm Springs Creek	3.46	2

Grand Total	**147.70**	**166**

Table 12. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 11 Manastash.

First Source Listed	Sum of Qi	Count of Rights
Bull Pen Creek	2.50	1
Hatfield Canyon Creek	3.43	2
Manastash Creek	91.72	102
Spring Creek	2.51	3
Unnamed Spring	1.33	11
Unnamed Stream	0.07	5
Grand Total	**101.57**	**124**

Table 13. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 12 Shushuskin Canyon.

First Source Listed	Sum of Qi	Count of Rights
Sorenson Creek	0.29	1
Unnamed Ditch	0.36	1
Unnamed Drain	0.34	2
Unnamed Pond	2.36	1
Unnamed Spring	0.03	2
Yakima River	34.75	5
Grand Total	**38.13**	**12**

Table 14. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 13 Umtanum Creek.

First Source Listed	Sum of Qi	Count of Rights
Unnamed Spring	0.19	2
Grand Total	**0.19**	**2**

Table 15. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 14 Roza Creek.

First Source Listed	Sum of Qi	Count of Rights
Yakima River	10.62	2
Grand Total	**10.62**	**2**

Table 16. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 15 Wenas Creek.

First Source Listed	Sum of Qi	Count of Rights
Dippin Vat Canyon	0.10	1
North Fork Wenas Creek	1.30	1
South Fork Wenas Creek	21.01	29
Spring Creek	1.02	1

Unnamed Pond	0.50	1
Unnamed Spring	0.35	6
Wenas Creek	51.41	93
Grand Total	**75.69**	**132**

Table 17. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 16 Upper Naches.

First Source Listed	Sum of Qi	Count of Rights
American River	0.01	1
Benton Creek	0.17	1
Bumping River	0.01	1
Carmack Canyon Creek	1.36	2
Davison Spring	0.34	1
Dry Creek	0.36	1
Gold Creek	202.01	5
Groundwater	0.22	1
Naches River	222.56	59
Nile Creek	4.28	3
Nile Springs Stream	9.95	1
Rattlesnake Creek	5.02	17
Rock Creek	0.07	1
Strawberry Creek	0.20	1
Timber Creek	0.01	1
Unnamed Spring	1.45	19
Unnamed Stream	0.02	2
Webb Spring	0.03	7
Grand Total	**448.08**	**124**

Table 18. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 17 Tieton.

First Source Listed	Sum of Qi	Count of Rights
Andy Creek	0.20	1
Cold Creek	0.10	1
Hart Creek	0.04	3
Jumpoff Creek	0.25	1
NA	0.13	2
Naches River	0.07	1
Russell Creek	0.01	1
Unnamed Spring	0.18	3
Unnamed Stream	0.11	1
Grand Total	**1.08**	**14**

Table 19. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 18 Cowiche Creek.

First Source Listed	Sum of Qi	Count of Rights
Cowiche Creek	4.05	18
Groundwater	0.06	1
NA	1.10	2
North Fork Cowiche Creek	2.74	13
South Fork Cowiche Creek	20.09	38
Unnamed Spring	1.22	5
Grand Total	**29.26**	**77**

Table 20. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 19 Lower Naches.

First Source Listed	Sum of Qi	Count of Rights
Basalt Spring	0.79	6
Buckskin Slough	4.22	3
Kauzlarich Spring	0.12	5
Naches River	679.13	65
Nelson Spring	8.00	1
Nichols Spring	0.09	1
Spring Creek	0.30	1
Unnamed Spring	6.92	10
Unnamed Stream	0.10	4
Grand Total	**699.67**	**96**

Table 21. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 20 Selah.

First Source Listed	Sum of Qi	Count of Rights
Yakima River	23.32	1
Grand Total	**23.32**	**1**

Table 22. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 21 Burbank.

First Source Listed	Sum of Qi	Count of Rights
Ranch House Spring	0.20	1
Unnamed Creek	0.18	1
Unnamed Pond	0.78	1
Unnamed Slough	3.10	2
Yakima River	4.19	2
Grand Total	**8.45**	**7**

Table 23. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 22 Wide Hollow.

First Source Listed	Sum of Qi	Count of Rights
Cottonwood Creek	0.02	1

Groundwater	1.30	1
Spring Creek	0.30	1
Unnamed Spring	0.11	3
Unnamed Stream	0.75	5
Wide Hollow Creek	29.12	22
Grand Total	**31.60**	**33**

Table 24. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 23 Ahtanum Creek.

First Source Listed	Sum of Qi	Count of Rights
Ahtanum Creek	5.74	51
Bachelor Creek	9.90	93
Gillette Springs	0.12	6
Hatton Creek	8.65	57
NA	2.92	15
North Fork Ahtanum Creek	8.88	39
South Fork Ahtanum Creek	0.08	2
Stanton Creek	1.54	13
(blank)	0.20	1
Grand Total	**38.02**	**277**

Table 25. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 24 Moxee.

First Source Listed	Sum of Qi	Count of Rights
Blue Slough	0.84	2
Moxee Slough	2.62	4
NA	0.20	1
Unnamed Slough	1.20	1
Unnamed Spring	1.86	15
Yakima River	2.18	10
Grand Total	**8.89**	**33**

Table 26. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 26 Granger.

First Source Listed	Sum of Qi	Count of Rights
Groundwater	0.56	1
Unnamed Spring	0.54	5
Unnamed Stream	0.06	1
Yakima River	23.26	2
Grand Total	**24.42**	**9**

Table 27. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 28 Sunnyside.

First Source Listed	Sum of Qi	Count of Rights
Campbell Spring	0.01	1
Gap Spring	0.02	1
Giffin Lake	4.50	1
Lower Lozier Spring	0.01	1
Lozier Spring	0.01	1
Two Spring	0.01	1
Two Springs	0.02	1
Unnamed Spring	0.72	5
Washout Spring	0.00	1
Yakima River	0.14	2
Grand Total	**5.43**	**15**

Table 28. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 29 Mabton-Prosser.

First Source Listed	Sum of Qi	Count of Rights
Unnamed Spring	0.00	1
Yakima River	3.54	4
Grand Total	**3.55**	**5**

Table 29. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 30 Hanford.

First Source Listed	Sum of Qi	Count of Rights
NA	0.40	1
Unnamed Ditch	0.65	2
Unnamed Spring	0.22	1
Yakima River	81.39	20
Grand Total	**82.66**	**24**

Table 30. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin 31 Richland.

First Source Listed	Sum of Qi	Count of Rights
Groundwater	2.11	4
NA	0.41	1
Unnamed Spring	0.04	1
Unnamed Stream	0.13	1
Well	0.09	1
Yakima River	105.64	33
Grand Total	**108.41**	**41**

Table 31. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin FN Federal Reserved (Non-Tribal). Note, values displaying as “0.00” are either water rights for storage that have no associated Qi or water rights with a Qi value beyond two decimal places.

First Source Listed	Sum of Qi	Count of Rights
American River	0.04	1
Cle Elum Lake	0.03	1
Kachess Lake	0.07	1
Manastash Creek	0.07	1
Mill Creek	0.07	1
Naches River	0.30	2
Pine Creek	0.50	1
Salmon La Sac Creek	0.30	1
Snake Creek	0.00	2
Swauk Creek	0.03	1
Taneum Creek	0.08	1
Teanaway River	0.02	1
Thetis Creek	0.02	1
Tieton River	0.34	3
Toppenish Creek	5.80	3
Unnamed Spring	0.08	3
Unnamed Stream	0.04	3
Wilson Creek	0.02	1
Yakima River	0.30	2
Grand Total	**8.11**	**30**

Table 32. Total instantaneous (Qi) water amounts and total number of rights by source from certificated water rights in Yakima Adjudication Subbasin Major Claimants (MC). Note, values displaying as "0.00" are either water rights for storage that have no associated Qi or water rights with a Qi value beyond two decimal places.

First Source Listed	Sum of Qi	Count of Rights
American River	0.01	1
Andy Spring	0.00	1
Badger Creek	15.60	1
Bethel Ridge Spring	0.00	1
Bumping River	0.00	1
Caribou Creek	30.00	1
Cash Prairie Spring	0.00	1
Cedar Creek	0.02	1
Cle Elum River	3.00	2
Coleman Creek	25.00	1
Cowiche Creek	0.22	1
Currier Creek	7.05	1
Deadhole Spring	0.00	1
Glen Spring	0.00	1
Groundwater	0.82	2
Ironstone Spring	0.00	1
Kachess Lake	0.00	1
Kachess River	0.00	1

Larkin Spring	0.05	1
Little Bald Mountain Spring	0.00	1
Lyle Creek	10.00	1
Morgan Draw Spring	0.00	1
NA	0.00	3
Naches River	479.83	26
Naneum Creek	17.52	1
North Fork Cowiche Creek	20.00	2
Parke Creek	7.87	1
Pine Tree Spring	0.00	1
Poverty Basin Spring	0.00	1
Red Rock Spring	0.00	1
Salmon La Sac Creek	0.04	1
Short Spring	0.00	1
Spring Creek	0.02	1
Thetis Creek	0.05	1
Tieton River	347.07	5
Timber Creek	0.01	1
Timberwolf Spring	0.00	1
Unnamed Creek	0.01	1
Unnamed Spring	0.55	23
Unnamed Stream	0.06	2
Willow Spring	0.00	1
Yakima River	9280.74	58
Grand Total	**10245.58**	**156**

Table 33. Approximately 15 of 168 named streams (one source identified as "NA") have over 146 cfs of cumulative water rights with a purpose of use as only Instream Flow. Sources are named streams identified in the WRTS as having a surface water right. Note, values displaying as "0.00" are either water rights for storage that have no associated Qi or water rights with a Qi value beyond two decimal places. All streams, except the NA stream, are listed in the CRIA.

Row Labels	Sum of Qi	Count of Qi
Big Creek	**1.53**	**2**
Instream Flow	1.53	2
Coleman Creek	**0.43**	**1**
Instream Flow	0.43	1
Cowiche Creek	**1.02**	**2**
Instream Flow	1.02	2
First Creek	**7.53**	**5**
Instream Flow	7.53	5
Iron Mountain Creek	**0.33**	**1**
Instream Flow	0.33	1
Manastash Creek	**16.21**	**20**
Instream Flow	16.21	20

NA	**2.70**	**5**
Instream Flow	2.70	5
Naches River	**0.38**	**1**
Instream Flow	0.38	1
Naneum Creek	**0.26**	**1**
Instream Flow	0.26	1
Schnebly Creek	**0.02**	**1**
Instream Flow	0.02	1
South Fork Cowiche Creek	**6.61**	**13**
Instream Flow	6.61	13
Swauk Creek	**2.01**	**4**
Instream Flow	2.01	4
Taneum Creek	**39.83**	**2**
Instream Flow	39.83	2
Teanaway River	**12.40**	**31**
Instream Flow	12.40	31
Wenas Creek	**0.87**	**1**
Instream Flow	0.87	1
Yakima River	**54.08**	**9**
Instream Flow	54.08	9
Grand Total	**146.21**	**99**

Appendix 2. CRIA Flow for Fish Score Methods.

June 9, 2022

To: Justin Bezold, Trout Unlimited – Washington Water Project
Richael Young, ERA Economics

From: Jonathan Kohr, WDFW

RE: WDFW staff Yakima River water market scoring

Eastern Washington Water Science Team (WST) staff were asked to provide technical assistance to update scores to Yakima Basin stream reaches from the most recent Columbia River Instream Atlas (CRIA) (Scott et al., 2016). The request came from Trout Unlimited and ERA Economics as part of a Yakima Basin Water Market Strategy Development, in furtherance of the Yakima Basin Integrated Plan's Market Reallocation element. This scoring for water marketing consisted of streams and stream reaches within Water Resource Inventory Areas (WRIAs) 37, 38, and 39. Using the existing fish, habitat, and flow scores from 2016 CRIA, WST staff sorted the streams and associated reaches, highest to lowest for combined scores.

Binning of the scores was determined using a range of the lowest and highest scores stratified into thirds, i.e., 3 bins. The final combined scores for the 3 metrics (fish, habitat, flow) had a possible range of 0.26 to 0.74. All the stream reach scores were divided evenly from an affixed low score of 0.26 to the highest score of 0.74. The lowest 1/3 of the scores were assigned a rating of "3= Low"; the middle 1/3 of the scores are assigned a rating of "2= Medium", and the highest 1/3 of the scores for the WRIA are assigned a rating of "3= High".

A thorough review was then conducted by WST staff to use a best professional knowledge process to change or rescore any streams that had obviously inflated or deflated scores due to any inconsistencies in the original CRIA scores. The end result was a general assessment of the need for water in the streams and stream reaches reviewed from the CRIA for the three Yakima River WRIAs.

For questions and comments please contact:

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Scott, T., J. Kohr, R. Granger, A. Marshall, D. Gombert, M. Winkowski, E. Bosman Clark and S. Vigg. 2016. Columbia River Instream Atlas (CRIA), FY2016. A component of the Columbia River Basin 2016 Water Supply & Demand Forecast. November 9, 2016. Funded by Washington Office of the Columbia River, Department of Ecology. 98 Pages

S2.4: Crop Water Needs and Values

The researchers from Washington State University (WSU) provided a technical analysis of water resources related crop water needs. Additionally, WSU researchers provided information on crop water values. The technical report and associated data sets were used by ERA Economics in the market simulations and water rights analyses.

This report was developed for this project and is not intended for use beyond the scope of the smart market strategy development.

WSU Technical Documentation for:

Leveraging Agricultural Water Transactions to Increase Instream Flow Executive Summary

Trout Unlimited and Mammoth Trading

December 17, 2020

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1. Introduction

WSU was tasked with the following effort:

Complete water rights analyses for valuation purposes, including compiling and processing agricultural and water data, developing and running a crop-water model, developing the economic valuation of crop water demands, conducting spatial analysis of crop-water values, and simulating and analyzing water market transactions.

Involved in this, WSU completed the following subtasks

Subtask 1: Estimate Crop-Specific Water Demand

- *Compile and curate Yakima Basin agricultural data* (see section 2)
- *Complete necessary crop-water modeling to provide accurate and up-to-date estimates of crop irrigation demands. Run the crop-water model for the Yakima Basin that encompasses at least 40 crops produced (past or present). The model will incorporate the most recent science of surface water hydrology and crop growth modeling. The model will allow for evaluation of crop water demands based on: crop type, soils, local climate, and additional factors as identified by the technical work group.* (see section 2; note that while we do not provide crop-water estimates for 40 different crop groups, many of these 40 crop types have similar crop model parameters; instead we provide estimates for each of the crops that have a unique set of parameters. Therefore they can be considered to represent "crop groups".

Subtask 2: Update Crop-Specific Water Values

- *Assist Mammoth Trading with the development of a valuation methodology for water rights based on crops and water use/needs and then analyze the spatial distribution of the economic values of water. Include the most recent water valuation methodology informed by geospatial water right analysis to project water values in the current market framework and future scenarios based on water user needs to include agriculture, municipal, industrial, and/or environmental water demands.* (see section 3)

Subtask 3: Ongoing Review and Technical Assistance

- *Provide review and technical assistance to Mammoth Trading regarding the water market simulations based on geospatial water rights data and valuation, and Yakima water transfer constraints.* (this is not reflected in this report)

As deliverables, we provide this technical report and two data files, both of which are listed in the Appendix.

Please note that Drs. Adam, Liu, and Scarpare are responsible for the material and data from section 2 where Dr. Brady is responsible for material and data from section 3.

2. Crop Irrigation Demands

2.1 Overview

This effort involved the following steps: 1) collection of hydrologic and cropping data needed to parameterize the VIC-CropSyst model, 2) calibration of the soil parameters of the VIC hydrologic model, 3) calibration of the cropping parameters of the CropSyst model, 4) implementation of the coupled (VIC-CropSyst) model to simulate top-of-the-crop irrigation

demands by major crop groups in the Yakima River basin. Note that this effort overlaps with other funding that we have received to run the VIC-CropSyst model over the portions of the Columbia River basin, including 1) development of the irrigation depletions dataset for the 2020 Modified Flows dataset of the BPA, and 2) the Columbia River basin water supply and demand dataset of the Washington State Department of Ecology. Therefore, the technical documentation is similar in format to the technical documentations of these other reports. Also, even though we only provide data for the Yakima basin in this report, we provide the complete documentation for calibration of the VIC-CropSyst model for the Columbia River basin.

2.2 VIC-CropSyst Model Description

For this study, we applied the newly developed version (V3) of VIC-CropSyst, which couples the macro-scale hydrologic VIC (Variable Infiltration Capacity) model (Liang et al., 1994) and the CropSyst crop growth model (Stockle et al., 1994; 2003) to estimate irrigation depletions. In this approach, hydrology except plant transpiration is handled by VIC, while crop growth, plant transpiration, phenology and management are handled by CropSyst (Figure 1). VIC-CropSyst tightly integrates regional scale hydrologic and agricultural systems and has been used for long-term projections of Columbia River surface water supply and irrigation demands (e.g., Hall et al., 2016; Yorgey et al., 2011).

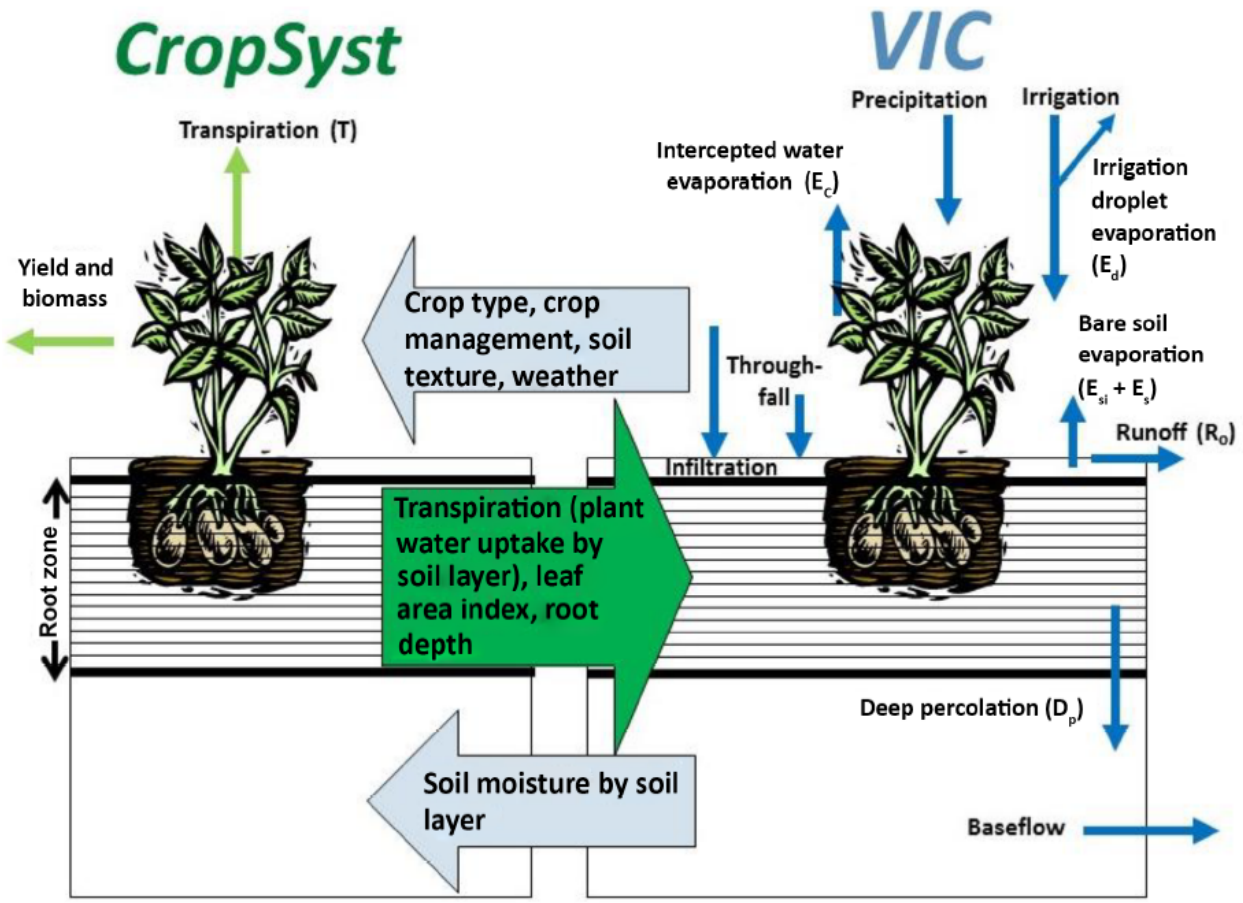

Figure 1. This schematic shows how VIC and CropSyst are coupled. VIC provides the availability of water and energy to CropSyst. CropSyst uses this information to grow the crop, produce biomass and yield, and simulate transpiration. CropSyst passes back the information that is needed by VIC (e.g., the distribution of transpiration uptake in different soil layers, leaf area index (LAI), and root depth) to simulate the hydrologic and energy cycles, and the scheduling of irrigation. (Figure from Malek et al., 2017)

The VIC model is a spatially-distributed, physically-based macro-scale (with a spatial resolution of 1/16th - 2°) land surface model which solves both water and energy budgets at every time step (from 1 to 24 h). For each grid cell, sub-grid variability in land cover and topography is based on statistical relationships. VIC models moisture and energy fluxes between the land surface and the atmosphere and includes shallow subsurface (frozen and unfrozen) moisture, snow, lake, and wetland dynamics (Andreadis et al., 2009; Bowling and Lettenmaier, 2010; Cherkauer and Lettenmaier, 1999). VIC has been evaluated and applied at multiple scales including global (Adam et al., 2009; Barnett et al., 2005; Nijssen et al., 1997), over the U.S. (Livneh et al., 2013; Maurer et al., 2002), and over the Columbia River Basin (Elsner et al., 2010; Hamlet and Lettenmaier, 1999; 2007; Liu et al., 2013).

CropSyst is a mechanistic crop growth, phenology, and management model that captures a spectrum of biological, physical, and chemical processes. The "growth engine" in the model is based on both solar radiation capture efficiency and water/transpiration-use efficiency, modulated by weather conditions affecting atmospheric evaporative demand and vapor pressure deficit, and by soil conditions and irrigation management affecting available water. Crop water demand (evapotranspiration) is determined from a crop coefficient factor (kc)[1] at full canopy and ground coverage determined by canopy leaf area index (LAI). This produces integration of crop production, weather and management with atmospheric warming and atmospheric CO_2 concentration, including responses to drought-induced water shortages. CropSyst has been evaluated in multiple studies (e.g., Benli et al., 2007; Stockle et al., 2010, 1996) with respect to crop biomass and yield production, crop water use, and in relation to crop response to water deficit. Note that CropSyst is invoked for each fraction of a VIC grid cell that is occupied by that crop (so may be invoked repeatedly for a single VIC grid cell; see Figure 2).

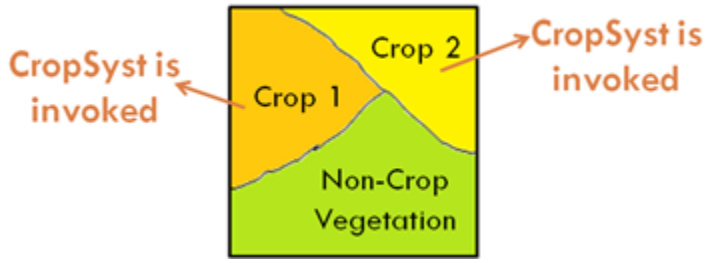

Figure 2. An illustration of how heterogeneity in land cover is handled in VIC-CropSyst. The model is run for each of the "sub-grids" that are associated with each land cover type. These sub-grids are not explicitly located in space but are lumped together as a single unit for each

[1] Crop factor coefficient (kc) incorporates crop characteristics (changes in vegetation and ground cover) and averaged effects of evaporation from the soil.

grid cell. CropSyst is invoked only for the sub-grids occupied by cropland. (Figure from Stockle et al., 2014)

VIC-CropSyst simulates irrigation water loss either with predefined irrigation efficiency and loss parameters, or through mechanistic approach, which is described in detail by Malek et al. (2017).

2.3 VIC-CropSyst Model Calibration

Hydrologic calibration

VIC parameters include watershed-scale hydrologic properties that either cannot be measured directly or have significant spatial variations that need to be calibrated by iteratively comparing simulated results against observations. The following five parameters in VIC-CropSyst are automatically calibrated: BI, Ds_{max}, Ds, Ws, and D2:

- BI is the parameter controlling the shape of variable infiltration capacity curve;
- Ds_{max} is the maximum baseflow from the lowest soil layer;
- Ds is the fraction of Ds_{max} where non-linear baseflow begins;
- Ws is the fraction of the maximum soil moisture (of the lowest soil layer) where non-linear baseflow occurs; and,
- D2 is the soil depth of the lowest soil layer. These are the standard VIC parameters used for calibration.

More details about and the normal ranges of these parameters can be found in Appendix A.

Calibration methods

The automatic calibration is based on the multi-objective complex evolution (MOCOM-UA) global optimization method (Yapo et al., 1998). Six metrics/objectives are selected to evaluate model performance:

1) Nash-Sutcliff model efficiency coefficient (NSE):

$$\mathrm{NSE} = 1 - \frac{\sum_{t=1}^{T}(Q_m^t - Q_o^t)^2}{\sum_{t=1}^{T}(Q_o^t - \overline{Q_o})^2} \quad (2)$$

where $\overline{\mathrm{Qo}}$ is the mean of observed discharges, and Q_m^t and Q_o^t are modeled and observed discharge at time t (here we use monthly time step), respectively.

2) Nash-Sutcliffe efficiency with logarithmic values (Ln NSE)

To account for the effect of low flows in our evaluation of model performance, we use the logarithmic value of Q_m^t and $Q\ _o^t$ in equation 2.

3) Relative bias in annual flow

$$\mathrm{RelBias} = \left|\frac{\overline{Q_m}}{\overline{Q_o}} - 1\right| \quad (3)$$

$\overline{Q_m}$ and $\overline{Q_o}$ are the average annual modeled flow and observed flow, respectively.

4) Coefficient of determination r^2

$$r^2 = \left(\frac{\sum_{t=1}^{T}(Q_o^t - \overline{Q_o})(Q_m^t - \overline{Q_m})}{\sqrt{\sum_{t=1}^{T}(Q_o^t - \overline{Q_o})^2}\sqrt{\sum_{t=1}^{T}(Q_m^t - \overline{Q_m})^2}} \right)^2 \quad (4)$$

5) Absolute average peak flow difference (AvgPeakDiff)

$$\text{AvgPeakDiff} = \left| \overline{Q_o^{peak}} - \overline{Q_m^{peak}} \right| \quad (5)$$

The average peak flow is calculated from average monthly flow (i.e., the maximum value).

6) Root mean square error (RMSE)

$$\text{RMSE} = \sqrt{\frac{\sum_{t=1}^{T}(Q_o^t - Q_m^t)^2}{T}} \quad (6)$$

The multiple objectives of the calibration is to get the Pareto set, that is, solutions that cannot be improved without degrading at least one of the other objectives. To standardize the above matrices, the NSE, Ln NSE, and r^2 metrics are multiplied by -1 (as greater numbers are preferable for these metrics) and the standardized variable is minimized.

Calibration data sets and screening

Because the calibration model runs were performed under no irrigation conditions (i.e., no water withdrawal from streams for irrigation) and reservoir influences, naturalized streamflow data sets were used for model calibration. We used four major data sources for this report (with the total number of stations for this calibration shown):

1) streamflow from USGS GAGES-II Reference stations and the drainage area larger than 200 km^2 (33 stations);

2) No Regulation No Irrigation (NRNI) data products from USACE (197 stations);

3) naturalized streamflow from Columbia Basin Climate Change Scenarios Project (CBCCSP) of University of Washington (166 stations); and,

4) naturalized streamflow for the Umatilla basin (1 station) (Figure 3).

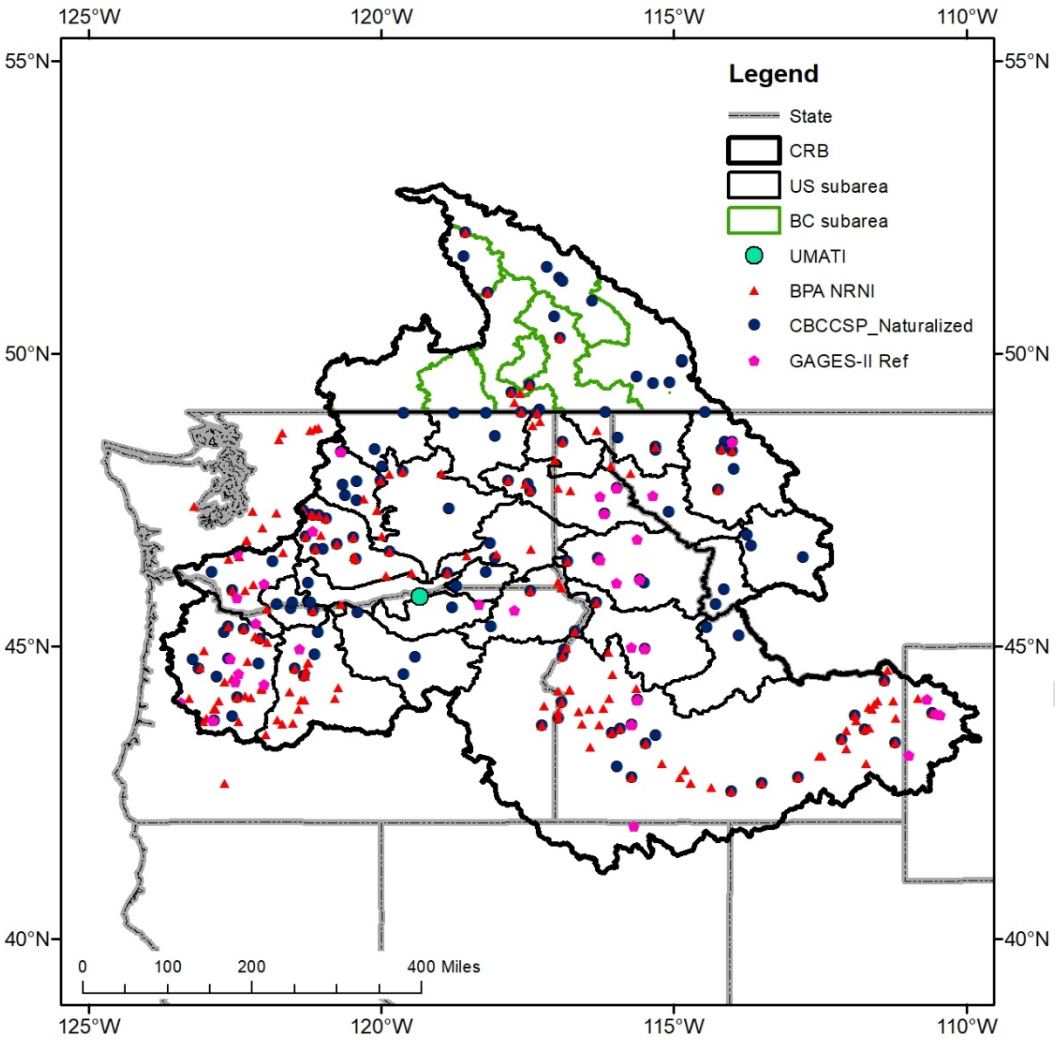

Figure 3. Hydrological gauges/stations with naturalized streamflow data for model calibration. (Note: this figure shows all stations. We screened these to a smaller set of stations for our own use. CRB: Columbia River Basin; US: United States; BC: British Columbia, Canada; UMATI: Umatilla; NRNI: No Regulation No Irrigation; CBCCSP: The Columbia Basin Climate Change Scenarios Project; GAGES-II Ref: Geospatial Attributes of Gages for Evaluating Streamflow, Version II, reference sites)

The corresponding grid cells for each station were identified by using VIC grid cell flow direction and the estimated accumulated area (comparing with each station's contribution area). Among these 397 stations, 317 of them were successfully identified with a corresponding VIC grid cell (by visual interpretation with VIC generated watershed boundary with 1:250,000 scale of USGS Hydrologic unit codes (HUC) boundary map) (https://water.usgs.gov/GIS/metadata/usgswrd/XML/huc250k.xml). To eliminate biases due to inconsistencies in drainage area and because of the limitations of VIC in simulating small watersheds, we used the following approach. We only selected the stations with drainage areas larger than 500 km^2 and that are within 25% error in calculated drainage area (note that the flow direction file created using GIS and a digital elevation model gives the VIC-simulated drainage

area; this is compared to the drainage area reported with the streamflow observations). After this screening process, 274 stations were left for the calibration process. If several datasets provided the same stations, the order of priority of use was as follows: USGS reference gauges > NRNI > CBCCSP naturalized flow.

Calibration procedure

The calibration was conducted using a nested approach, in which the most up-stream stations were calibrated first, followed by the remaining grid cells at the next station downstream, etc., until the whole watershed was calibrated. For example, the most up-stream (headwater) stations was set to a level 0 and with increasing levels moving downstream. Through this iteration, 39 levels are identified over the CRB basin. Figure 4 (which contains 5 levels from level 0 to 4 for an example watershed) depicts an example of the hierarchy of watershed levels.

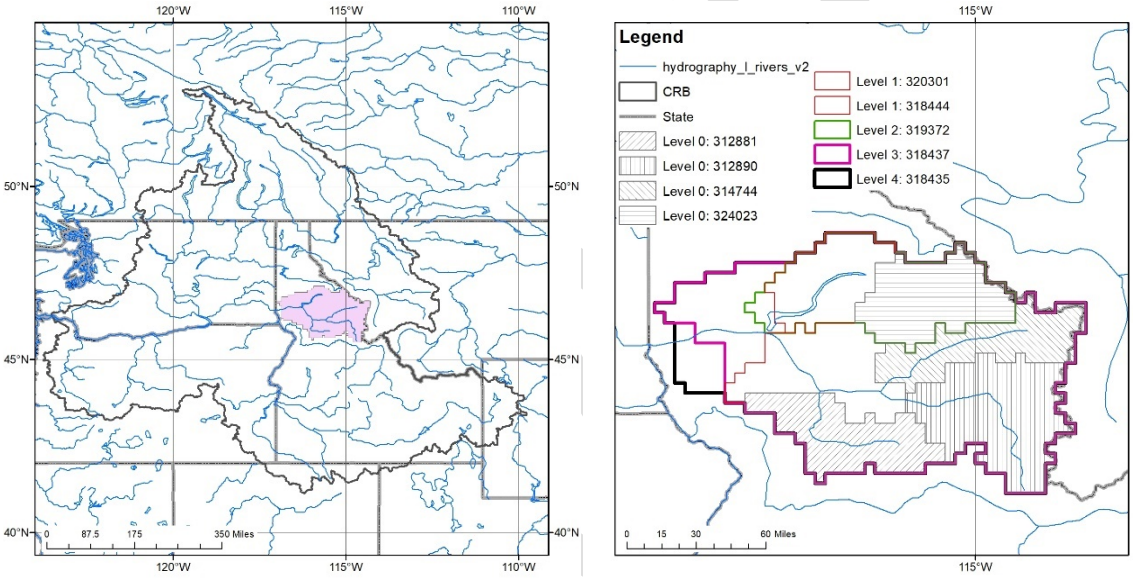

Figure 4. Example watershed levels for model calibration. (The left panel show the location of this sampling watershed; the right panel shows the watershed boundaries for different levels.)

For model calibration, we compared routed model output from 1980-current for comparison against naturalized streamflow. The routing is conducted with the VIC routing post-process developed by Lohmann et al. (1996, 1998). If the observations (after the year 1981) were less than two years, the station was removed from analysis and the calibration moved to the next level. If the maximum of the average NSE and Ln NSE was equal or higher than 0.5, then we accepted the calibrated soil parameters for this watershed (and set the station as valid); otherwise, this station was removed from calibration and steps into the upper level watershed for calibration. The final calibration results can be found in Section 2.5.1.

CropSyst parameterization and calibration

CropSyst parameterization

CropSyst crop parameters describe the crop's phenology, canopy growth, transpiration, biomass production, and yield. These parameters are crop and region-specific and there is no single standard source of information. Initially, the crop parameter values were taken from existing model applications in the region (Malek et al., 2017, 2018; Rajagopalan et al., 2018).

For the purposes of this project, given that we were not interested in crop response to stress, the critical parameters that needed fine-tuning through communications with local experts were planting and harvest dates, timing of various phenological (growth) stages and canopy cover at different growth stages. To account for site-specific and local variation in crop growth/ development, management information collected from field trials (under ten years old), including average sowing, flowering and heading (when available), harvest dates, total irrigation water applied and yield were used as the main source of calibration information. These field trials, conducted mostly by University Extension employees, include a range of management practices and crop varieties that represent the diversity of farmers' practices in the Pacific Northwest. Moreover, information from local growers, USDA NASS information on usual planting and harvest dates (USDA NASS, 2019), and other sources of literature were used to ensure the parameters used reflect reality in terms of actual practices in a region.

We parameterized and calibrated the CropSyst model for the main agricultural area spread across the U.S. part of CRB; for most of Oregon, eastern Washington, southern Idaho and western Montana. Eleven calibration sites were used to run the CropSyst simulation; these were compared against yields records and crop cycle development length information (when available) from field trials. In this regional crop calibration type, the simulations and field trials locations were not the same since the planting and harvest dates used for calibration (based on USDA crop calendar) were not necessarily the same as from the trials. Moreover, for calibration, we used only one soil type and the forcing data used represents the climate condition of the grid cells. The field trials and calibration site locations used in this project are shown in the map below (Figure 5) and (Table 1).

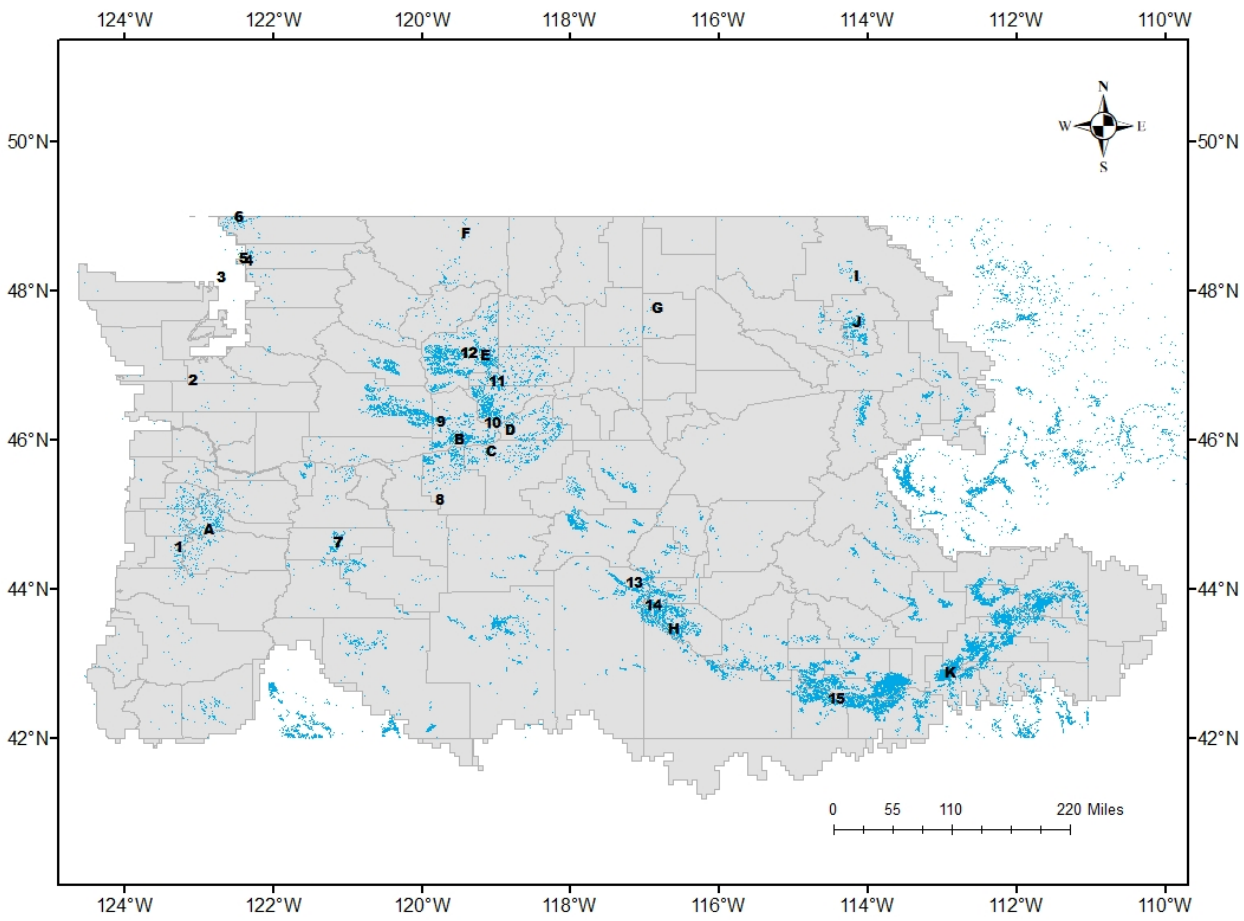

Figure 5. Field trials (numbers), model calibration (letters) sites and the irrigated extent area (MIrAD) in the U.S. Columbia River Basin. See Table 1 for calibration and field trials site details.

Table 1. Field trials and model calibration site descriptions used in this project.

Site code	Site name	Site description	Longitude	Latitude
A	Marion County_OR	Calibration	-122.85000	44.81000
B	Benton County_WA	Calibration	-119.48000	46.02000
C	Umatilla County_OR	Calibration	-119.06000	45.85000
D	Walla Walla County_WA	Calibration	-118.81000	46.14000
E	Grant County_WA	Calibration	-119.14000	47.14000
F	Okanogan County_WA	Calibration	-119.40000	48.78000
G	Kootenai County_ID	Calibration	-116.84000	47.78000
H	Canyon County_ID	Calibration	-116.61000	43.48000
I	Flathead County_MT	Calibration	-114.15000	48.21000
J	Lake County_MT	Calibration	-114.15000	47.59000
K	Bingham County_ID	Calibration	-112.89000	42.89000
1	Corvallis_OR	Field trial	-123.26205	44.56457
2	Thurston_WA	Field trial	-123.08100	46.80600
3	Island_WA	Field trial	-122.69500	48.19500
4	Mount Vernon_WA	Field trial	-122.33410	48.42120
5	Skagit_WA	Field trial	-122.38800	48.44000
6	Whatcom_WA	Field trial	-122.45000	48.99600
7	Madras_OR	Field trial	-121.12917	44.63056
8	Hardman_OR	Field trial	-119.75561	45.20000
9	Yakima Valley_WA	Field trial	-119.74000	46.26000
10	Pasco_WA	Field trial	-119.10060	46.23960
11	Othello_WA	Field trial	-119.04947	46.79472
12	Moses Lake_WA	Field trial	-119.30597	47.18068
13	Ontario_OR	Field trial	-117.08416	44.09313
14	Parma_ID	Field trial	-116.94278	43.78611
15	Kimberly_ID	Field trial	-114.36476	42.53380

The CropSyst stand-alone *version 4.0* was used to calibrate 25 crops including cereal grains, vegetables, fruits, root crops, legumes, forages, and oil seeds crops (Table 2).

Table 2. Crop names (common and scientific) and types calibrated in this project.

Crop name	Scientific name	Crop type & metabolic pathway [a]
Alfalfa	*Medicago sativa*	Perennial_forage_C3
Apple	*Malus domestica*	Perennial_fruit_C3
Barley_spring	*Hordeum vulgare*	Annual_cereal_C3
Beans_dry	*Phaseolus vulgaris*	Annual_legume_C3
Blueberry	*Cyanococcus*	Perennial_fruit_C3
Canola	*Brassica napus*	Annual_oilseed_C3
Cherry	*Prunus avium*	Perennial_fruit_C3
Clover	*Trifolium*	Perennial_forage_C3
Corn_grain	*Zea mays*	Annual_cereal_C4
Corn_sweet	*Zea mays subsp. mays*	Annual_cereal_C4
Grape_wine	*Vitis vinifera or V. labrusca*	Perennial_fruit_C3
Grass_pasture	----------	Perennial_forage_C3
Hops	*Humulus lupulus*	Perennial_vegetable_C3
Lentil	*Lens culinaris*	Annual_cereal_C3
Mint	*Mentha*	Perennial_forage_C3
Oats	*Avena sativa*	Annual_cereal_C3
Onions	*Allium cepa*	Annual_bulb_C3
Pears	*Pyrus*	Perennial_fruit_C3
Peas_dry	*Pisum sativum*	Annual_legume_C3
Potatoes	*Solanum tuberosum*	Annual_tuber_C3
Radish	*Raphanus raphanistrum subsp. sativus*	Annual_vegetable_C3
Sod_seed_grass	----------	Annual_grass_C3
Triticale	×*Triticosecale*	Annual_cereal_C3
Wheat_spring	*Triticum*	Annual_cereal_C3
Wheat_winter	*Triticum*	Annual_cereal_C3

[a] C3 and C4 refer to different metabolic pathways for carbon fixation for photosynthesis in plants.

Parameters for most other crops were estimated by approximation to this basic set. Biomass production and yield information for some crops that have small production acreage were not readily available. For those crops, the primary parameterization emphasis was on canopy cover and water use, by approximation to crops in the basic set; thus, yield outputs for these crops should not be considered definitive.

2.4 Calibration Results

2.5.1 Hydrological calibration results

Figure 6 shows the distribution of NSE along the drainage area. Figure 7 shows the final calibrated stations/watersheds and the values for evaluation metrics. Overall, with increasing drainage area, the model gives better results in terms of NSE.

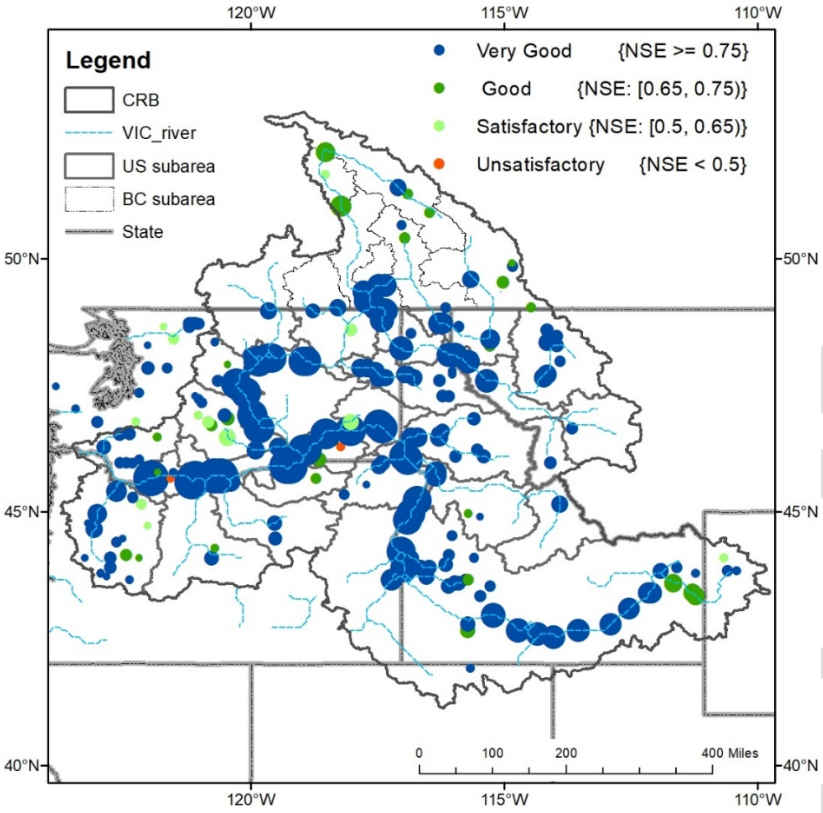

Figure 6. NSE values and its distributions of stations that were used for model calibration and their relationships with the size of drainage area. NSE categories for each calibration station and the symbol for them are scaled with drainage area.

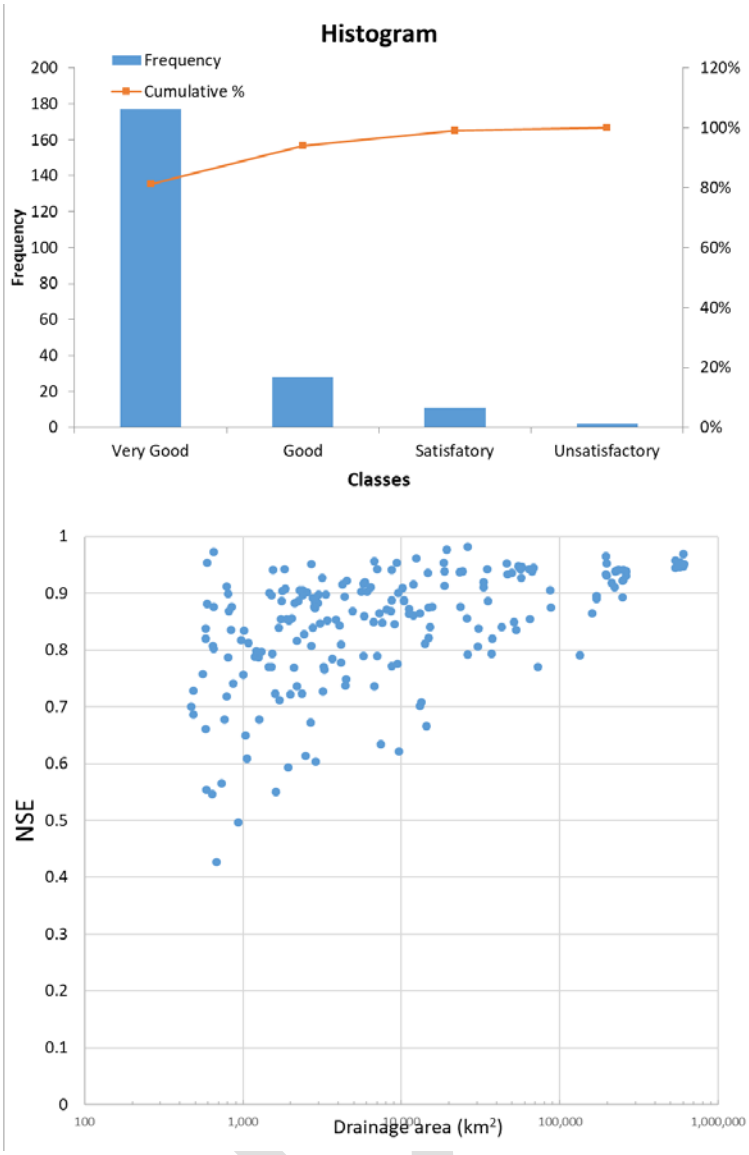

Figure 7. NSE values and its distributions of stations that were used for model calibration (shown in Figure 10). Top panel: left y-axis and column bars: the number of stations/basins falls in each NSE ranking/categories and the right y-axis and line shows the accumulative percentage; Bottom panel: NSE value distributions for each station with various drainage area.

2.5.2 CropSyst calibration results

Crop calibration was performed by adjusting the crop development (phenological stages), canopy growth (leaf area index [LAI] and Green area index [GAI] [2] at key events such as peak and

[2] Both green area index (GAI) and leaf area index (LAI) are simulated by CropSyst model. GAI and LAI measure the projected area of leaves over a unit of land (m^2/m^2). The main difference between the two variables is that LAI considers the green and dead leaves for evapotranspiration (evaporation + transpiration) estimations while GAI considers only green leaves for transpiration estimation.

senescence) and above ground dry matter assimilation (yield formation) based on available trial information.

Primary emphasis was focused on the crop length and the occurrence of a few important phenological events such as: crop emergence, beginning and end of flowering, beginning of yield formation, end of vegetative growth, and maturity if reached. As an illustration, different development patterns for some crop types explored in this project are presented below (Figure 8).

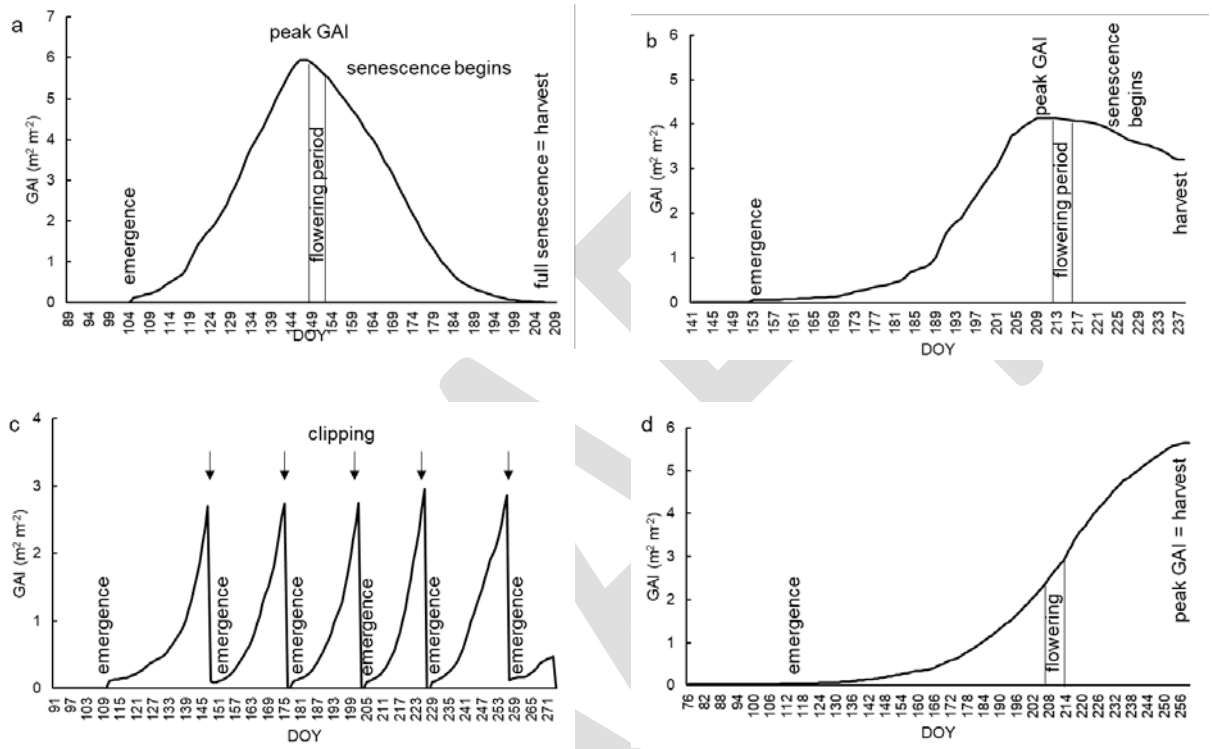

Figure 8. CropSyst simulated Green Area Index (GAI, m^2 m^{-2}) development and phenological stage events for a) Oats in Marion County, Oregon - 1981, b) Sweet corn in Marion County, Oregon - 1980 c) Grass pasture in Grant County, Washington -1983 and d) Hops in Marion County, Oregon - 1993.

Using the most common planting date, growing degree-day parameters were adjusted to approximate flowering and maturity dates typical for a particular site location within the CRB. Next, canopy cover (peak, beginning and full senescence – if reached) and above ground dry matter were calibrated concomitantly since canopy development drives crop water use, which is intrinsically related to yield. In this step, adjustments in the initial, maximum, and green canopy cover at the time of maturity (biomass accumulation has ended) were made.

For yield assessment, small adjustments to the transpiration-use efficiency and harvest index parameters to fine-tune the simulated yields were made when necessary. Calibration was considered finalized when simulated yields presented the same range of variation as the local experiments (on dry basis).

2.5 VIC-CropSyst Simulation Design

The simulation was conducted from the start of 1979 to end of 2015 and the mean irrigated water demand between 1986 to 2015 was used as the crop water demand (CWD). The simulations between 1979-1985 were used as the "spin-up" period to obtain initial state/soil moisture. For this report, the CWD was calculated as the deficit to field capacity from soil layers to the root depth whenever the Maximum Allowable Deficit (MAD) above the observation depth (crop-specific) was less than 0.2 for all crops. For alfalfa, pastureland, and other perennial crops (fruit trees), the first irrigation event was triggered when the soil moisture (above the observation depth) was less than 0.5; i.e., we set the MAD as 0.5 for the first irrigation event. After that threshold was reached, subsequent irrigation events were triggered by soil moisture less than MAD 0.2.

3. Updating Crop-Specific Water Values for Washington State

3.1 Overview

The purpose of this document is two-fold. First, it summarizes how estimates of the value of water for irrigating specific crop types were updated relative to previous estimates. Second, it provides guidance on key steps to using information provided in the spreadsheet for a specific analysis.

The value of water for irrigated agriculture depends on net revenue and water use per acre assuming that water use intensity does not vary. This is a potentially strong assumption given that there is a sound economic reason for farmers in many situations to use less than the amount of water that maximizes yield. However, estimating the value of incremental units of water associated with varying water use intensity per acre requires knowing how yields vary as a function of water use. Process-based crop growth models are only recently capable of producing these estimates. Also, there is empirical evidence that farmers tend to fallow in response to reduced water availability either through drought or the decision to lease water.

When valuing water for a seasonal lease market, net revenue is calculated as gross revenue minus variable costs. This is in contrast to permanent transfer, or sale, markets where net revenue is gross revenue minus total costs, which is then converted to a water value by calculating the discounted present value of annual net returns. Scott et al. (2004) developed a model for analyzing short-run drought impacts that has been used to evaluate many water storage and market investments in Washington over the past 15 years. Volatility in commodity markets means that water values can change significantly over short time horizons. Also, changes in production practices and input prices can result in big changes in costs. Most applications of the "Scott" model maintained assumptions for net revenue per acre by crop group over time for many reasons. One reason was to maintain consistency across studies that were considering same projects (Yoder et al., 2017).

Moving forward, it is important to update water values when new information is made available. The only source for estimates of variable costs for many crops in Washington is enterprise budgets. Updates to enterprise budgets are irregular, and some crops have not had updated

budgets in more than a decade. Price and yield estimates are relatively easy to update based on USDA statistics. These gaps are filled in with the next best information. Costs can be updated to current year based on producer price indices.

Another important aspect of the Scott model is significant aggregation of crop types into a smaller number of crop groups. There are 17 crop groups in the model compared to around 75 crop types. Aggregation is necessary in order to develop a tractable economic model where there are meaningful differences in water value between the crop groups.

3.2 Updates and Improvements to Scott et al. (2004)

- Some crop groups were removed while others were added to reflect changes in the regional crop mix. For example, asparagus was removed while blueberries were added.
- Cost, price, and yield information was updated with the most recent enterprise budget. WSU Extension has produced new budgets for many crops in the last 5 years. When no new WSU budget is available, the best alternative is for a nearby state such as Oregon or Idaho that is very recent. When this is not available, the best approach may be to use an older WSU budget and then update cost information using a relevant price index from the USDA or Bureau of Labor Statistics. This is provided within the spreadsheet. Crop price and yield can be updated easily with USDA statistics.
- The Scott model used "other" categories in order to be inclusive. New estimates of these categories are not provided. The reason is that these should be tailored to the scope of the project being analyzed.
- An updated value was not provided for wine grapes because there is so much variety across regions and wine varieties. This is especially true for the water use intensity variable that is the denominator when calculating crop water values. The value of water for irrigating wine grapes should be customized to the scope of the study.
- While fixed costs are not included in the water values reported, this report collected them as new information in case a permanent water sale scenario is being considered. This expands potential applications.
- The value for irrigating apples is an unweighted average across varieties. It would be advisable to weight using the variety specific values reported along with the acreage mix for the region of study.
- Establishment costs for perennial crops are included for modeling drought scenarios where losses could include the capital invested in the plant during the establishment phase if it dies due to a lack of water. Lifespan of the perennial is also included because this cost is amortized over the lifetime of the crop, so only the remaining portion should be subtracted in this scenario.
- Biophysical modeling produced year and location specific crop water demands. Average over space and time was used to calculate consumptive crop water requirements, which then is used to calculate water values. It is possible to now consider a distribution of crop water values due to variation in water requirements. The minimum and maximum for each crop group are reported in the data table.

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Appendix A: VIC Soil Parameters

Appendix A.1 Calibrated Soil Parameters and its Ranges over the CRB

Variable Name	Unit	# Dimensions	Description	Range (Min, Middle, Max, Mean)
Ds	N/A	1	The fraction of Dsmax where non-linear (rapidly increasing) baseflow begins. With a higher value of Ds, the baseflow will be higher at lower water content in lowest soil layer.	0.0004 0.2617 0.9771 0.3676
Dsmax	mm/day	1	Maximum baseflow that can occur from the lowest soil layer	0.0314 3.8070 29.9709 8.0600
Ws	N/A	1	The fraction of the maximum soil moisture (of the lowest soil layer) where non-linear baseflow occurs. This is analogous to Ds. A higher value of Ws will raise the water content required for rapidly increasing, non-linear baseflow, which will tend to delay runoff peaks.	0.0502 0.4677 0.9965 0.4992
BI	N/A	1	Defines the shape of the Variable Infiltration Capacity curve. It describes the amount of available infiltration capacity as a function of relative saturated grid cell area. A higher value of BI gives lower infiltration and yields higher surface runoff.	0.0022 0.1992 0.2981 0.1836
D2	Meter	1	Soil depth of the bottom layer: [typically 0.1 to 1.5 meters; this range is for the depth of each layer in traditional 3-layer VIC model run]. Soil depth effects many model variables. In general, for runoff considerations, thicker soil depths slow down (baseflow dominated) seasonal peak flows and increase the loss due to evapotranspiration.	0.0241 1.9347 2.9968 1.7693

Appendix A.2 List of Major Other VIC Gridded Soil Parameters and their Ranges over the CRB.

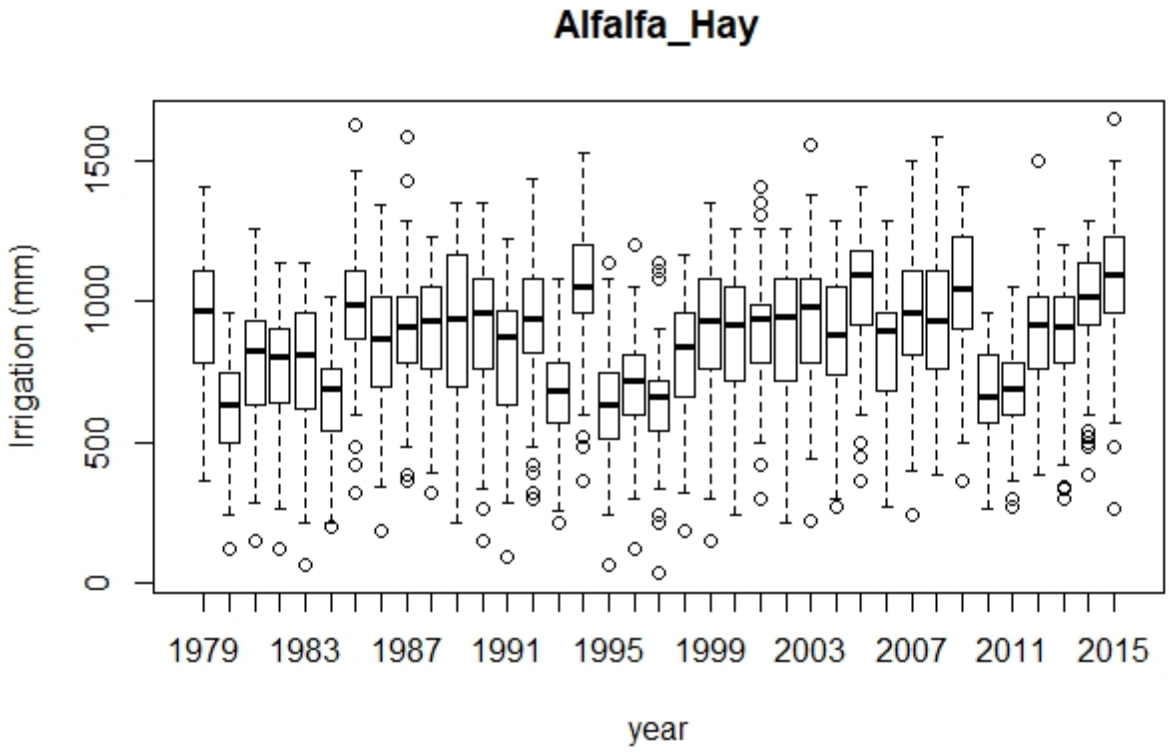
Variable Name	Unit	# Dimensions	Description	Range (Min, Middle, Max, Mean)
c	N/A	1	Exponent used in baseflow curve, normally set to 2	2
expt	N/A	[nlayer]	Exponent n (=3+2/lambda) in Campbell's eqn for hydraulic conductivity	3.4 12.7 43.7 13.2
Ksat	mm/day	[nlayer]	Saturated hydrologic conductivity	0 473 5087 630
depth	m	[nlayer]	Thickness of each soil moisture layer	0.003 0.1 3.0 0.2
avg_T	Celsius Degree	1	Average soil temperature, used as the bottom boundary for soil heat flux solutions	-7. 5.3 12.2 5.0
dp	m	1	Soil thermal damping depth (depth at which soil temperature remains constant through the year, ~4 m)	4
bubble	cm	[nlayer]	Bubbling pressure of soil. Values should be > 0.	5.9 8.6 56.7 9.8
quartz	fraction	[nlayer]	Quartz content of soil	0.00 0.41 0.98 0.45
bulk_dens_min	kg/m3	[nlayer]	Bulk density of soil layer	1115 1468

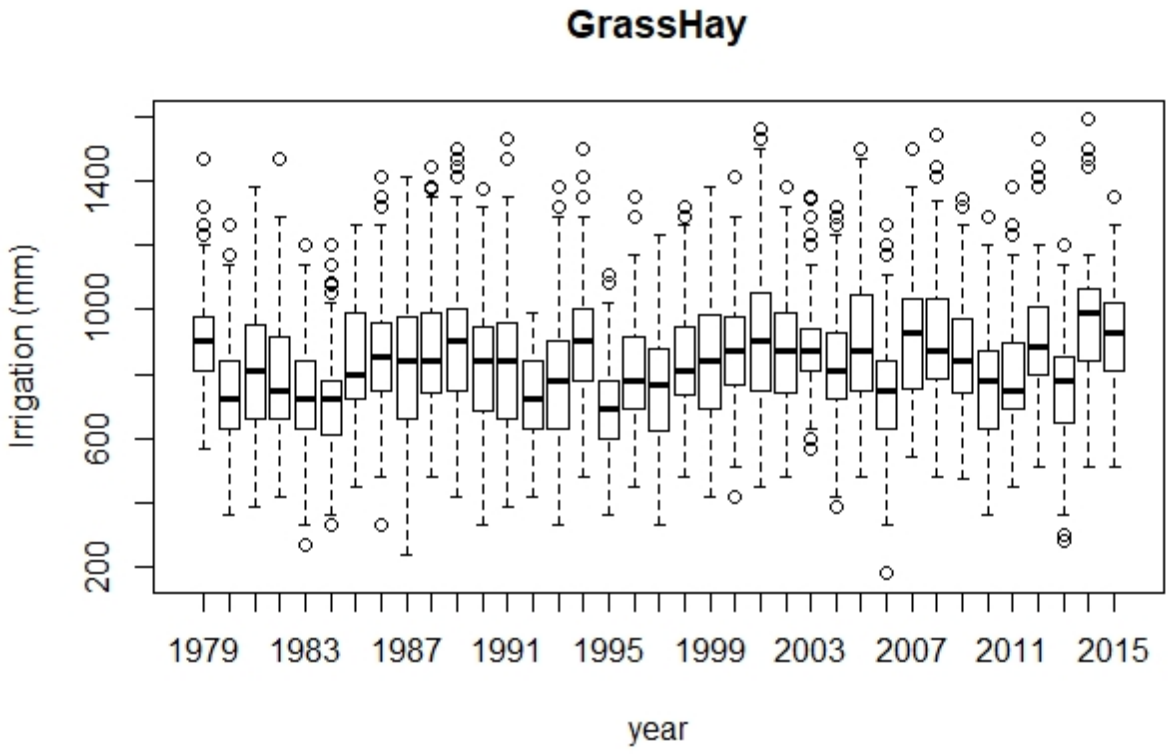
				2050 1472
soil_dens_min	kg/m3	[nlayer]	Soil particle density, normally 2685 kg/m3	1485 2650 2650 2617
rough	m	1	Surface roughness of bare soil	0.01
snow_rough	m	1	Surface roughness of snowpack	0.03
annual_prec	mm	1	Average annual precipitation	161 678 5523 826
avg_July_Temp	Celsius Degree	1	Average July air temperature	6.6 17.5 24.9 17.4
Clay	fraction	[nlayer]	Clay content of soil	0.01 0.15 0.88 0.19

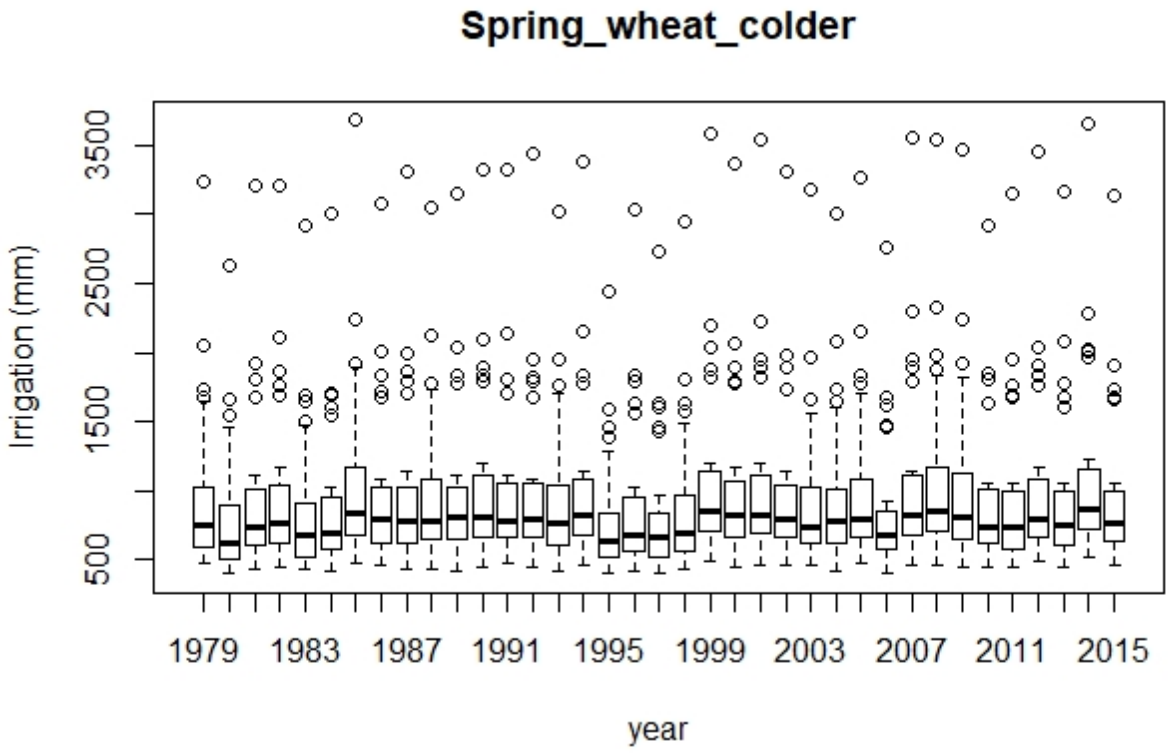
Appendix B: Top-of-the-Crop Irrigation Demands

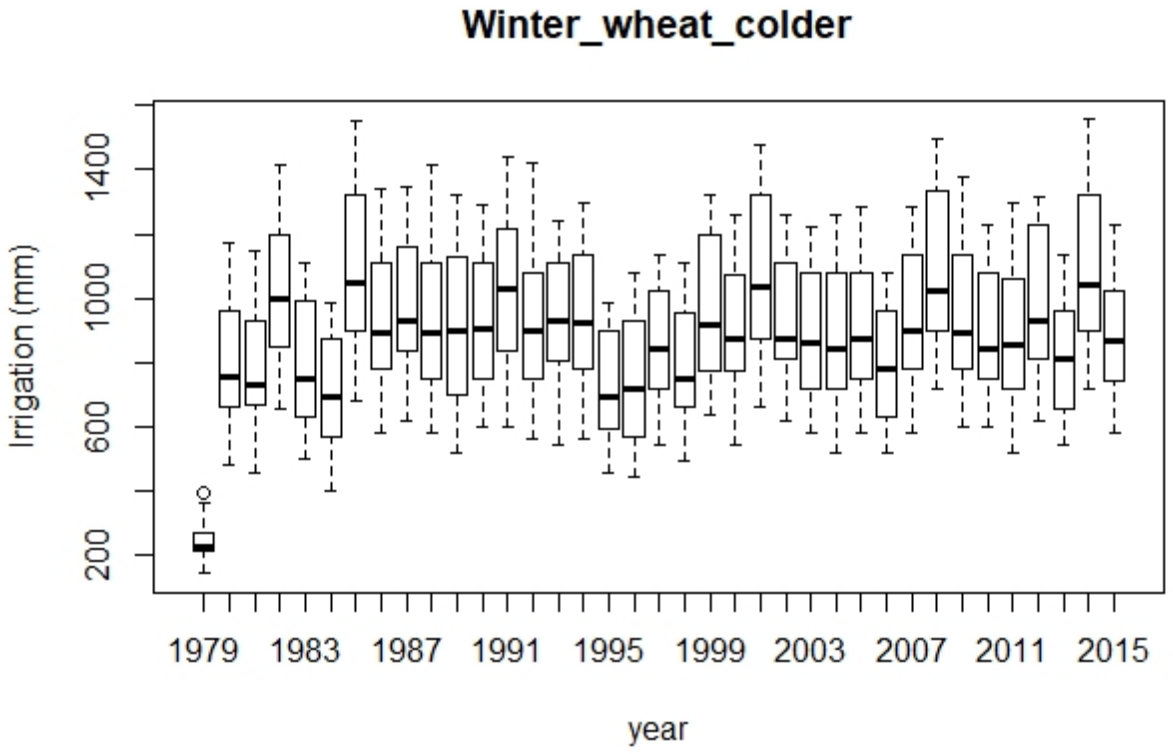
Appendix B.1 Plots for crop types

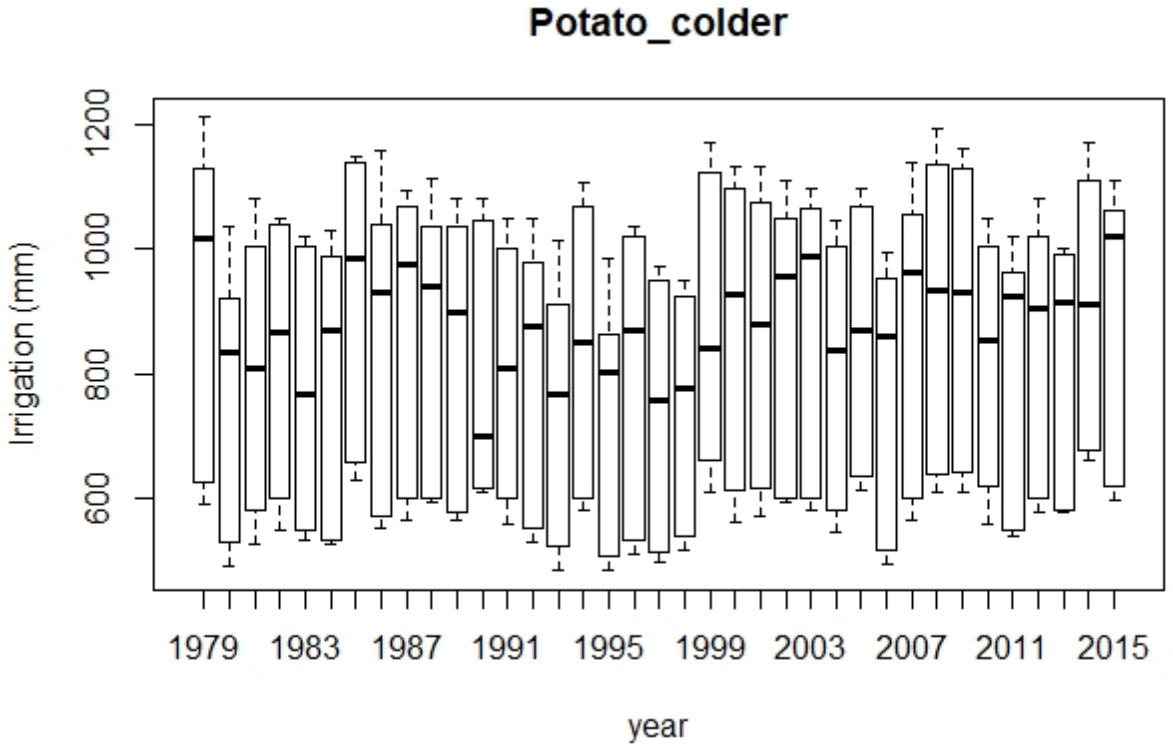
The irrigation distribution (boxplots) is from all 73 grids cells which has crop land use in the Yakima area.

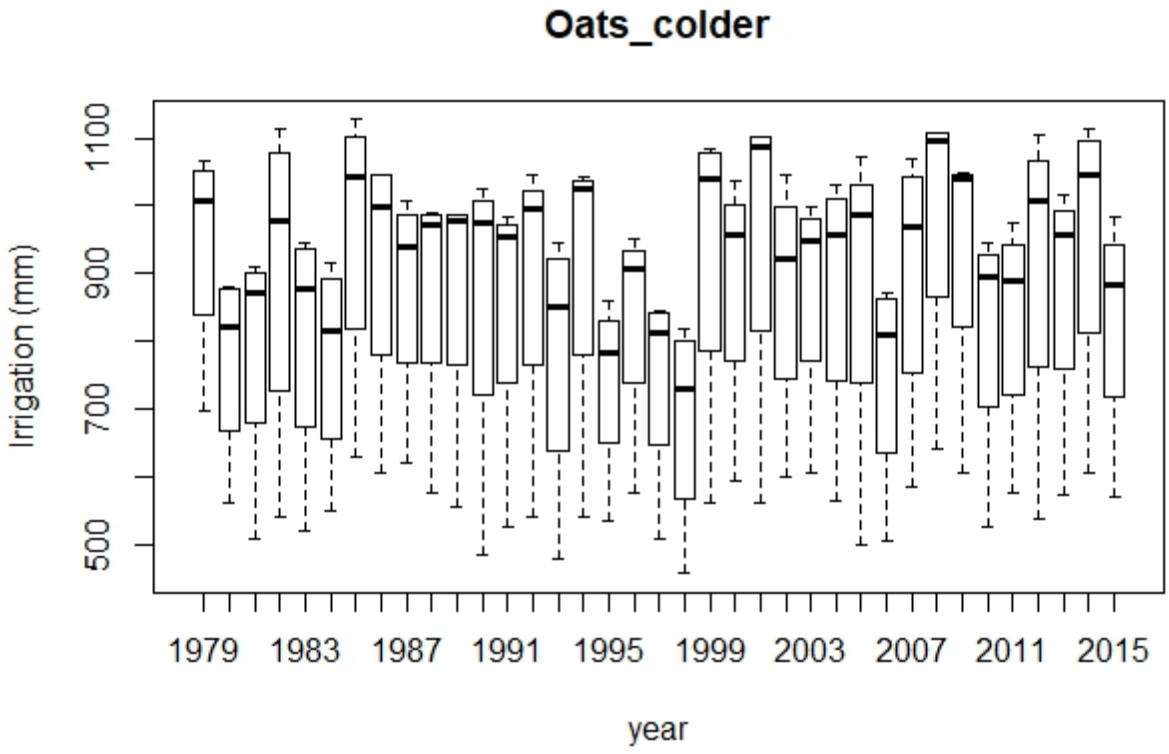


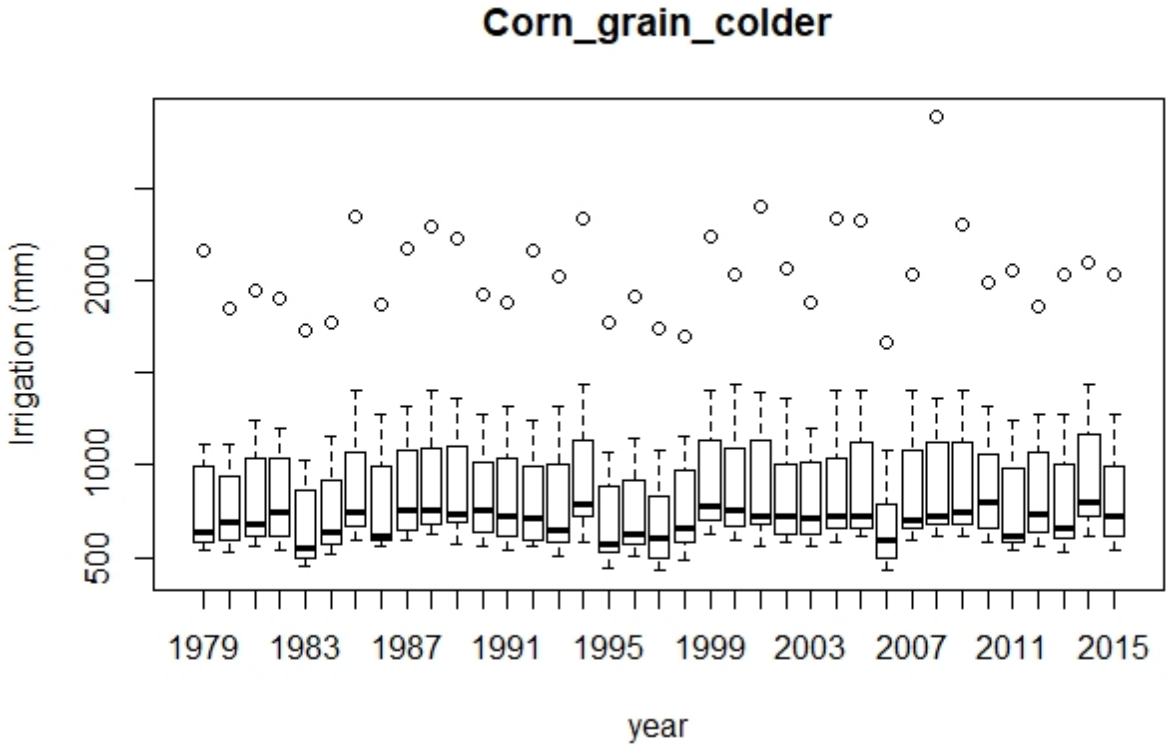

GrassHay
Irrigation (mm)
200
600
1000
1400
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

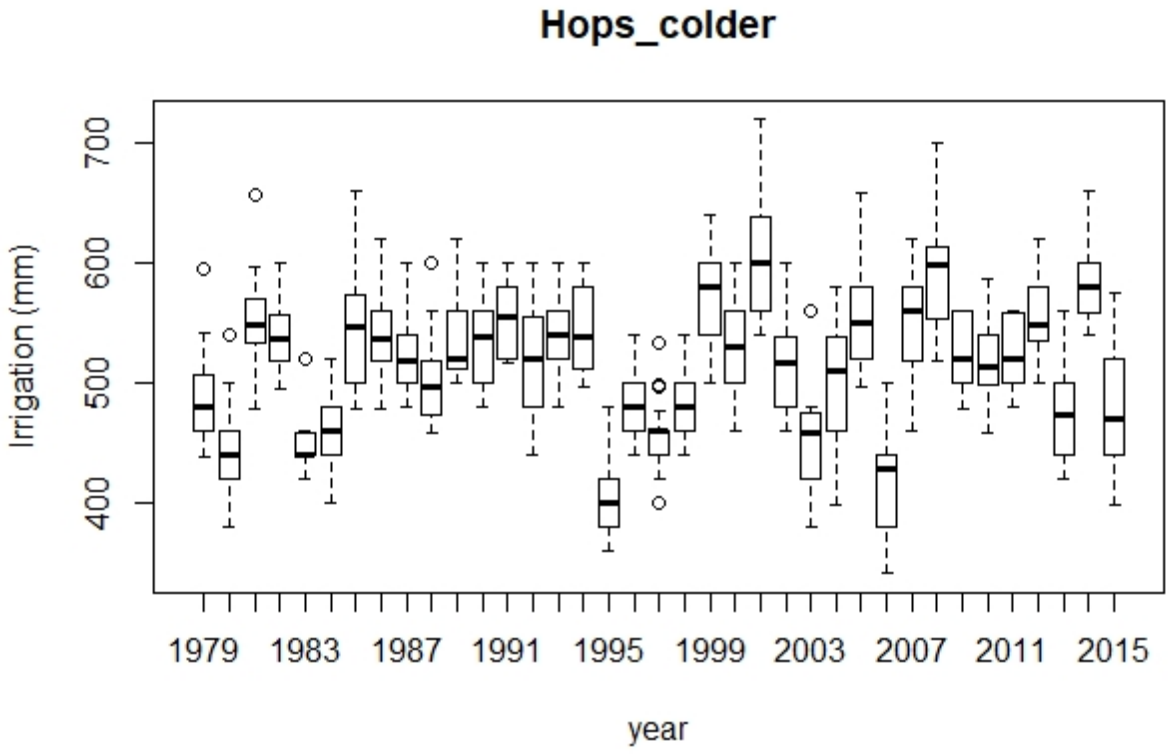

Spring_wheat_colder
Irrigation (mm)
500
1500
2500
3500
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

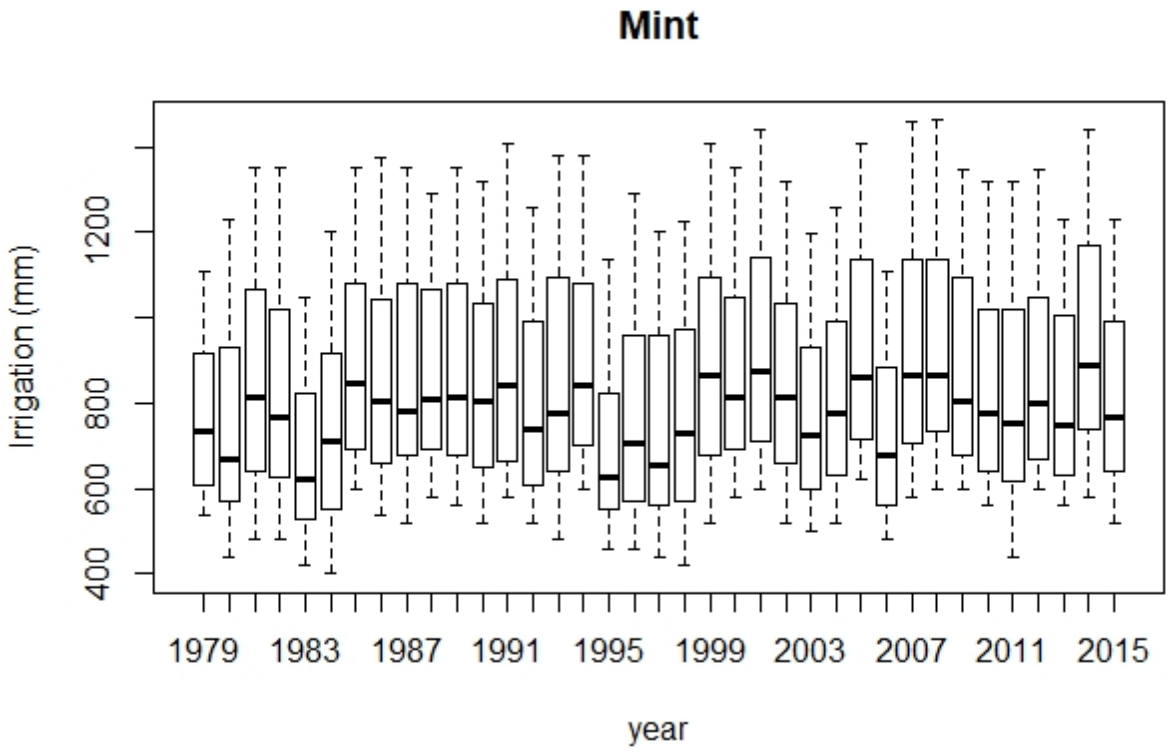

Winter_wheat_colder
Irrigation (mm)
200
600
1000
1400
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

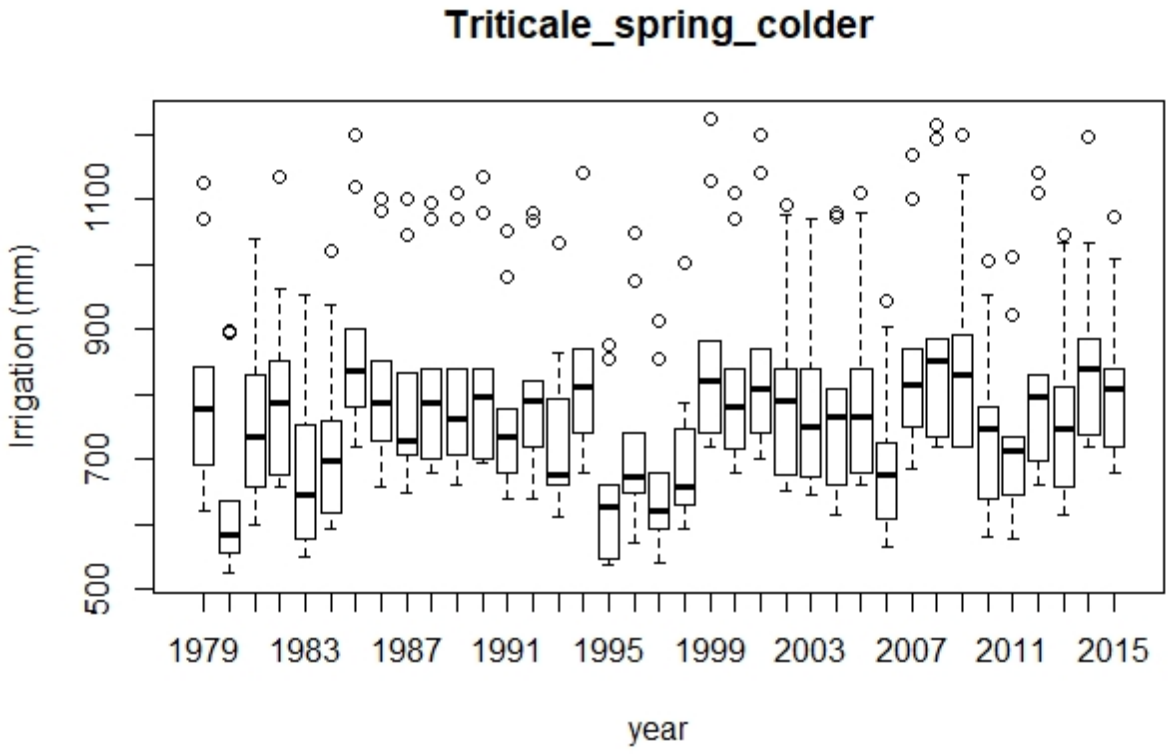

Potato_colder
Irrigation (mm)
600
800
1000
1200
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

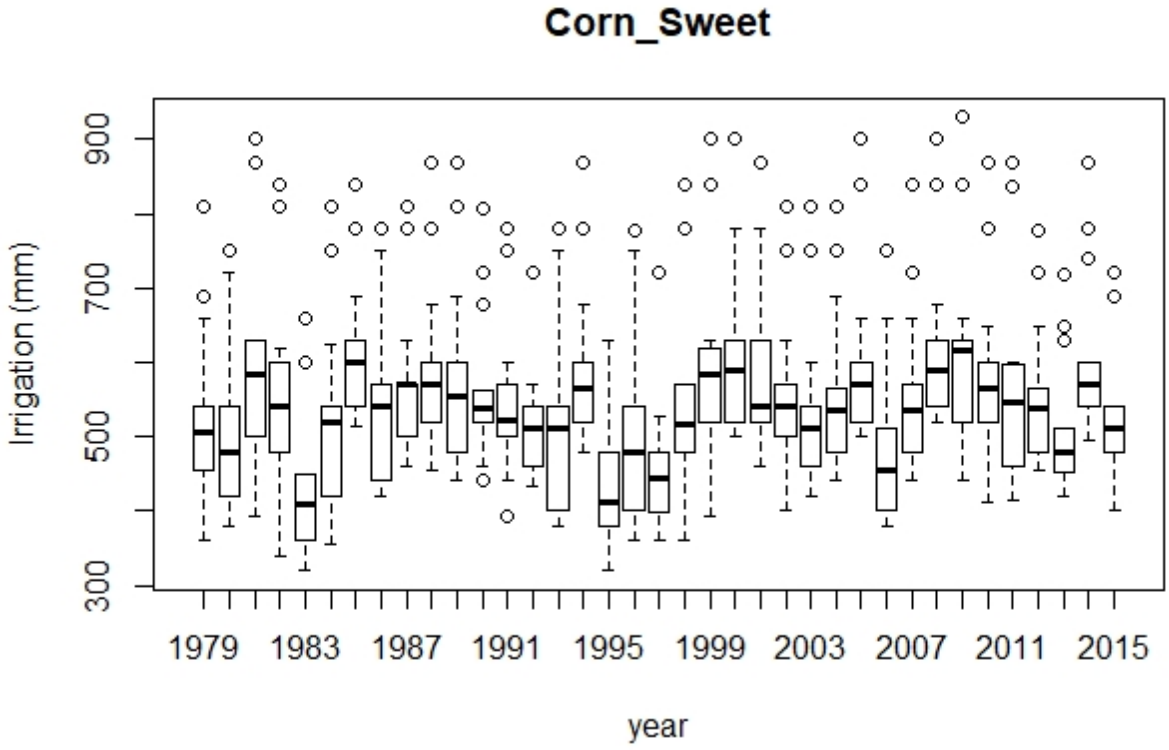

Oats_colder
Irrigation (mm)
500
700
900
1100
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

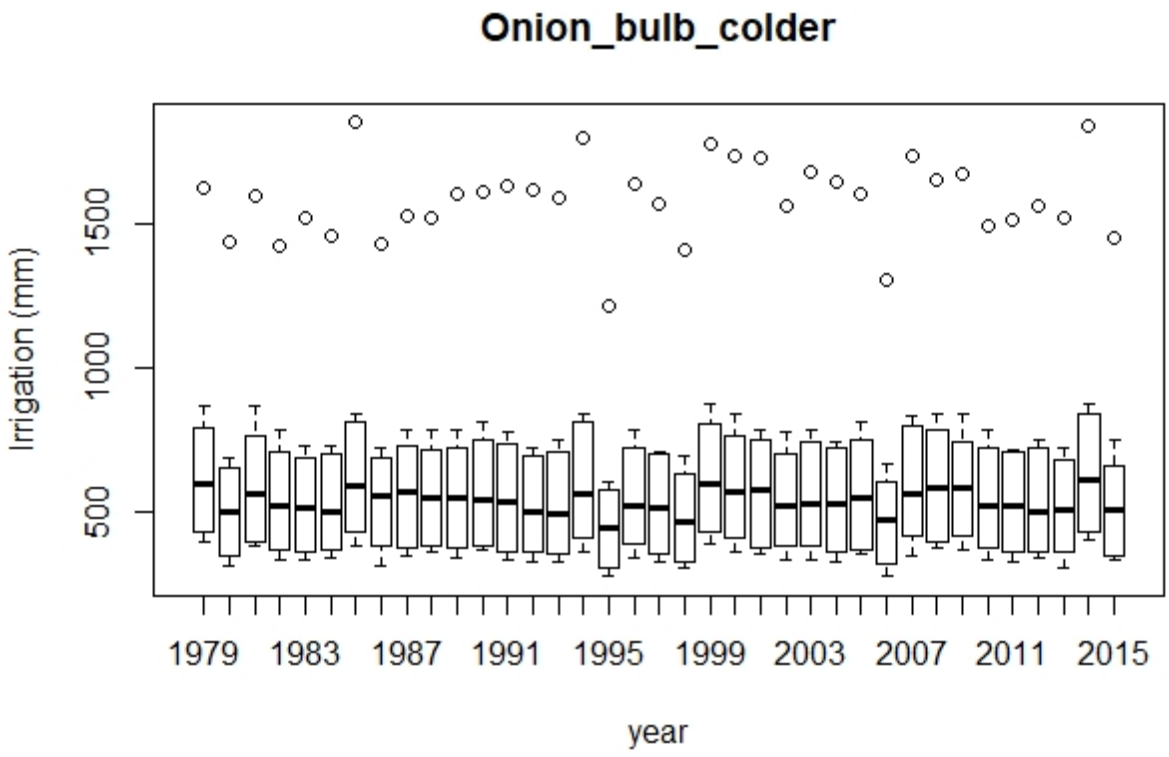

Corn_grain_colder
Irrigation (mm)
500
1000
2000
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

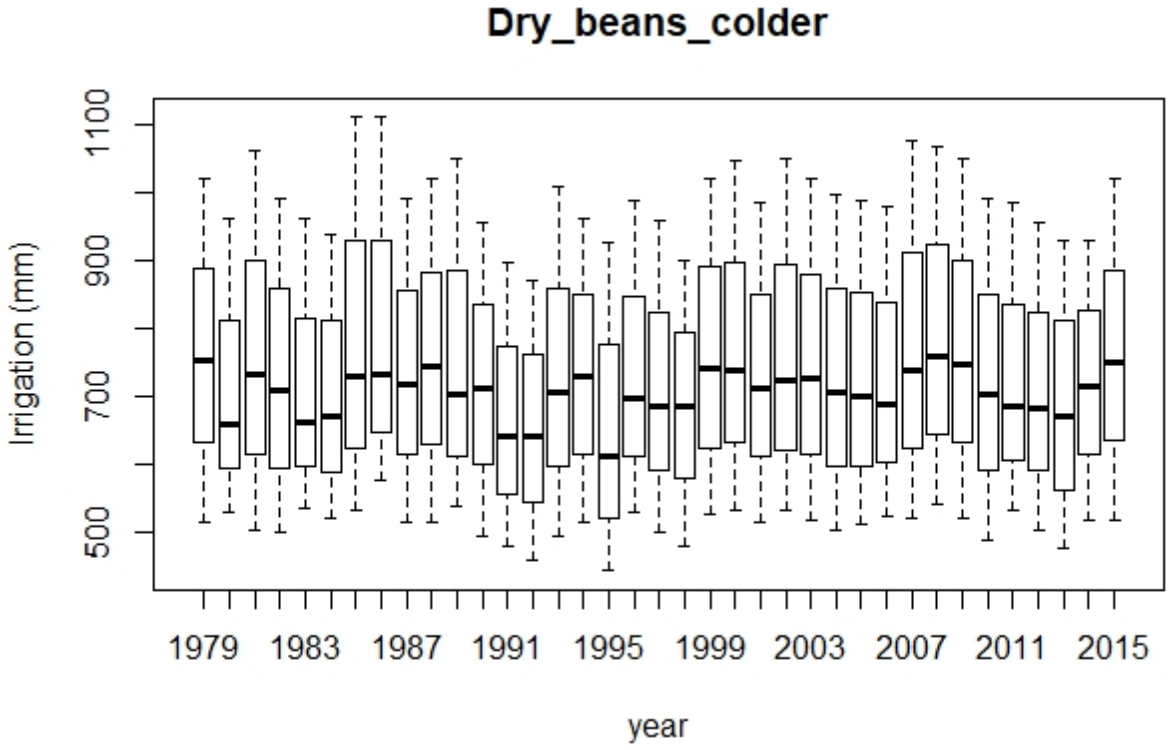

Hops_colder
Irrigation (mm)
400
500
600
700
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

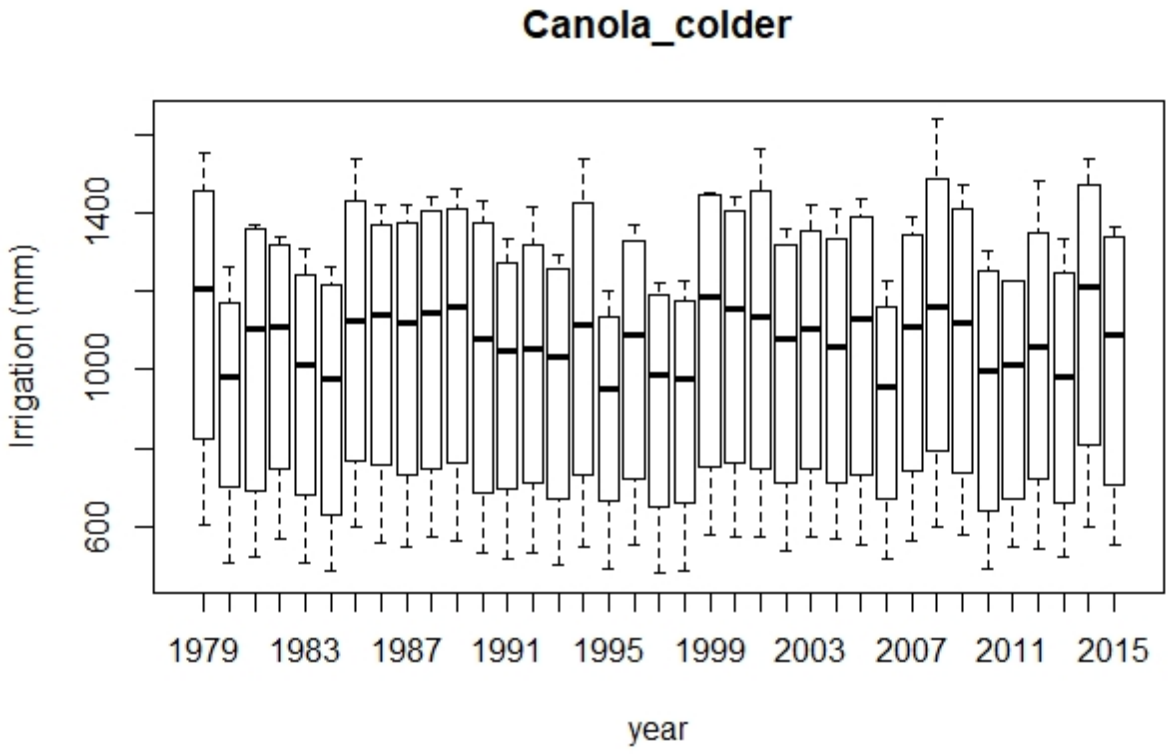

Mint
Irrigation (mm)
400
600
800
1200
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

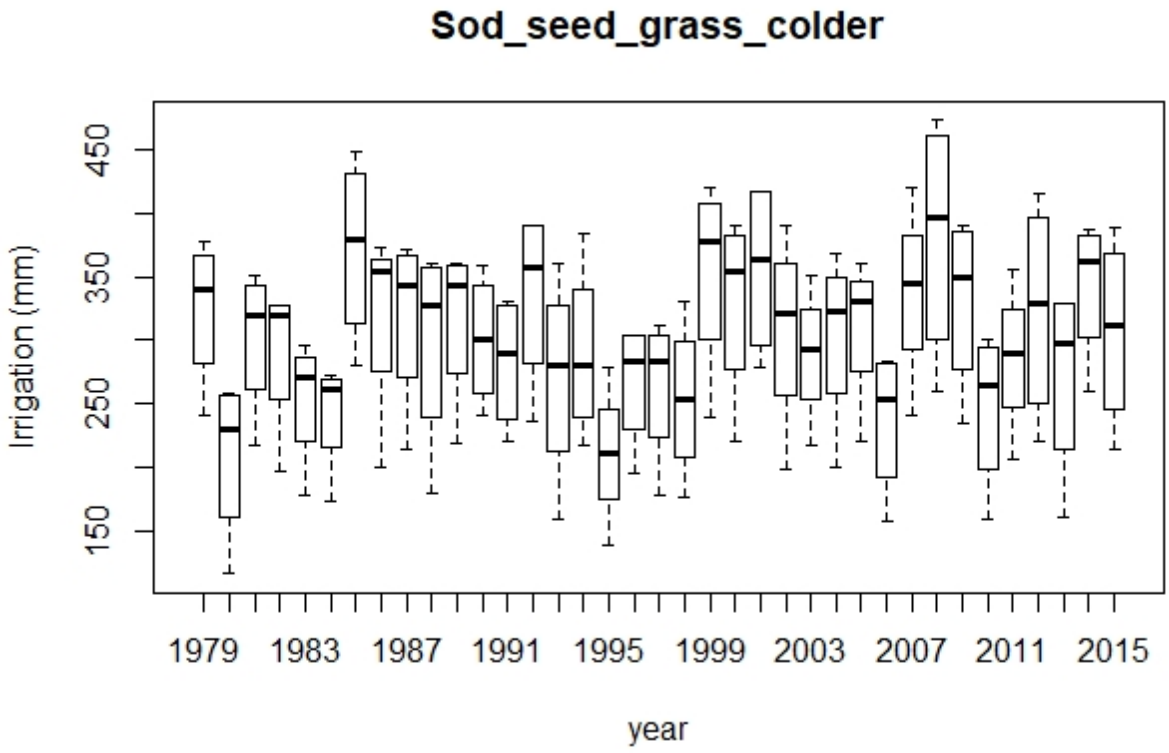

Triticale_spring_colder
Irrigation (mm)
500
700
900
1100
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year


Corn_Sweet
Irrigation (mm)
300
500
700
900
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year


Onion_bulb_colder
Irrigation (mm)
500
1000
1500
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year


Dry_beans_colder
Irrigation (mm)
500
700
900
1100
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year


Canola_colder
Irrigation (mm)
600
1000
1400
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year


Sod_seed_grass_colder
Irrigation (mm)
150
250
350
450
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
year

Appendix B.2 Raw data text file for irrigation demand data

See attached file called “Yakima top of crop irrigation demand.txt”.

Appendix C: Crop Water Value Update data

See attached file called “KRD-TU-CropWaterValueUpdate.xlsx”.

S2.5: Legal and Policy Review

The review of Yakima Basin water rules, regulations, and policies was conducted by Jeff Slothower and Peter Dykstra, with support from the project team as necessary. The "legal and policy" review resulted in four documents for use in market strategy development. The four documents lay the groundwork for developing a Yakima Basin strategy and provide key historical legal information. The documents are provided in the following order: Yakima Basin rules framework, Yakima Basin legal framework, 4 water transfer scenarios (example for allowable and not allowable transfers), and the Terms & Conditions to participate in the Yakima Basin Smart Market.

Rules

1. Is it a valid water right?

    1.1. Does the applicant have title to or a valid claim to the title of the water right?
    If yes go to 1.2.
    If no stop the right cannot be transferred
    1.2. Is there continued beneficial use history to ensure that the water right has not been relinquished or abandoned under Washington law.
    If yes go to 2.
    If no stop the right cannot be transferred

2. Can the transfer be made without detriment or injury (impairment) to existing junior or senior rights?

    2.1. Is the water right transfer as proposed water budget neutral?
    If yes go to 2.2.
    If no stop there is impairment

    2.2. Does the transfer result in a decrease in the Total Water Supply Available ("TWSA")?
    If yes stop there is impairment
    If no go to 2.3

    2.3. Does the transfer of the right result in an increase in consumptive use?
    If yes stop there is impairment
    If no go to 3.

3. Does the transfer reduce instream flows?
    If yes go to 3.1
    If no go to 4

    3.1. Is the reduction in instream flows in an identified reach of the river or tributary which is a "flow depressed" (need a better word) reach?
    If no go to 3.2
    If yes stop there is impairment

    3.2. Is the transfer upstream?
    If no go to 4
    If yes go to 3.3

    3.3. Does the transfer involve a previously identified reach where upstream transfers do not result in impairment?
    If yes go to 3.4
    If no stop there is impairment
    3.4. Is there a risk the transfer will create a flow impaired reach?
    If yes Stop there is impairment

If no go to 4

4. Does the transfer have or create negative operational considerations for the USBR or other water users or to fish and other aquatic life?
   If yes stop there is impairment
   If no go to 5

5. Does the transfer involve groundwater or does the transfer involve water banking?
   If yes go to 5.1
   If no go to 6

   5.1. Is the transfer against public policy?
   If yes Stop the transfer cannot be approved
   If no go to 6

6. The transfer can be approved.

Framework Draft

Introduction

The water supply in the Yakima River Basin has been established by a treaty, acts of Congress, and litigation, which began in 1855 and continued until 2019. Taken together, the rights of the various water users to the water within the Yakima River Basin are now relatively certain. The water supply available to satisfy those water rights is entirely dependent on natural moisture and is therefore always uncertain.

Background

In the Treaty of 1855, the Yakama Nation's time immemorial water right was recognized. Shortly after the Treaty of 1855, settlement of the Yakima River Basin began and between 1860 and 1905 water rights were established by a variety of individuals and entities based on territorial and State law.

In 1905 the United States Department of Interior, through the United States Bureau of Reclamation (hereinafter "USBR"), withdrew all of the unappropriated water and began the development of the Yakima Irrigation Project (hereinafter the "Project"). Over time, five different divisions of the Project were developed. In 1945 the United States District Court entered a Consent Decree in *Kittitas Reclamation District, et al. v. Sunnyside Valley Irrigation District*, Civil No. 21 (ED WA, 1945) (hereinafter the "Consent Decree"). The Consent Decree established two classes of non-Indian water users; to wit, senior users, whose use commenced prior to May 10, 1905, and junior users, whose use commenced after May 10, 1905. The Consent Decree also established the concept of Total Water Supply Available ("TWSA") and defined it as follows:

> … "total water supply available" is defined as that amount of water available in any year from natural flow of the Yakima River, and its tributaries, from storage in the various Government reservoirs on the Yakima watershed and from other sources, to supply the contract obligations of the United States to deliver water and to supply claimed rights to the use of water on the Yakima River, and its tributaries, heretofore recognized by the United States.

The Yakama Nation was not a party to the Consent Decree and, as a result, the Consent Decree failed to adequately deal with and allocate tribal water rights. From 1945 until 1976 the water users operated under the Consent Decree with USBR controlling the amount and timing of flows in the Yakima River and some of its tributaries through the storage and release of water stored in five (5) reservoirs. The *KRD v. SVID* court determined in the Consent Decree that TWSA is in part comprised of the water stored in those five (5) reservoirs.

In 1977 the Washington State Department of Ecology, under the authority of Chapter 90.03 RCW, commenced an adjudication of all surface water rights to the Yakima River and its tributaries. The Yakama Nation joined the case and from 1977 until August 9, 2019 the Yakima County Superior Court adjudicated the rights of all water users in and to the Yakima River and its tributaries in *State of Washington, Department of Ecology v. James J. Acquavella, et al.*, Yakima County

Superior Court Cause No. 77-2-01484-5 (*"Acquavella"*). On August 9, 2019 the *Acquavella* court entered its Final Decree, which incorporated a 2,477-page Schedule of Rights. The effect of the Final Decree is that every water user's rights are fixed. The Final Decree was appealed and a decision is expected in late 2021 or early 2022 on the issues which were the subject of the appeal.

What started in 1977 as an acrimonious and protracted legal battle over water rights settled into a realization by the parties that it is in their best interests to cooperate on water rights issues. As a result, the Yakima Basin Integrated Plan was developed by and among one-time courtroom adversaries.

The goals of the Integrated Plan are as follows:

- Provide opportunities for comprehensive watershed protection, ecological restoration, and enhancement addressing instream flows, aquatic habitat, and fish passage;
- Improve water supply reliability during drought years for agricultural and municipal needs;
- Develop a comprehensive approach for efficient management of water supplies for irrigated agriculture, municipal and domestic uses, and power generation;
- Improve the ability of water managers to respond and adapt to potential effects of climate change; and
- Contribute to the vitality of the regional economy and sustain the riverine environment.

The effect of litigation over the last half of the twentieth century was to create a river basin where water rights are known with certainty and reduced to writing. This created a certain group of water users who may benefit from participating in a SMART water market. However, several factors will impact how much water may be available to be reallocated through a SMART market.

Climate Issues

Sid Ottem,[1] in his article on the *Acquavella* adjudication,[2] summarized the climate conditions that affect the water supply in the Yakima River Basin as follows:

> Precipitation in the region, in regard to both quantity and seasonality, greatly affects the use and capacity of the river. Annual precipitation decreases from 108 and 92 inches at Stampede (elevation 3958 feet) and Snoqualmie (elevation 3004 feet) Passes, respectively, to 22 inches at Cle Elum (elevation 1920 feet), approximately 28 miles from Snoqualmie Pass.[10] Twenty miles farther downstream, at the City of Ellensburg (elevation 1727 feet), precipitation decreases to nine annual inches.[11] Approximately seventy-five percent of the precipitation

[1] Sidney P. Ottem is an attorney and a Court Commissioner who presided over the *Acquavella* adjudication from 1999 to 2008.
[2] Sidney P. Ottem, *The General Adjudication of the Yakima River: Tributaries for the Twenty-First Century and a Changing Climate*, 23 J. Envtl. L. & Litig. 275 (2008).

falls in the period from October through March.[12] Rainfall in July and August accounts for only five percent of the annual total.[13]

Despite the lack of dependable and timely precipitation throughout the region, the Yakima Basin's unique geography affords outstanding agricultural opportunities.[14] To the west of the basin is a large water source, created by the impact of the Cascade Mountains, capable of supplying a continuous flow of water to generally level basins topped by relatively deep layers of fine, silty, highly fertile volcanic soils.[15] In addition, the region boasts a fairly long growing season.[16]

As our climate changes, the effects on water supply will continue to create an uncertain quantity of water to satisfy known existing water rights that are available for change or transfer. The result of that uncertainty will be that priority dates, and thus the risk of curtailment of junior water rights in water short years, will be a bigger factor in determining which water rights can participate in a SMART market and the price of those water rights.

Over Appropriation

One outcome of the *Acquavella* adjudication is that as water rights became certain it became clear that the Yakima River Basin was over appropriated. As a result, often there is not enough water in TWSA to satisfy all water rights.

In years when there is not enough water in TWSA to satisfy all water rights, water users with post-1905 priority dates (hereinafter "Junior Water Users"), as required in the Consent Decree,[3] must abate their water use to satisfy pre-1905 senior water rights. The effect is that the Junior Water Users often do not receive the full supply of water they are entitled by contract to receive from USBR. Consequently, Junior Water Users review and take steps to ensure that transfers of water rights do not negatively impact TWSA. Three of the largest junior irrigation districts in the Yakima Project are the Wapato Irrigation Project, the Roza Irrigation District, and the Kittitas Reclamation District (hereinafter collectively referred to as the "Junior Districts").[4]

Junior Districts and other Junior Water Users will typically not support a proposed transfer that involves a Water User transferring a secondary irrigation water right with a priority date prior to 1905 (a "Priority Water Right") to a new use inside or outside the Junior District's boundaries if that new use will result in an increase in consumptive use of water within the Yakima River Basin. This is because such a transfer could result in the Junior Water User being prorated earlier in a year and/or more often, which constitutes "impairment" of the Junior Water User's water right pursuant to RCW 90.03.380. Therefore, water rights not used in conjunction with a second water right for the same place of use will generally be the rights available for transfer though a Smart Market system. While the identification of these overlapping water rights has not been undertaken and is beyond the scope of this report, the rights which are not within the place of use of an existing irrigation district or other irrigation water purveyor are the rights that are generally available for

[3] The *Acquavella* court adopted and applied the Consent Decree.
[4] Collectively referred to as "Junior Districts."

transfer because the place of use of these rights may be fallowed if the water right is transferred to avoid an increase in consumptive use and a corresponding negative impact to TWSA.[5]

Junior Districts will typically support a proposed change or transfer of a Priority Water Right to instream flow and/or other non-consumptive uses that can be protected from consumptive use by third parties.

Irrigation Season

All adjudicated water rights have a period of time when the water may be diverted from the source and used, which is referred to in the Schedule of Rights as a "Period of Use." One of the challenges of transferring water in an over appropriated basin is ensuring that consumptive use is not increased (see discussion above). When water is used for a longer period of time because of a change or transfer there is a risk of an increase in consumptive use and resulting impairment to Junior Water Users. Additionally, use of water for a different period than authorized in the water right may cause flow issues in the river that impact either fish or USBR operations. To avoid or mitigate these impacts, the Washington State Department of Ecology and USBR developed a storage contract which allocated space in the reservoirs to store and release water ("Ecology Storage Contract"). However, the storage contract has a finite amount of water that can be stored and, as a result, it is at best a short-term fix for a limited type of water right transfer. Presently, the storage contract is used primarily to mitigate impacts to TWSA caused by the transfer of irrigation water rights to be used for year-round domestic supply.

A key component of the integrated plan is the development of more options for storage of natural moisture and conserved water particularly in the upper reaches of the Yakima River basin in Kittitas and Yakima Counties. As additional storage is developed through the Integrated Plan, the availability of additional options for storage and release of water from new reservoirs should result in more ways to mitigate for transfers which result in an expanded period of use. New storage facilities will also increase water available for instream flows purposes throughout the Yakima River Basin.

Emergence of Water Banks

Like in other parts of Washington State, groundwater is regulated in the Yakima Basin under Chapter 90.44 RCW. Although the Yakima Basin surface water is governed under the above-described legal framework, groundwater was not part of the Acquavella adjudication or the elements of the above-described legal framework. Nevertheless, over the past 20 years groundwater use in the Yakima Basin has had a significant influence on water rights and the water market in Washington. In the Yakima Basin, the US Geological Survey has determined that much of the groundwater in the Basin is in hydrologic continuity with the surface waters of the Yakima Basin. Groundwater withdrawals have an impact on surface water rights.

In 1999, Ecology imposed a moratorium on all new groundwater withdrawals in the Upper Kittitas County portion of the Yakima Basin except for groundwater withdrawals that were exempt from

[5] Maps of the places of use of irrigation districts and other water purveyors are attached as Exhibit ___ and provide a general description of the location of the lands where there are not overlapping water rights.

the permitting requirements Chapter 90.44 RCW. After several years of proposals and debate about Ecology's authority to do so, in 2009 Ecology issued Chapter 173-539A WAC which withdrew all public groundwaters within the upper Kittitas County from appropriation. The only pathway to new uses of groundwater for consumptive use activities in that part of the Yakima Basin was through mitigation from water in the Trust Water Rights Program.

The Yakima Basin Trust Water Rights Program ("TWRP"), Chapters 90.38 and 90.42 RCW, allow for the change of the purpose of use of an existing water right to instream flow and mitigation, including mitigation of groundwater uses that would impact surface waters in the Yakima Basin. In other words, the TWRP allows for water banking of surface water rights which can then be sold for mitigation of new uses both ground and surface. The combination of the groundwater moratorium in Chapter 173-539A, the need for mitigation of domestic groundwater uses to support a growing community, and the water banking tools in the TWRP, led to the creative development of water banks in Upper Kittitas County, primarily by private water right holders, the early 2010s.[6] The groundwater mitigation market in this area of the Yakima Basin was robust because people began to purchase mitigation water from these water bankers in order have the mitigation required by Chapter 173-539A WAC for their proposed groundwater uses.

As the result of litigation under the Growth Management Act in the mid-2010s, both Kittitas and Benton County began developing public groundwater mitigation strategies for domestic exempt groundwater uses through the Yakima Basin within their counties beyond the geography covered by Chapter 173-539A WAC. While not as a result of litigation, Yakima County also began developing its own groundwater mitigation strategy for domestic exempt groundwater uses. These county efforts lead to another significant uptick in market activity in the Yakima Basin since all three counties began buying surface water rights and transferring them to TWRP to support the counties groundwater mitigation programs. All three counties have purchased pre-1905 surface water rights to support their mitigation programs and now make mitigation water available for sale to their citizens as part of the building process in portions of the counties where mitigation is required.

Conclusion

While who has what right to use water in the Yakima River Basin is certain, there are limitations on those rights that will impact the supply of water available for transfer through a SMART water market.

[6] Because the water rights placed into the TWRP are almost always seasonal water rights and the vast majority of mitigation purchases are for uses that are year-round uses, the water banks depend on the Ecology Storage Contract to support the conversion from seasonal to year-round use of the water placed in the TWRP for mitigation.

Four Water Right Transfer Scenarios

Scenario No. 1

Landowner M owns real property that received irrigation water from the Kittitas Reclamation District ("KRD") and has a surface water right authorizing the irrigation of 160 acres. Landowner M proposes to sell and transfer its creek water right, which authorizes the irrigation of 160 acres to a downstream water right user and continue irrigating using the KRD water attributable to 115 acres of irrigable KRD acres.

The transfer was not approved because the irrigation of new acreage downstream while the parent parcel continues to be irrigated with KRD water would have resulted in an increase in the consumptive use equal to the quantity used by the downstream receiver of the water, which would negatively impact TWSA and harm proratable irrigation districts in the Yakima Basin. The transfer could have been modified to only include the quantity of water attributable to the acres that could be irrigated from the surface water right that were in excess of the KRD irrigable acres with the excess acres being fallowed.[7] However, the buyer did not finalize the water right transfer because of the reliability of the water right.

KRD acres cannot be fallowed because KRD is contractually obligated to deliver water to irrigable acres within its service area. While one (1) landowner may say they will not irrigate with KRD water, if future owners demanded irrigation water, KRD would be forced to deliver the irrigation water. The only way to fallow KRD acres that are designated as irrigable is to move the irrigable acres to another area in the KRD service area. Transfers of irrigable acres with in the KRD service area must follow KRD rules and USBR rules.

Scenario No. 2

Landowner A receives a grant through the Kittitas County Conservation District ("KCCD"), which will fund a new and improved irrigation system. Landowner A agrees that in exchange for receiving funds to improve the irrigation system Landowner A will convey its rights in Manastash Creek to a third party who will donate those rights to the Department of Ecology Trust Water Rights Program. Landowner A will continue to use both its KRD water and a portion of its Manastash Creek water with the more efficient irrigation system to raise the same crops.

The transfer was approved because the water saved as a result of the increase in efficiency was not transferred to a new consumptive use and instead was dedicated, in perpetuity, to instream flow purposes. Therefore, there was no negative impact to the TWSA.

Scenario No. 3

Landowner B determines it will put its farm to a new use that will not require irrigation water. Landowner B transfers all of its water rights to instream flow purposes and Landowner B agrees to fallow and never irrigate again the original place of use. The water, once used for instream flow purposes, is donated to the Trust Water Rights Program. The consumptive use associated with the fallowed ground was authorized for use in the lower Yakima River Basin for a new consumptive use. The water is in trust from the original point of diversion to the new point of withdrawal.

The transfer was approved because it was a downstream transfer that transferred the consumptive use from one place of use to a new place of use, with the old place of use being permanently fallowed and not irrigated. The transfer had a benefit to river operations because its increased flows in the river from the old point of diversion to the new downstream point of diversion.

Scenario No. 4

Landowner C has senior water rights that it receives from an irrigation company because it owns stock in the company. The water must be used within the authorized place of use of the irrigation company. Landowner C also has creek rights, which Landowner C has historically used in conjunction with its ditch company rights. Landowner C sells its creek rights to a downstream water user, who will use the water for municipal purposes. The water will stay in trust between the old point of diversion and the new point of withdrawal for municipal purposes. The original place of use will be fallowed with a deed restriction and the stock surrendered to the Ditch Company and not irrigated.

The transfer was approved because there was no increase in consumptive use and the consumptive use associated with the old place of use is transferred downstream to a new place of use and new consumptive use.

TERMS AND CONDITIONS OF YAKIMA BASIN SMART WATER RIGHTS MARKET PARTICIPATION

If you are interested in being a purchaser in the Smart Market, please complete Sections 1, 4, and 5 below.

If you are interested in being a seller in the Smart Market, please complete Sections 2 and 3 below.

SECTION 1

Purchaser Name: _____

Purchaser Address: _____

Purchaser Phone Number: _____

Purchaser Email Address: _____

SECTION 2

Seller Name: _____

Seller Address: _____

Seller Phone Number: _____

Seller Email Address: _____

SECTION 3

Water Right Information:

Claimant Name: _____

Court Claim No. _____

Certificate Number: _____

Subbasin: _____

Source: _____

Use: _____

Period of Use: _____

Quantity: _____

Priority Date: _____

Point of Diversion: _____

Place of Use: _____

_____

_____

Limitations of Use: _____

SECTION 4
Legal Description of Purchaser's Property on Which Water Right Will be Used: _____

SECTION 5
Description of Use Purchaser Intends to Put Purchased Water to: _____

Terms and Conditions:

1. Not all water rights are capable of being bought and sold through the Smart Market. The undersigned acknowledges that the market coordinator will make the final decision on whether this application may be accepted for participation in the market.

2. The undersigned acknowledges that if the undersigned is matched with a willing Purchaser or Seller, as the case may be, that the market coordinator is not responsible for negotiating and preparing a water purchase agreement. The parties are responsible for negotiating and consummating any transaction arising out of the Smart Market. The undersigned acknowledges and agrees that all such transactions must be reduced to writing.

3. Closing of a transaction may be contingent upon the timely satisfaction of one or more of the following events, which events may be referred to as "contingencies".

3.1 Purchaser's Review of Water Rights. Purchaser's determination, in Purchaser's sole discretion, of the condition of title for the Water Rights and such other information as may be reasonably necessary to confirm Seller's ownership of the Water Rights and showing title to the Water Rights to be free and clear of all encumbrances, which determination and approval shall be made or waived by Purchaser within sixty (60) days of the mutual execution of an Agreement.

3.2 Purchaser's determination and approval, in Purchaser's sole discretion, of the extent, validity, and prior use of the Water Rights. Seller shall undertake and diligently pursue the reasonable confirmation to Purchaser of the validity, prior use and freedom from defect of the Water Rights; provided that all costs of such confirmation shall be the responsibility of Purchaser. In the event Purchaser reasonably determines, in Purchaser's sole discretion, that such confirmation cannot be obtained, then Purchaser may terminate this Agreement whereupon the earnest money shall be returned to Purchaser.

3.3 Title Insurance. On or before the date of closing, Purchaser's review and approval of Seller's title to the Property, which shall be free and clear of all encumbrances or defects except for those which are acceptable to Purchaser. Encumbrances to be discharged by Seller may be paid out of purchase money at date of closing.

3.4 Until such time as the Transfer has been completed, Seller shall continue to use and manage the Water Rights on the property owned by Seller and/or maintain the water in the Yakima River Basin Trust Water Rights Program. Purchaser and its employees, representatives, and agents shall, at reasonable times and upon the giving of reasonable notice, have the right to enter upon said property to ensure the Water Rights are being used and managed in a manner that will not adversely impact the Transfer, and to gather such information as Purchaser deems necessary to obtain approval for the Transfer as contemplated by Purchaser.

3.5 Water Right Transfer Process. Approval by the Department of Ecology of the transfer of the Water Rights. Approval shall be deemed given when all appeal periods applicable to Ecology's decision have expired without an appeal of Ecology's approval of the transfer. In the event there is an appeal of Ecology's decision by any party then, in that event, Ecology's decision shall not be final until a complete resolution of all appeals.

3.5.1 In the event the Department of Ecology denies the transfer of Water Rights then in that event, at Purchaser's option, to be exercised in Purchaser's sole and absolute discretion, this Agreement will be null and void and Purchaser shall be entitled to a complete refund of the earnest money.

3.5.2 In the event Ecology approves the transfer in part, but not all, of the Water Right as set forth in Paragraph 1.1 or in the event Ecology attaches terms and conditions to the transfer of the water, then, in that event, Purchaser has the option, to be exercised in Purchaser's sole and absolute discretion, to cancel this sale and receive a full refund of the earnest money. Purchaser must elect to cancel this sale within 21 days of Ecology's decision becoming final pursuant to Paragraph 3.5.

3.5.3 Seller recognizes that in order to satisfy the contingencies Purchaser and Seller must go through a water rights transfer process with the Department of Ecology. Seller agrees to provide to Purchaser, when requested, any and all documents, records, or other information Purchaser may need to facilitate and accomplish the transfer when requested by Purchaser. The cost of the water rights transfer shall be based on an agreement between the Parties which will be reduced to writing.

3.5.4 The application and all matters necessary for final approval and satisfactory resolution of all appeals (hereinafter the "Transfer") shall be at Purchaser's sole cost, risk and control; provided, however, Seller shall cooperate with Purchaser, or Purchaser's successors or assigns, and shall not object to the Transfer.

4. Seller and Purchaser recognize that part of the transfer process requires the Department of Ecology to make a tentative determination of the extent and validity of the water right. Seller also recognizes that Ecology, in processing the transfer of water rights, follows certain statutes and administrative code provisions. Seller also recognizes that in applying the statutes and administrative code provisions, Ecology interprets the statutes and administrative code provisions in a manner which is beyond the control of Seller and Purchaser. Ecology's processing of the transfer request may result in all or part of the water right being determined to be relinquished. Seller agrees to assume the risk of all or part of the water right being relinquished and agrees to hold Purchaser harmless from any and all damages, loss or water or property rights which may occur as a result of the transfer process.

5. Seller's title to the Water Rights is to be free and clear of all encumbrances or defects. Encumbrances to be discharged by Seller may be paid out of purchase money at closing. Title to the Water Rights shall be conveyed by Special Warranty Deed. Seller shall cooperate with Purchaser in executing any reasonably necessary documents relative thereto.

S2.6: Water Management and Protection

Another key part of the strategy development is an understanding of practical issues around transferring, managing, and protecting water rights. This document describes these issues and provides recommendations for improved protection of transferred water rights. This work was completed by private consultants, Joel Hubble and Walt Larrick, that are experts on water and fish issues in the Yakima Basin.

Water Marketing Constraints

Joel Hubble and Walter Larrick

June 2022

INTRODUCTION

This paper is one piece of a larger effort to investigate market-based reallocation opportunities in the Yakima Basin being conducted in partnership by the Kittitas Reclamation District and Trout Unlimited. This work was funded through a USBR WaterSMART grant and an agreement between the Washington Department of Ecology (DOE) and Kittitas Reclamation District (KRD).

Our (tasks) statement of work was to, 1) identify water management and protection constraints/limitations, 2) describe ongoing and potential tributary supplementation programs (Stream Supplementation) and how they could be linked to a in basin water market, 3) identify operational, structural, functional and economic limitations as they pertain to a Yakima basin water market, and 4) summary findings.

METHODS

Task 1- Water Management and Protection, we conducted phone or email interviews with the following agencies-

1. Washington State Department of Ecology (phone, Tom Tebb and Carrie Sessions)
2. Bureau of Reclamation (phone, Kerrie Mathews)
3. Yakama Nation (email, Danielle Squeochs)

These three entities oversee water management and policy level decisions for the Yakima Basin.

Task 2- Operational, Structural, Functional and Economic Limitations, was accomplished by way of phone and in-person interviews with the following Yakima basin irrigation district managers-

Phone Interviews:

1. Lori Brady (SVID)
2. Rick Dieker (YTID)
3. Scott Revell (RID
4. Urban Eberhart (KRD)

In Person Interviews:

1. Nathan Draper (SMID)
2. Justin Harter (SNID)

Task 3- Stream Supplementation

This was carried out mostly relying on our own experience/knowledge[1] of potential tributary supplementation opportunities in the basin, and our current involvement with the KRD Tributary Supplementation program.

Literature Search

In addition, a brief Google search turned up two papers and one water market that had application to develop of a Yakima basin water market-

1. Meza-Garcia, Oscar. 2016(?). *Barriers to Temporary Inter-District Water Transfers in the Yakima River Basin: Irrigation District Perspective*. A Capstone project presented in partial fulfillment of the requirements for the degree of Master of Arts in Policy Studies Interdisciplinary Arts and Science.

   This document proved most beneficial, since several Yakima basin irrigation district managers were similarly interviewed to get their perspective on limitations/constraints needed to be address in order for a successful in basin water market. Key results are summarized in Appendix A.

2. Sessions, Carrie and Dave Christensen. 2020. *Water Trust, Banking, and Transfers in Washington State; Findings and Recommendations Informed by Ecology's Advisory Group on Water Trust, Banking, and Transfer*. Published under the Water Resources Program, Washington State Department of Ecology.

   See Appendix A for a summary of this document and its findings and recommendations.

[1] Joel Hubble- 1979 to present. Fisheries biologist 25 years with Yakama Nation (YKFP), Fisheries biologist 13 years Bureau of Reclamation (CCAO & YFO), and currently a fisheries biologist consultant to the Yakima Basin Defense Coalition and Kittitas Irrigation District.

Walt Larrick- to be added

RESULTS

Task 1: Water Management and Protection

It's our opinion that the existing document. "Water Master Function- Measuring, Monitoring, Reporting and Enforcement" (2005[2]) would provide the necessary framework to address the need to manage the protection and enforcement of water sold-purchased/leased through a Yakima basin water marketing program. The legal and administrative framework could be built upon the structure discussed under section B of this document to provide statutory framework for the YBIP, Water Marketing element.

Task 2: Streamflow Supplementation

The KRD's irrigation distribution system is unique compared to other districts in that, 1) it intersects several tributaries that flow into the Yakima River providing several opportunities to augment streamflow downstream of the main, north, south branch canals, and 2) being the upstream most major diverter, water needed to meet irrigation demand further downstream (e.g. Roza) can be routed through its canal system used to augment tributary flows that eventually flows back into the Yakima River before reaching the Yakima Canyon (e.g. Ringer Road area). No other irrigation district affords this same level of opportunity to supplement flow deficient tributaries in the basin. The objective of the KRD Tributary Supplementation program is to improve tributary flow during the summer/fall low flow period, which then provides opportunity for improved salmonid rearing and spawning conditions. Supplemented flows also contribute to allowing improved access to stream habitat upstream of the KRD canal.

Improved riparian conditions are being seen at various locations since the inception of this program in 2015. This is most noticeable on Manastash Creek where perennial vegetation is growing on former cut banks because of now having perennial flow. This has also resulted in less flood damage to the stream channel because this new vegetation decreases stream energy and creates channel aggregation. Swauk Creek is the next big "target" for tributary supplementation using the KRD distribution system, however additional opportunities exist on tributaries that bisect the KRD north branch canal (i.e., Naneum Creek).

It should be mentioned that current YBIP studies (e.g., groundwater and surface water storage) are in progress evaluating the potential to use the KRD distribution system to route winter water

[2] Yakima River Basin Water Enhancement Project, Conservation Advisory Group. 2005. Discussion Paper- Measuring, Monitoring, Reporting and Enforcement of Water Diversions in the Yakima Basin – the Water Master Function.

(primarily) to ground and surface water sites with the idea to store this water and retime its use that could be used in-part for water marketing purposes (both instream and out-of-stream).

The Roza Irrigation District (RID) does not cross over any tributaries that suffer low summer flows like observed for those with KRD. In fact, lower basin tributaries like Spring and Corral creeks currently receive spill water to some extent.

Similar to RID, the Sunnyside Valley Irrigation District (SVID) does not bisect any tributaries that are key to salmonids and/or are lacking summer flow. The YBIP Lower River Subcommittee is investigating the mouths of some of these tributaries like Spring and Coral creeks to see if they have potential benefit as cold water refugia for salmonids.

The Yakima Tieton Irrigation District (YTID) has one successful water exchange project, where Cowiche Creek diverter(s) exchanged water sources. They now using YTID water to irrigate with and leave the Cowiche water in the creek to improve summer flow conditions.

Task 3: Operational, Structural, Functional, & Economic Limitations

Large Irrigation Districts

There were two primary findings expressed by the large irrigation districts that pertained to infrastructure. First, the amount of water available to move between districts (especially in a drought year) is very limited-- <10 KAF, and often first priority is to transfer water between water users within district. In general, the districts we spoke with who had available water did not see their future quantity of available water to sell increasing much even as they continue to make water conservation related infrastructure improvements.

Small Irrigation Districts

SMID

More recently, however, the Selah-Moxee Irrigation District (SMID) has developed a water conservation program designed to generate district revenue that can be used to modernize their water delivery system through water marketing. The SMID has initially identified approximately 9,400 acre-feet of water that they are willing to lease and/or sell. The SMID has primarily senior water rights (about 88%) and has realized this available water through district level and on-farm water conservation measures and the conversion of agricultural lands to residential/municipal land use.

They believe their water conservation program coupled with water marketing is “win-win” both for the district and for potential users of their saved water. They believe additional water will be available as they continue to modernize their water delivery infrastructure, and as the Moxee valley continues to experience population growth and agricultural lands are converted to residential and

municipal land uses. In their view there exists the potential for this water conservation-revenue-water marketing approach to be adopted by other smaller districts with senior water rights.

The inability currently to store their conserved water over multiple years to sell/lease in a water market was identified by SMID as a key impediment to their ability to maximize their revenue generation potential.

Other identified obstacles were a general lack of trust with state and federal entities, coupled with the fact as a senior water right holder, "What is the incentive to me to participate in extensive water conservation measures that would potentially provide additional water for water marketing". Tied to this is the "extent and validity examination" process. Thus, there is a need to consider creative ways to provide attractive incentives to potential districts.

Selah-Naches Irrigation District (SNID)

Similar to SMID, the Selah-Naches Irrigation District is mostly comprised of senior water right holders (approximately 92%). Much of their delivery system has been modernized both at a district and on-farm basis, and has been self-funded. At this time, the district has not investigated in detail what quantity of conserved water could be potentially available to contribute to a basin-wide water market. District bylaws currently give first priority of available water to water users within the district.

Another, albeit smaller economic consideration, would be the cost by the district/grower to cover the administrative fees and additional operational expenses to facilitate a water transfer between districts.

Task 4: Summary Conclusions for Managing & Protecting Water

- It's apparent that the amount water available by selling-buying water between districts for a water market is very limited. The two main reasons for this are:
    - The bylaws of many of the districts restrict water transfers to within the district as first priority.
    - There is a point at which transferring additional water out-of-district, even if available by a district to sell, would have a negative impact on their canal/laterals operations. This would be conveyance loss that effects the ability of certain water users to receive their entitled amount of water. This potentially could be remedied through efficiency measures in how water is both delivered and applied, both at a district and on-farm level that allows for meeting an in-district customer's water needs by using less carriage water.

- The current legal inability to conduct an upstream water transfer was identified as potential limiting factor to a water market. Some felt this rule should be re-visited and discussed on a case-by-case basis. It's argued that emphasis should be placed on the fishery biological impact or benefit specific to the stream reach(es) affected, including seasonality. Second, was the issue of documentation and enforcement of fallowed land for the associated amount of water being transferred.

- For the smaller districts with less operational revenue need financial assistance to develop a water conservation plan in order to identify what their district level amount of conserved water would be.

- Uncertainty of water supply for the next season was an important economic factor that may impact the amount of water a willing seller has available to sell in a water market. This was stated especially for growers who produce annual crops. Their business decision as to what crop to plant and how many acres needs to be made in February/March, usually before a firm TWSA water supply forecast is available. Thus, once the seed, etc. is in the ground, their willingness to sell available water has to be weighed against what their net profit will be after harvest, to what they could have sold their water for that year.

- The "Water Master Function: Measuring, Monitoring, Reporting and Enforcement" document prepared by the Yakima River Basin, Conservation Advisory Group (May, 2005) provides a solid administrative process that could be applied as a starting point for developing similar program for a future Yakima Basin water market program.

- A corollary to conclusion statement E (above), is a need to think through the practical challenge, and who would be responsible, to ensure the water sold reached the water buyer. Depending geographically water the water being sold exists and is being bought and applied could potentially be complicated depending on how complex the routing system to deliver the water.

APPENDIX A

Supporting Documents

While researching for this topic of water banking/marketing, a Master of Arts thesis by Oscar Meza-Garcia, entitled, *Barriers to Temporary Inter-District Water Transfers in the Yakima River Basin: Irrigation District Perspective* was discovered. The stated purpose of his thesis was-- *The objective of this research paper is to identify the primary factors that Irrigation Districts consider when deciding whether or not to participate in temporary inter-district water transfers.* Through interviews with Yakima basin irrigation district managers the author endeavored to state constraints to developing a Yakima Basin water market. Stated constraints by the managers were organized by water sellers vs buyers, discussing constraints common to both (called *Common Barriers*), as well as, those more specific to each type. The *Common Barriers* were further categorized by *Institutional*, *Infrastructure*, *Market Forces* and *Climate Variability*.

Google link-
https://digital.lib.washington.edu/researchworks/bitstream/handle/1773/36311/Meza-Garcia%20-%20Capstone.pdf?sequence=1&isAllowed=y

Key take-aways from the Meza-Garcia thesis:

As way of organization, Meza-Garcia categorized his findings based on barriers common to both buyers and sellers, and for buyers only and sellers only.

Common Barriers

Four common barrier categories were presented: institutional, infrastructure, market forces, and climate.

1. Institutional[3] (comprised 45% of all cited barriers)
    a. The water transfer regulation that requires water for transfers to come from fallowed land (Washington State RCW 90.03.380 (1)).
        i. When fallowing of land occurs, water it's usually an intra-district transfer.
        ii. Fallowing of land for the purpose of water transfers is influenced by economic forces (What's the economic incentive to fallow my land?)
    b. The time (excessive) it takes to complete a water transfer.
        i. Involves, 1) negotiation of the terms, 2) the approval of the transfer by both districts, 3) review by the Water Transfer Work Group, and 4) a hearing by the Yakima Superior Court.

[3] "…institutional factors are defined as policies in place, actions taken or lack of actions taken by agencies, or even norms, or beliefs that dictate the conduct of other individuals or groups."; cited by Meza-Garcia.

        ii. Average time six weeks in a non-drought year and 15-30 days in a drought year. Note- several districts stated that 15 days was too long for a drought year.
    c. Within district water management objectives.
        i. District level considerations were, 1) water conservation measures, and 2) system level water delivery efficiencies.
    d. Unclear "operational structure and policies" for Wapato Irrigation Project, which operates under Federal law (Bureau of Indian Affairs). The author notes that they did not participate in the survey he conducted for his thesis.
2. Infrastructure
    a. Location of diversion points in relation to the location of storage reservoirs.
    b. Location of diversion points in relation to the districts potentially involved with the transfer must be considered.
        i. For both 2.a and 2.b the primary concern is potential impacts to instream flows and/or to another's water rights, or the difficulty to account with precision the amount of water being transferred.
    c. Lack of sufficient storage.
        i. Limits flexibility. Specifically, additional storage would allow for increased storage carryover from a "wet" year to the next irrigation season or to be used to sell in a water market.
    d. Crop mix is an important consideration- effects a landowner's decision to fallow or not, to make water available to sell in a water market.
        i. Grower's with perennial crops are less likely to fallow because of the economic impact over multiple years.
        ii. Grower's with perennial crops typically of high economic value, thus less likely to fallow.
3. Market Forces
    a. "A strong agricultural economy can discourage senior rights holders from selling their water if the crop they grow are providing strong returns."
    b. A water market in the Yakima Basin is viewed to favor the sellers.
        i. Demand is greater than the supply.
4. Climate Variability
    a. Increased weather variability year-to-year effects the uncertainty in the water supply for the next irrigation season.
        i. In a drought year there may not be water available to sell/transfer.
    b. Reclamation's first estimate of the water supply on April 1st, is considered by some growers to be too late for planning purposes.
        i. Once seed is in the ground and an initial capital investment made by the grower, it's unlikely they will be willing to fallow and make their water available.

Seller Specific Barriers

1. Uncertainty
    a. Approval/denial of a temporary transfer by the district.
        i. Primary concerns by district and its board
            1. Social and economic impacts to the district and/or community.
    b. Perceptions of the water right holders.
        i. Ongoing Aquavella adjudication makes some water holders "hesitant" to participate in a transfer- continued stigma on potential impact to their water right.

Buyer Specific Barriers

1. Miscellaneous Barriers
    a. Washington State law only allows for the transfer of consumptive water (plant use + evapotranspiration)- this is viewed as a restriction.
    b. Some water selling districts limit the amount of water they are willing in a drought year to leave the district.
    c. Aquavella and basin wide YRBWEP water conservation has reduced diversions.

Recommendations by the author

These recommendations by the author are designed to help address the various seller and/or buyer barriers listed above.

1. "Provide Education and Outreach on Fallowing, Water Rights, and Transfers to Senior Water Rights Users"
    a. The YBIP should focus on educating senior water right holds on the benefits of fallowing land for the purpose of water transfers.
    b. Consider involving a third party to conduct this educational outreach, not Ecology, in order to build trust with the water rights holders, which was "damaged" during the Aquavella adjudication process.

2. "Shorten the Time-Frame to Process an Expedited Water Transfer"
    a. Think creatively on ways to shorten the 15-day time period during a drought.
    b. Consider having the buying district pay for all the "externalities" associated with the cost of facilitating a water transfer between the seller and buyer.

3. "Have Irrigation Districts Log and Report the Reasoning Behind Inter-District Transfer Denials"

a. A means to provide future policy makers with insight as to why a specific water transfer request was denied.

A second paper published by the Water Resources Program, Washington State Department of Ecology (October 2020) may prove useful, entitled, *Water Trust, Banking, and Transfers in Washington State; Findings and Recommendations Informed by Ecology's Advisory Group on Water Trust, Banking, and Transfers*. Findings in this document are the result of six public hearing convened by the *Advisory Group on Water Trust, Banking, and Transfers* that were held in early 2020.

Google link-

https://apps.ecology.wa.gov/publications/documents/2011091.pdf

The purpose of these hearings was to "increase (Ecology's)understanding" in the areas of, 1) downstream, out-of-stream right transfers; 2) water rights sales; 3) use of the Trust Water Rights Program (TWRP); and 4) water banking, to make "well-informed recommendations to the Legislature".

This legislative directive was in response to concerns voiced of potential misuse of water banks and the Trust Water Rights program; specifically concern over potential speculation and the transfer of water rights downstream and out-of-basin (WIRA level), such that it could impair the economy of the local community(s) where the water right originated from The outcome was 25 policy concepts[4] in the four following areas, 1) *Recommendations requiring statutory changes*, 2) *Recommendations to pursue under existing authority*, 3) *Concepts for future legislative evaluation*, and 4) *Ideas considered and not recommended*.

Key Findings & Recommendations

Ecology identified 22 key findings based on the Advisory Group participant's comments and discussion[5]. These were categorized according to the four topics stated above-

1. downstream, out-of-stream right transfers: #1-4

[4] See pp 17 – 28 (Policy Analysis)
[5] Note- These findings are clearly stated on pp. 13-16 of Ecology's document, so won't be repeated here.

2. water rights sales: #5-8
3. use of the Trust Water Rights Program (TWRP): #9-16
4. water banking: #17-22

Using these 22 findings, Ecology discussed with the Advisory Group participants several policy concepts, which were grouped into one of the following four categories-

1. "Ecology recommendations requiring statutory changes"
    a. "Establish that a water right transferred downstream may later be moved back upstream."
    b. "Rewrite the Trust Water statutes (chapter 90.42 RCW) to clarify key terminology and create a cohesive framework for trust water and water banking"
    c. "Authorize Ecology to recover the administrative costs of developing water banks."
    d. "Modernize how Ecology provides public notice of water right transfers."

2. "Ecology recommendations to pursue under current authority"
    a. "Promote the use of *conservation easements* on water rights to limit their use to the basin-of-origin."
    b. "Make information on water right change applications more accessible to the public through administrative improvements."
    c. "In policy, clarify that any water right used for long-term or permanent mitigation must first undergo a tentative determination of extent and validity."
    d. "Develop an application form for prospective bankers in which they outline their proposed banking and operations plan."
    e. "Publically post draft water banking agreements and consider public comment before finalizing water banking agreements."
    f. "Clarify statutory requirements and administrative processes for trust water and water banking in program policy and guidance."

3. "Concepts for future legislative evaluation"
    a. "Align disclosure laws for water right sales with the laws for land sales. Require that water right sales (including prices) are reported to the state and made publicly available."
    b. "Require that before the place of use of a water right may be transferred downstream out-of-basin, Ecology must determine that the change will not be detrimental to the public interest."
    c. "Establish that before a water may be sold for transfer out of the basin of origin, state, local, and tribal governments, and non-profits are provided a *right of first refusal*."

d. “Create a revolving loan fund or grant program to fund water right purchases for use in the basin of origin.”

4. “Ideas considered but not recommended”

Out-of-Basin Transfers

a. “Authorize Ecology to *close* a basin to out-of-basin transfers through rulemaking.”
b. “Restrict the number of water rights that may be transferred for use out-of-basin from any one WIRA.”

Water Right Sales

c. “Limit who can by a Washington water right to Washington residents and entities.”
d. “Provide advance public notice of sales including price disclosure.”
e. “Require the reporting of any water right change or transfer to county commissioners.”

Use of the TWRP

f. “Limit use of the TWRP such that individuals who buy a water right must plan to put the water to beneficial use themselves.”
g. “Restrict how long a temporarily donated water right may remain in trust.”
h. “Limit the number of trust water rights that can be removed from trust in any given year.”

Water Banking

i. “Amend chapter 90.42 RCW to establish that water banks must define their service area and then have a *duty to serve* within that area.”
j. “Clarify in statute that Ecology may deny a proposal to establish a new water bank.”

S2.7: Market Simulations and Water Rights

The final technical document provided is the technical memorandum on Water Valuation and Smart Market Simulations for Water Marketing for the Yakima Basin from ERA Economics LLC. The draft document makes use and incorporates the results or information from the preceding technical reports.

DRAFT Technical Memorandum

Subject: Water Valuation and Smart Market Simulations for Water Marketing for the Yakima Basin

By: ERA Economics LLC

To: Kittitas Reclamation District and Trout Unlimited

Date: June 14, 2022

Overview

In a study funded by the US Bureau of Reclamation and Washington Department of Ecology, called Water Marketing for the Yakima Basin, the Kittitas Reclamation District and Trout Unlimited are evaluating whether development of a smart market could reduce transaction costs in the Yakima Basin and advance the Market Reallocation Element of the Yakima Basin Integrated Plan. Trout Unlimited (TU) engaged ERA Economics (ERA) to develop and run market simulations that are customized to the Yakima Basin. The market simulations are developed to inform the potential economic and environmental impacts of smart market frameworks. The following Technical Memorandum (TM) summarizes ERA's technical approach, results, and analysis for a smart market for the Yakima Basin.

We did not consider and specifically excluded from the market strategy analysis water rights (both district and non-district) on the Yakama Nation reservation. The Yakama Nation reservation water rights are the subject of complicated treaty, congressional and Yakama Nation water code laws, rules and regulations. As a result, Yakama Reservation water rights are not subject to being transferred and traded in a market-based setting such as the smart market.

Background

Appropriative water rights are normally defined by a quantity, a place, a time, and a type of use. Water markets allow a quantity of water to change place of use, and often time and type of use. Changing the nature of the water right in place, time, or purpose of use often requires approval by the state regulatory agency; in Washington, the Department of Ecology. However, intra-district transfers may move water within an authorized place of use such as a district such that no state oversight may be required. Inter-district transfers often require state approval, and federal approval when using federal facilities such as reservoirs or canals. A proposed transfer must be deemed possible under given hydrology and water delivery systems; often, a finding of no harm to third parties is also required.

Water markets allow water users to voluntarily reallocate their water. This typically happens in a way that moves limited water to higher-value uses. This could happen on a grower's own operations, where they reallocate water on their own fields or in what are called "arms-length transactions", transfers of water between two separate entities. As an example, a corn grower might sell their water to a grower of apples or wine grapes, crops that are both potentially higher-value and have higher establishment costs. In an arms-length transaction, a water transfer is typically compensated at a price at or higher than the seller's value of water and at a price at or lower than the buyer's value of water. Agricultural values of water vary over space and time and are driven by characteristics including climatic factors (e.g., drought severity and crop water demands), water rights priorities, crop choice and commodities prices, irrigation efficiency, water costs, and more. Many of these factors may vary over place of use, such as crop choices, water costs (e.g., allotment fees), and irrigation efficiencies. Many of these factors also vary over time.

In order to simulate water market activity in the Yakima Basin, it is necessary to estimate the values of water at different places and times. Note that this is still a limited analysis: while we examine the variability of some factors (crop choice, crop water demands, and irrigation efficiency), we do not examine the variability of all factors (commodities prices, water and other input costs, and changes in crop choice). As a result, the marginal values of water derived here are both an average and static snapshot of potential market activity, even though, in reality, marginal water values are dynamic and even vary on a given field. For example, the second or third foot of water applied on a crop may be higher-value than the fourth or fifth (the concept of diminishing returns). Further, the smart market analysis does not incorporate any transaction costs and assumes that all agricultural water users behave rationally in a water market, with no endowment effects. In reality, transaction costs, lack of awareness of or misconceptions about a water market, endowment effects, and other factors reduce participation in water markets. In other words, simulations often over-estimate trading participation.

With these limitations in mind, the simulations illustrate the potential magnitude of trading by volume and value. The analysis presented provides a useful snapshot of the potential value that a frictionless water market could offer the Yakima Basin under current crop and market conditions, and under a range of drought or prorationing conditions.

Tradeable Water

Water markets rely on there being both supply and demand. This section focuses on the supply of water: that is, who has what quantity of water available for trade. Per the direction of the Technical Work Group, we used field-level consumptive use to estimate how much water is being used for irrigation—and therefore what the total supply and demand of irrigation water are in the Basin in a full-supply year. To minimize third-party effects, consumptive use is often used as a measure of transferrable water. This is in contrast to the total quantities listed of the Basin's water rights, which are much larger as a water right's diversion authority (quantity) accounts for more than the consumptive use; that is, irrigation diversion quantities also include the non-consumptive portion of the water right, such as carriage water or additional applied water to account for technology inefficiencies.

Another benefit of using consumptive use over the paper water rights quantities is that it avoids the potential for so-called "stacked water rights" to be traded, which is when a field has access to multiple sources of water (i.e., a private water right and an irrigation district allotment). In such a scenario, there is a concern that a field could sell one source of water (its private water right) and increase its use of the other source of water (its irrigation district allotment), such that consumptive use increases in the Basin and Total Water Supply Available decreases, thereby impairing proratable users (for more discussion on this topic, see the Legal Framework). Therefore, using consumptive use as the source of supply avoids this pitfall.

Below are descriptions of the Basin's total water rights compared to consumptive use estimates.

Water Rights in the Yakima Basin

The Yakima Basin Final Schedule of Rights (FSOR) includes 2,341 individual water rights, which total 4,353,948 acre-feet (AF). Of the 2,341 rights, and excluding all water rights servicing or within the boundary of Yakama Nation, 1,207 include irrigation as a purpose of use, which total 2,469,234 AF. However, there may be other purposes of use listed in the water right, such as stock water or domestic use. Therefore, adjusting for the additional listed purposes of use, we estimate that the total quantity of water rights for irrigation in the Basin (but excluding irrigation in Yakama Nation) is 2,424,160 AF.

Water rights are categorized two ways for this analysis: by priority, to evaluate the security of a water right, and by district overlap, to evaluate the extent of stacked water issues. Senior users are those with water rights dating earlier than May 10, 1905. Proratable users are those with water rights dating May 10, 1905. Junior users are those with water rights dating May 11, 1905 or later. Senior users hold 842,707 AF (33%) of irrigation rights, proratable users hold 1,601,172 AF (65%), and junior users hold 25,355 AF (<1%).

Stacked water rights refer to parcels that have more than one source of water. This is most common when a parcel had a private water right prior to the development of the Yakima Irrigation Project. If the parcel is served by both a private water right and a district allotment, it is considered stacked. While water rights can be unstacked, doing so is a complicated and manual procedure. As a result, parcels with stacked water rights are excluded from participating in a smart market. This is largely to address a concern that was

raised early in the project process by the Technical Work Group: that the transfer of one water right, such as the private water right, could lead to an increase in reliance of the district allotment, and consequently increase total consumptive use and decrease Total Water Supply Available. As a result, parcels with stacked water rights may not trade in a smart market.

Identifying stacked water use can be done two ways: using irrigation district water right Place of Use (POU) boundaries or using irrigation district boundary maps. The latter approach is selected because irrigation district POU boundaries frequently overlap. POU boundaries for all rights often overlap between different irrigation districts making it difficult to determine exactly where stacked water rights are located. One approach is to split the POU shapefile between overlapping areas and proportionally allocate that water rights irrigation allotment between the overlapping areas. This approach is summarized in Figure 1 below. The values shown in the figure are the sum of all irrigation district rights and private water rights within or partially within the irrigation district boundary, divided by the sum of basin irrigation rights. Stacked water rights are prevalent in Kittitas Reclamation District and in a number of smaller water districts. There are relatively few stacked water rights in the other large irrigation districts.

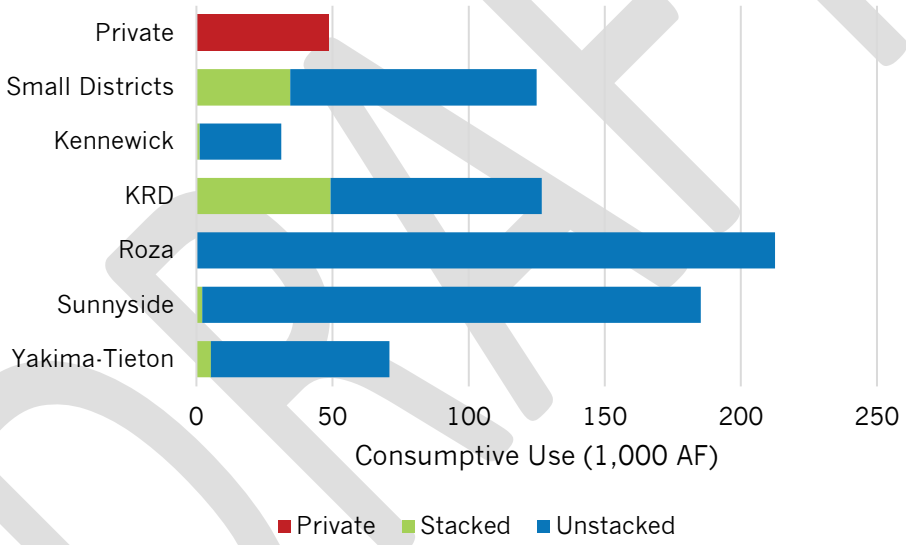


Figure 1: Stacked, Unstacked, and Private Water Rights

Consumptive Use Analysis

Consumptive use in the basin is estimated using two consumptive use methods: the Washington Irrigation Guide (WIG) and the Variable Infiltration Capacity-CropSyst (VIC) model, a model developed and run by Washington State University, and acreage data from the WSDA crop service layer. The VIC and WIG both estimate evapotranspiration of applied water (ET) values for different location within the basin. To account for spatial variability, consumptive use estimates are calculated for each WSDA parcel by taking a distance-weighted average, using the three nearest ET estimates for each source. An example of this process is shown in Figure 2 below. The three closest stations for each source to the example field are retrieved, and then an average ET value is calculated based on the distance to the three stations.

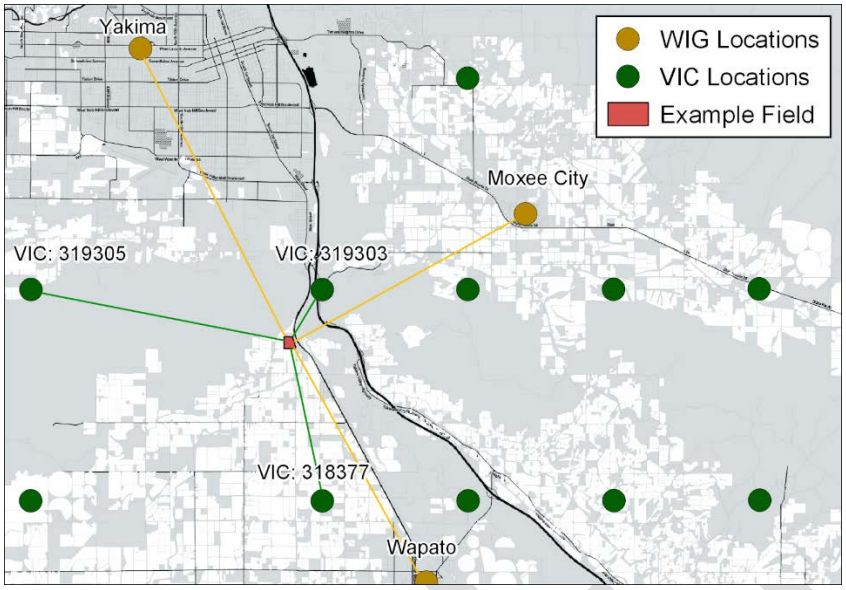


Figure 2: Example field with distance-weighted average of ET measurements.

The WIG provides a single, average ET estimate for each location while the VIC provides annual estimates. The VIC estimate used in this report relies on an average across all available years but could be refined in the future. Multiplying each field's acreage by its ET per acre estimate gives total consumptive use estimates. Total estimated consumptive use using WIG equals 760,594 AF and using VIC equals 697,975 AF. Consumptive use estimates are broken down by crop category in Figure 3 below.

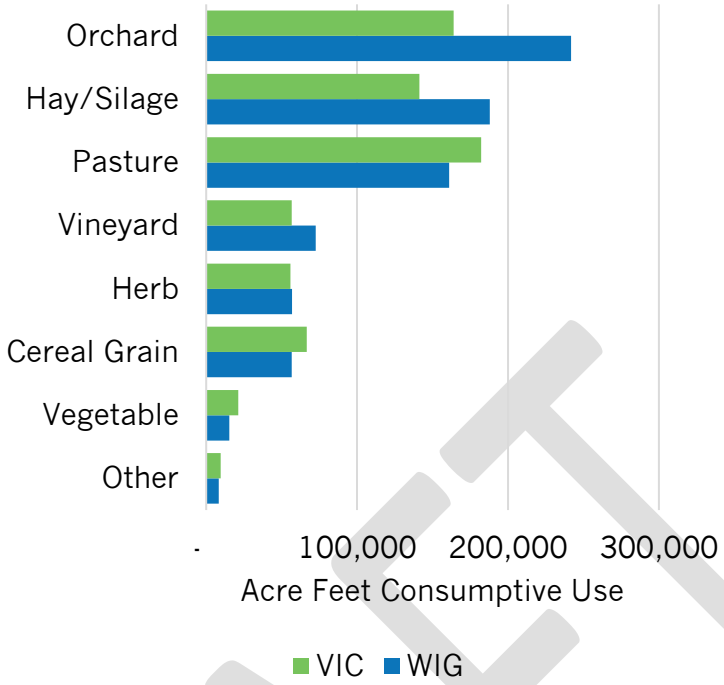


Figure 3: Total Consumptive Use by Crop Group

WIG values were used in the analysis because the dataset has a lower standard deviation within crop groups. For example, alfalfa ET estimates range from 1.46 to 73.01 acre-inches in the VIC dataset while values range from 17.11 to 39.56 acre-inches in the WIG. Note that WIG does not provide ET estimates by water year type. Consumptive use values vary by year type; however, correlating these values with prorationing level is not feasible using VIC estimates as the relationship between drought severity and ET did not meet expectations. Instead, we applied a synthetic increase in ET values using ET estimates from California's Department of Water Resources, which are correlated with the San Joaquin River index to establish a range of ET values. In California "Wet" years, ET values are roughly 7% lower than in "Critical" years. We apply this range to the Yakima Basin by assuming WIG values represent consumptive use in years with no prorationing. In years with 50% prorationing, we assume ET values are 7% higher than normal WIG values. These values may be better refined in the future through satellite ET estimation using sources such as OpenET, through field ET estimation, or through more thorough statistical analysis of VIC data.

Tradeable Water

The amount of water able to be traded within a district depends on the prorationing level and the districts mix proratable and senior water rights. Table 1 below uses VIC ET estimates adjusted for drought, as well as the districts percent proratable to estimate the amount available for trade and the total amount needed to meet all crop consumptive water demands in the district, by prorationing year type.

Table 1: District-Level Water Supply by Prorationing Level

		Prorationing Level				
District	**Subcategory**	**90%**	**80%**	**70%**	**60%**	**50%**
Roza	*Supply Available (%)*	90%	80%	70%	60%	50%
	Supply Available (AF)	191,258	170,007	148,756	127,505	106,254
	Total Demand (AF)	215,618	218,728	221,837	224,946	228,056
	Deficit (AF)	24,360	48,721	73,081	97,441	121,802
Sunnyside Valley	*Supply Available (%)*	97%	94%	91%	88%	85%
	Supply Available (AF)	179,664	174,088	168,512	162,937	157,361
	Total Demand (AF)	187,950	190,660	193,371	196,081	198,791
	Deficit (AF)	8,286	16,572	24,858	33,145	41,431
KRD	*Supply Available (%)*	90%	80%	70%	60%	50%
	Supply Available (AF)	114,220	101,529	88,838	76,147	63,456
	Total Demand (AF)	128,768	130,625	132,482	134,339	136,196
	Deficit (AF)	14,548	29,096	43,644	58,192	72,741
Yakima-Tieton	*Supply Available (%)*	97%	95%	92%	90%	87%
	Supply Available (AF)	69,105	67,266	65,427	63,588	61,750
	Total Demand (AF)	71,982	73,020	74,058	75,096	76,134
	Deficit (AF)	2,877	5,754	8,631	11,508	14,384
Kennewick	*Supply Available (%)*	91%	82%	72%	63%	54%
	Supply Available (AF)	28,340	25,468	22,597	19,726	16,854
	Total Demand (AF)	31,668	32,125	32,581	33,038	33,495
	Deficit (AF)	3,328	6,656	9,984	13,313	16,641

Marginal Water Values

Marginal water values represent the economic value of water for a particular purpose, such as growing apples or hay. As previously discussed, water values vary over space and time. Crop water values are estimated as short-run marginal values. That is, the marginal value is equal to the gross revenue per acre less operating costs and water costs, divided by the total consumptive use. In this sense the marginal value could be referred to as the willingness to pay per additional acre foot of consumptive use. Short run values are used because the nature of drought in the basin lends itself to single-year (temporary) water transfers, particularly for agricultural and instream flow needs. This formula assumes that perennial crops would not lose their future productive life if idled for the drought year. As described above, the average marginal value of water is estimated by calculating the following:

$$Marginal\ Value\ per\ AF = \frac{Gross\ Revenue - (Operating\ Costs + Water\ Cost)}{Consumptive\ Use}$$

To calculate the above, we used the following data sources:

- **Enterprise Crop Budgets** (various, see Table 2) for cost of production estimates. A total of 10 crop groups and 13 cost studies were used in this analysis. Costs and returns were adjusted to 2021 dollars using the Bureau of Economic Analysis Consumer Price Index (CPI).
- **Washington Department of Agriculture Crop Data Layer** for parcel-level crop choices, planted areas, and irrigation technology.
- **U.S. Department of Agriculture National Agricultural Statistics Service** for commodities prices.
- **Washington Irrigation Guide** for crop-specific consumptive use at weather stations in the Yakima Basin. As described in the Tradeable Water section, the Washington Irrigation Guide was chosen for having more reliable estimates of consumptive use.

Table 2: Enterprise Crop Budgets Used for Marginal Water Values

Crop Group	Cost Study
Orchard	2019 Cost Estimates of Establishing, Producing and Packing Fuji Apples in Washington, Gallardo & Galinato
	2019 Cost Estimates of Establishing, Producing and Packing Gala Apples in Washington, Gallardo & Galinato
	2019 Cost Estimates of Establishing, Producing and Packing Honeycrisp Apples in Washington, Gallardo & Galinato
Hay/Silage	2012 Costs of Producing Alfalfa Hay Under Center Pivot Irrigation in the Columbia Basin of Washington State, Norberg and Neibergs

Pasture	2015 Sample Costs to Produce Pasture, UCCE
Vineyard	2020 The Northwest Grapes Cost-of-Production Calculators, Washington Winegrowers Association
Vegetable	2008-2009 Establishment and Annual Production Costs for Washington Asparagus, Neibergs and Waters
Cereal Grain	2014 Corn Under Center Pivot Irrigation Minimum Tillage, North Central Region, Seavert and Horneck
Turfgrass	2010 Willamette Valley Grass Seed, Grain, Oil Seed and Forage Seed Enterprise Budgets
Herb	2011 Cost Estimates of Establishing and Producing Peppermint Under Rill Irrigation in Central Washington, Gallardo and Galinto
Other Deciduous	2015 Cost Estimates of Establishing, Producing and Packing Sweetheart Sweet Cherries in Washington
	2015 Cost Estimates of Establishing, Producing and Packing Bing Sweet Cherries in Washington
Melon	2013 Cost Estimation of Producing Seedless Watermelon in Eastern Washington, Galinato, Miles and Wimer

Note the following limitations: our analysis excludes district-level water costs due to data availability; commodity and input prices are static; enterprise crop budgets represent industry averages whereas there is more variability at the field level; and shortages are not enough to damage established perennial crops. The total gains from trade and clearing prices would be affected by the use of different economic data. Finally, Yakima is likely a region where agrotourism could have a significant effect on crop water values; therefore, the economic impacts may be understated.

Combining several of the data pieces above, the average marginal values by water district/entity, proratability of that water district/entity, and total consumptive use of that water district/entity are represented in Figure 4.

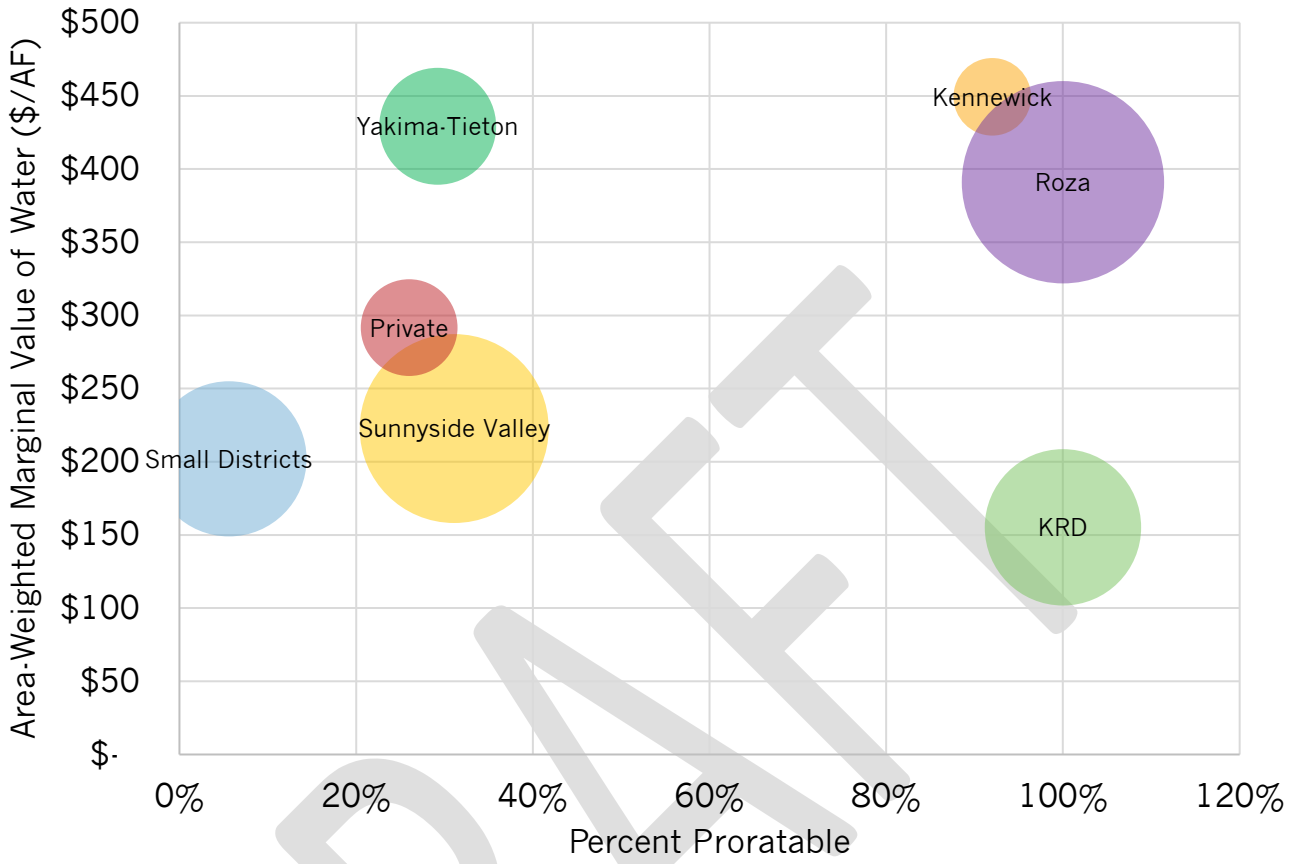


Figure 4: Average Marginal Values of Water by District or Subset of Water Rights. Each water rights category has its own seniority level, on the horizontal axis, based on how many of its water rights are junior or proratable. The size of the bubbles represents the total consumptive use.

Upstream/Downstream Analysis

In the trading of private water rights, the Department of Ecology must ensure that there are no third-party impacts. The Water Transfer Work Group developed criteria from which they would recommend approving or denying a trade, which include that the transfer does not create operational challenges for the Bureau of Reclamation. Based upon the criteria, and in collaboration with the Technical Work Group, it was decided that the smart market simulations should restrict the trading of water rights upstream. That is, only transfers that move water downstream of the original diversion point would be allowed.

To determine which water right transactions would be allowed in the analysis, water right diversion points and a linestring shapefile of streams from the National Hydrography Dataset (NHD) were used to create a basin transaction ledger.

The first step in this process was refining the NHD shapefile so it could be used to determine which transactions were upstream and which were downstream. Shapefile linestrings are broken up into segments between 1 and 5 miles long and labeled sequentially from the furthest downstream section to the streams uppermost reach with a "Waterway ID". For example, the lowermost section of the Yakima River is labeled "1" and its uppermost section near Kachess Lake is labeled "588". Once each stream section is labeled, we identify which stream it empties into and at what Waterway ID.

Next, we pair this data with water right POD data. Each diversion point is labeled with its nearest Waterway ID. From here we can use a logical statement (below) to tell if a transaction would be upstream or downstream between any two diversion points. This logical statement ensures that the seller's stream empties into the buyer's stream and that the buyer is downstream of the seller.

If the buyer and seller are on the same stream and the buyer's Waterway ID is less than the sellers Waterway ID,

Or the seller's stream empties into the buyer's stream at a Waterway ID greater than the buyer's Waterway ID,

Then the transaction is feasible.

Incorporation of an Environmental Buyer

Working with the Washington Department of Fish and Wildlife (WDFW) and TU, we devised a methodology for incorporating an environmental buyer into a smart market. Several methods were considered: using one of habitat, flow, or fish scores from the Columbia River Instream Atlas (CRIA), developing a composite score, prioritizing based off the water right's proportion to base flow, and more. Due to data challenges, the group ultimately arrived at a simpler but defensible method of identifying streams that are high-, mid-, and low-priority for additional instream flow (see Figure 5). We then used this method and combined it with a maximum per-AF of consumptive use payment. Two main considerations were taken into account when developing a payment method: Payments for high priority streams should always be higher than payments for medium priority streams and transactions that increase flow at the mouth of a tributary are more valuable than transactions that increase flows at headwaters.

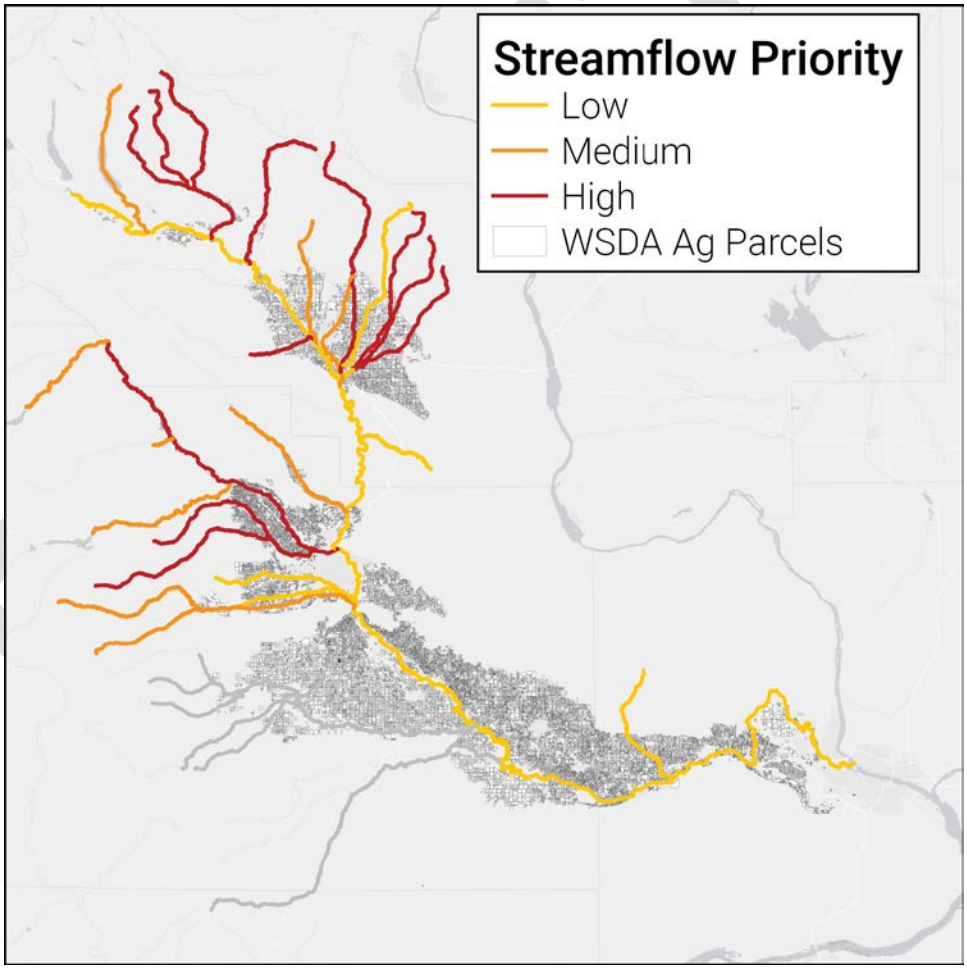


Figure 5: Priorities for Additional Instream Flow. Note: Toppenish, Satus, and Simcoe Creeks are priorities for streamflow restoration but are not assigned a priority due to the exclusion of water rights on the Yakama Reservation.

These ideas were taken and translated into a “payment score” for each individual transaction. Payment scores for low priority streams were always zero. Payment scores for medium priority streams ranged between 1 and 2. Payment scores for high priority streams ranged between 2 and 3.

If the transaction traveled the entire length of a waterway, its payment score would equal 100% of the max value for its priority category (3 for high and 2 for medium). If a transaction traveled only part of a streams reach its score would be equal to the inverse of the percent share of the stream covered, plus the stream priority’s minimum value. For example, a transaction that covers 0% to 25% of a medium priority stream its score would equal 0.25^0.5 - 0.0^0.5 + 1, 1.5. If the stream covered a range of 0.25% to 0.50% its score would equal 0.50^0.50 – 0.25^0.25 + 1, 1.2. This system allows us to prioritize transactions that cover the mouth of streams while preserving the ordinal ranking between stream priority types.

If a transaction covers more than one stream, the highest priority “payment score” is the score that gets used. Often water passes multiple tributaries which makes summing multiple “payment scores” a difficult approach, and the length of streams is highly variable making distance weighted scores difficult as well.

A payment score of 3 is normalized by dividing by the max payment score, 3, and multiplied by the environmental buyers max willingness to pay. If the buyer’s max willingness to pay is $100, then a transaction with a payment score of 3 would receive an incentive payment of $100 per AF. A transaction score of 1.5 would translate to $50 per AF.

Note that this environmental payment is not a standalone offer, but offered as a “wedge” on top of other agricultural water leasing. The water would eventually be consumptively used by another agricultural buyer, but downstream of the original diversion point, so that it creates an incentive for leasing water downstream and generates localized additional instream flow.

Market Rules and Simulations

As previously discussed, the market simulations focus on temporary, single-year leases of water rights for agricultural and environmental needs. Further, in recognition that inter-district trade is the subject of district-level policy, we further restrict trading simulations to only evaluate 1) the trading of private water rights among private water rights owners only ("private water rights" trading) and 2) the trading of irrigation district allotments within that irrigation district's boundaries ("intra-district" or within-district trading). We do not evaluate inter-district or other, more expansive water trading scenarios. We further do not allow parcels with stacked water rights to trade. As a result, our analysis is conservative for the potential volume and value of trading in the Basin.

The rules for private water rights trading are summarized as follows:

- No stacked water rights may be traded.
- A seller must lease to a buyer that is hydrologically connected and downstream of the seller's diversion point.
- Curtailment is based upon the priority date of the water right; 100% curtailment if dated after May 10, 1905 (a junior right) and 0% if before (a senior right).
- The total volume of water available for trade is based on the parcels' consumptive uses of the crop water demands, marginal values of water, and eligibility to trade given the upstream/downstream rule.
- An environmental buyer is incorporated in two of the three private water rights simulations. Two maximum payments are evaluated: $50/AF of CU and $100/AF of CU.

The rules for intra-district trading are summarized as follows:

- No stacked water rights may be traded.
- Curtailment is based upon the seniority or proratability of the district.
- The total volume of water traded is based on the parcels' consumptive uses of the crop water demands and marginal values of water.
- There is no environmental buyer participation in the intra-district markets.

Market Simulation: Private Water Rights Market

The market simulation assumes that 100% of consumptive water demands are met in a 100% water supply year. Then, as it simulates curtailment, 100% of junior private water rights holders are curtailed in full, so that they receive no irrigation water. This creates a new water demand that can be offset by a senior water rights holder, all of whom still receive 100% of their water deliveries. Water demands increase with the severity of the curtailment level. Sellers can sell up to 100% of their average consumptive use, and buyers

wish to purchase the amount of consumptive use that will meet their crop water demands (which are higher in drought years). Each seller enters the market with their field-specific average marginal value of water, and an amount to trade up to their average consumptive use. Each buyer enters the market with their field-specific average marginal value of water, and an amount to trade up to their current-year crop water demands. A seller will trade water at a price greater than or equal to their marginal value of water. A buyer will trade water at a price lower than or equal to their marginal value of water. A buyer will not purchase more water than needed, and a seller will not sell more water than they have available (their average consumptive use, or ET).

We order matches by matching highest price buyer to lowest price seller, then the second highest price buyer to the second-lowest seller, and so on, until there are no more eligible matches, by price point or by transfer rules. That is, if two parties are hydrologically connected to each other, but the senior water rights holder's water value is higher than the junior water right's holder, they will not trade. Alternatively, if two parties would financially benefit from a transfer but are not hydrologically connected, they cannot trade. We treat the price of the last trade executed as the clearing price.

The incorporation of the environmental buyer monetizes the instream flow benefit of moving water from higher priority streams to lower priority streams. The participation of an environmental buyer creates a wedge in the payments, so that it essentially reduces the price of water on an upstream and high-priority stream for a downstream and hydrologically connected buyer.

Market Simulation: Intra-District Markets

The market simulation assumes that 100% of consumptive water demands are met in a 100% water supply year. Then, as it simulates curtailment, it considers the district-specific water rights portfolio and proratability. For example, districts like Roza and KRD are 100% proratable. In a 90% prorationing year, they receive 90% of their water. On the other hand, Sunnyside is 31.1% proratable, so that in a 90% prorationing year, they receive 96.9% of their water. The market simulation assumes that in such a year, all fields in each district equally experience their district's curtailment level. In essence, in a 90% prorationing year, fields in Roza and KRD are limited to 90% of their consumptive use, whereas fields in Sunnyside are limited to 96.9% of their consumptive use. These deficits imply that fields would have to undergo fallowing to meet these curtailments.

These deficits create new water demands that can be offset by other fields within the district, all of whom are also experiencing the same curtailment. Water demands increase with the severity of the curtailment level. Sellers can sell their remaining allotments that would still be serviced (e.g., 90% in Roza or KRD in our example), and buyers wish to purchase the amount of consumptive use that will meet their crop water demands (e.g., 10% plus the additional crop water demands for a 90% prorationing year). Each seller enters the market with their field-specific average marginal value of water, and an amount to trade up to their remaining supply (e.g., 90% of their average consumptive use in Roza or KRD). Each buyer enters the market with their field-specific average marginal value of water, and an amount to trade up to their current-year crop water demands. A seller will trade water at a price greater than or equal to their

marginal value of water. A buyer will trade water at a price lower than or equal to their marginal value of water. A buyer will not purchase more water than needed, and a seller will not sell more water than they have available (their proratability percentage multiplied by their average consumptive use). We order matches by matching highest price buyer to lowest price seller, then the second highest price buyer to the second-lowest seller, and so on, until there are no more eligible matches. We treat the price of the last trade executed as the clearing price. Note again that in the intra-district (within-district) market, buyers and sellers may only trade with others within the same irrigation district. Inter-district (between district) trading is not simulated.

Results and Analysis

A summary of the smart market simulation results is presented in Figure 6. On the horizontal axis is the curtailment level. A 10% curtailment level corresponds to a 90% prorationing year. Curtailment is simulated up to 50%, such that fully proratable districts such as Kittitas Reclamation District and Roza Irrigation District would receive only 50% of their allotment. On the vertical axis is the total quantity of consumptive use traded, in thousands of acre-feet. The districts/entities are stacked from bottom to top in order of highest volume of trade to lowest volume of trade. A large majority (80-90%) of the water traded in the simulations occurs through intra-district trading, whereas a small portion of it occurs in the private water rights trading market.

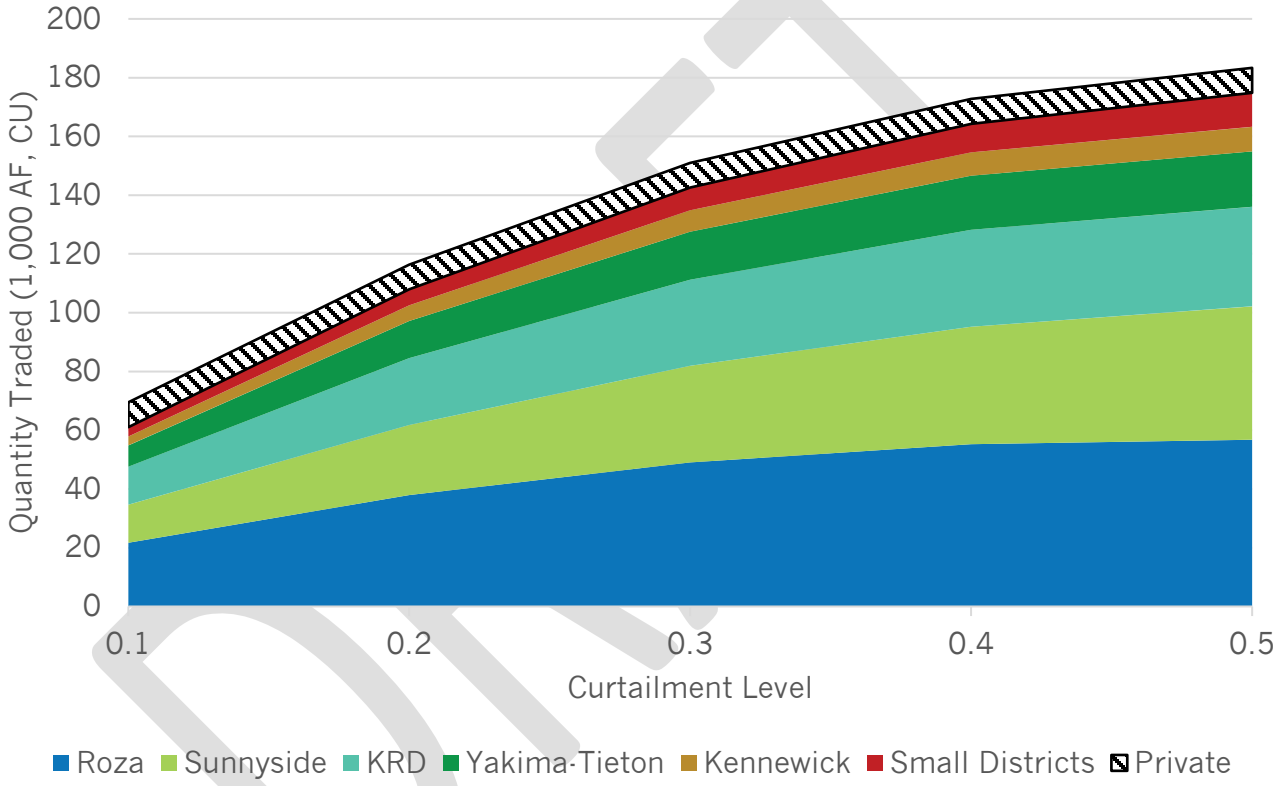


Figure 6: Intra-District and Private Water Rights Trading (Without an Environmental Buyer)

Intra-District Trading

Intra district trading accounts for 87%-95% of all trading by volume across all simulation runs. Further, 83%-89% of all trading occurs within five of the basins water districts: Kennewick, Kittitas Reclamation District, Roza, Sunnyside Valley, and Yakima-Tieton.

Total gains from trade within districts range from $13.2 million in 90% prorationing years to $34.3 million in 50% prorationing years. Gains are displayed in the figure below which shows gains from trade split between buyers and sellers.

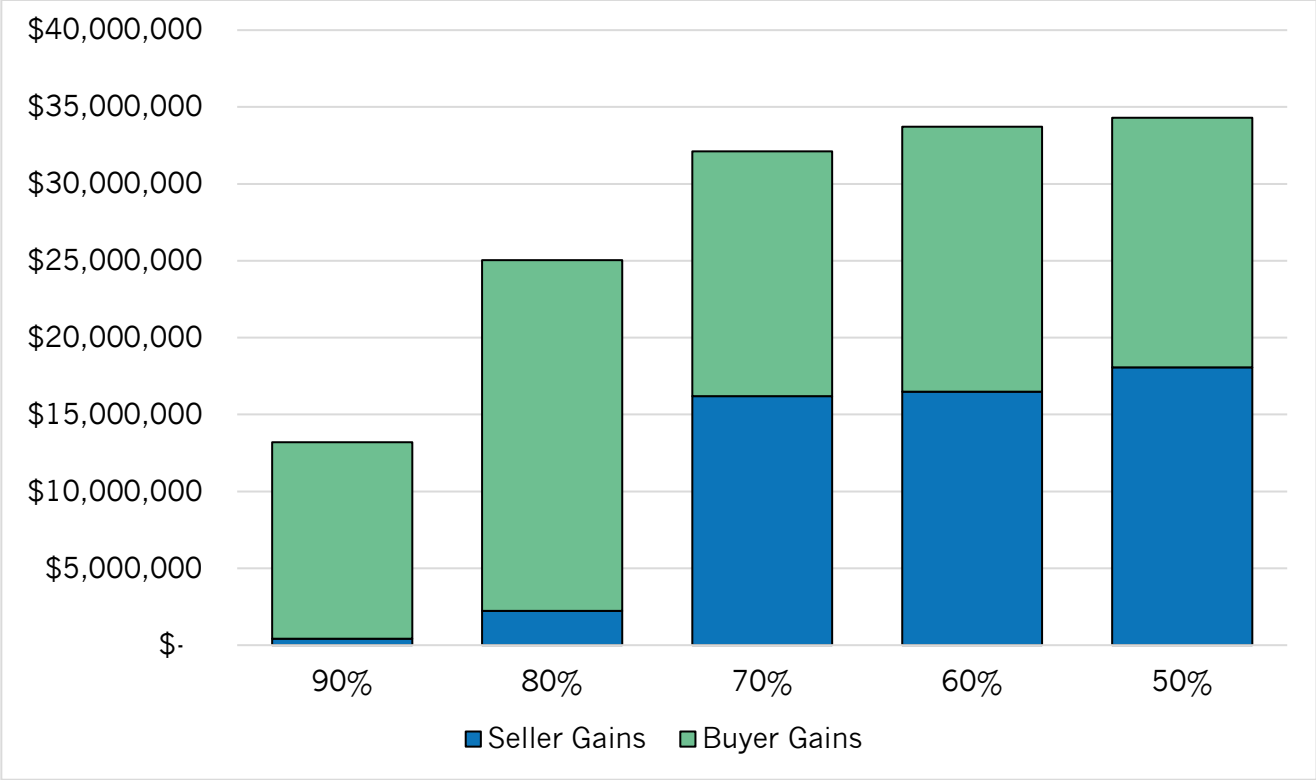


Figure 7: Gains of Trade by Prorationing Level

The split of gains from trade between buyers and sellers depends primarily on the crop mix within a given district. Districts with relatively uniform crop mixes will have smaller gains from trade whereas districts with more diverse crop mixtures may see much larger gains from trade. The distribution of gains between buyers and sellers depends primarily on the split of high value versus low value crops grown in the district. Gains from trade by major districts are broken down in Table 3 below.

Table 3: Gains of Trade by District and Prorationing Level

		Prorationing Level				
District	**Subcategory**	**90%**	**80%**	**70%**	**60%**	**50%**
Roza	*Sellers*	$121,000	$1,633,000	$15,536,000	$13,549,000	$11,531,000
	Buyers	$8,257,000	$14,325,000	$3,549,000	$4,172,000	$4,654,000
	Total	$8,378,000	$15,958,000	$19,085,000	$17,721,000	$16,185,000
Sunnyside Valley	*Sellers*	$2,000	$4,000	$12,000	$23,000	$171,000
	Buyers	$1,500,000	$2,955,000	$4,361,000	$5,721,000	$6,893,000
	Total	$1,502,000	$2,959,000	$4,373,000	$5,744,000	$7,064,000
KRD	*Sellers*	$140,000	$312,000	$302,000	$425,000	$574,000
	Buyers	$659,000	$1,039,000	$1,497,000	$1,764,000	$1,890,000
	Total	$799,000	$1,351,000	$1,799,000	$2,189,000	$2,464,000
Yakima-Tieton	*Sellers*	$22,000	$54,000	$111,000	$108,000	$3,666,000
	Buyers	$923,000	$1,783,000	$2,550,000	$3,351,000	$148,000

	Total	$945,000	$1,837,000	$2,661,000	$3,459,000	$3,814,000
Kennewick	*Sellers*	$71,000	$136,000	$138,000	$2,214,000	$1,881,000
	Buyers	$1,158,000	$2,189,000	$3,213,000	$1,308,000	$1,619,000
	Total	$1,229,000	$2,325,000	$3,351,000	$3,522,000	$3,500,000

Incorporation of the Environmental Buyer

Three instream flow scenarios are run. A scenario without an environmental buyer, a scenario with an environmental buyer with a max payment of $50/AF of CU, and an environmental buyer with a max payment of $100/AF of CU. In each of the environmental buyer scenarios the environmental buyer is limited to a budget of $500,000.

In each scenario, roughly the same amount of water gets traded (Table 4), but the locations of that water changes from low-priority to medium- and high-priority streams (Figure 7). In the $50/AF scenario, an additional 2,649 AF are traded on medium- and high-priority streams. In the $100/AF scenario, an additional 5,594 AF are traded on medium- and high-priority streams. Slightly more water is traded in the $50/AF scenario because the budget is not exhausted. This helps low-value buyers who participate last in the trading order buy water they otherwise would not have been able to. In the $50/AF scenario the payment comes out to $69/AF of additional water on high- and medium-priority streams, while in the $100 scenario this value increased to $90/AF. Prorationing occurs in 38% of years, meaning the annual cost of increasing flow on these streams is equal to $27/AF in the $50 scenario and $34/AF in the $100 scenario. A funded environmental buyer helps to incentivize trading from water rights in high- and medium priority reaches in a way that is not accomplished by agricultural trading alone. This method for targeted environmental purchases is effective and could be further improved through more advanced scoring techniques, such an update of the Columbia River Instream Atlas.

Table 4: Environmental Buyer Trading Volume and Budget

	No Buyer	**Enviro 50**	**Enviro 100**
Quantity Traded	8,449	8,640	8,636
Budget	$-	$182,956	$503,142

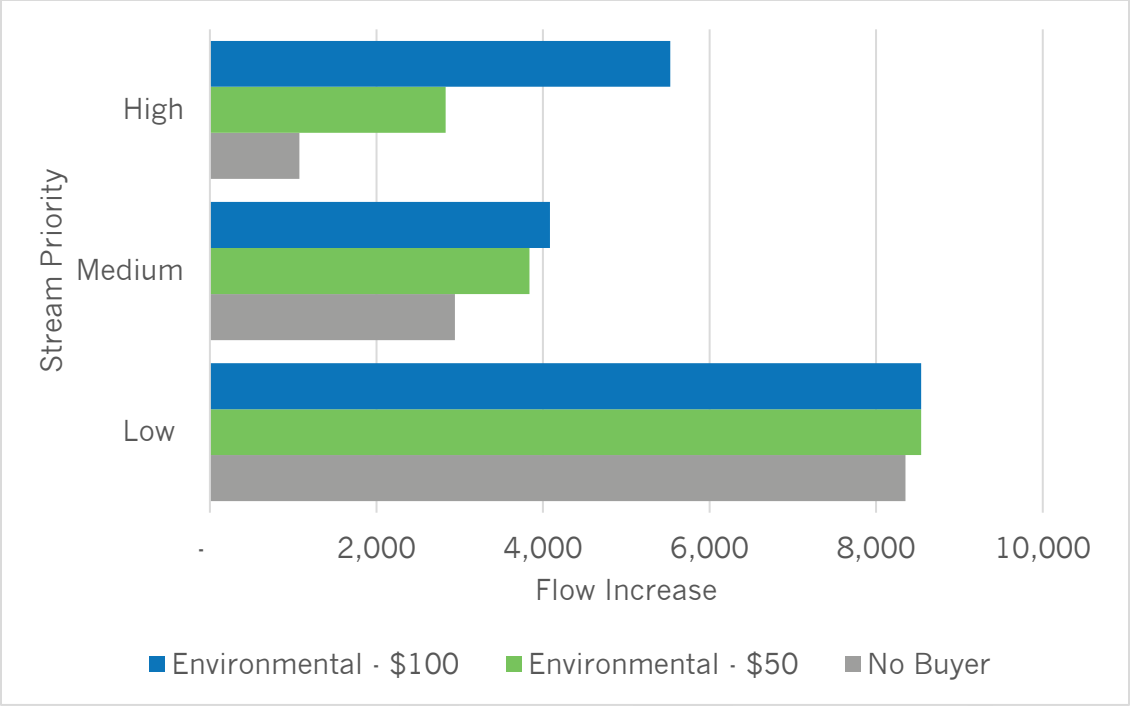


Figure 7: Environmental Buyer Effect on Trading Volume by Stream Priority

While a large majority of the agricultural benefits are realized through intra-district trading, instream flow benefits accrue only through the private water rights market. It is also important to note that the participation of a funded environmental flow buyer can drive more instream flows, particularly in high- and medium-priority reaches. Lastly, while the trading rules analyzed here are restrictive and conservative, they are easily adapted to allow more sophisticated and expansive trading rules, such as unstacking water rights, allowing inter-district trade, incorporating permanent trading, and more.

References

In addition to the data described in the *Yakima Basin Water Right Geospatial Analysis* and the *WSU Technical Documentation for Leveraging Agricultural Water Transactions to Increase Instream Flow Executive Summary,* we used the following data and sources for our work:

Superior Court of the State of Washington. Final Schedule of Rights. May 2019.

USDA National Agricultural Statistics Service. 2017 Census of Agriculture.

Washington Department of Ecology. Water Rights Tracking System.

Washington Department of Ecology. Columbia River Instream Atlas. December 2016.

Washington Irrigation Guide, GUID-1210 Water Resources Program Guidance.

Section 3: Draft Water Market Strategy

The provisional Yakima Basin Water Market Strategy DRAFT was completed in April 2022 and provided to the Technical Work Group for feedback in May 2022. Feedback was incorporated where practicable. Where feedback indicated or recommended further analyses, the project team took note and identifies that as part of revision process for completing a final draft in September 2022.

Yakima Basin Water Market Strategy – DRAFT

Kitittas Reclamation District in partnership from Trout Unlimited

April 2022, revised June 2022

Acknowledgements

Trout Unlimited (TU) in partnership with the Kittitas Reclamation District (KRD) prepared this Water Market Strategy for the Yakima Basin to advance the Market Reallocation element of the Yakima Basin Integrated Plan. The partners relied on technical expertise from Mammoth Water (now part of ERA Economics), Peter Dykstra (Plauché Carr), Jeff Slothower (KRD attorney), Jacobs Engineering, Walt Larrick and Joel Hubble, Univ. of Washington Evan's School of Public Policy, Washington State Univ. Water Research Center, and Trout Unlimited.

The core project team (TU staff, KRD staff, Mammoth, Dykstra, and Slothower) worked closely with a Technical Work Group ("TWG", member list in Appendix 3) composed of Yakima Basin stakeholders to discuss and vet technical steps and conclusions during the process.

This project was made possible through funding from the US Bureau of Reclamation's WaterSMART program and the Washington Department of Ecology's Water Resources Program and Office of Columbia River for the Yakima Basin Integrated Plan.

Contents

Executive Summary

A market for Yakima Basin water rights exists but is limited. The market evolved through a basin-wide adjudication, multiple droughts, and permit-exempt well issues. Over time, the steps to transfer water were established and revised. These steps are helpful and generally accepted but they also may limit market participation due to costs and timeliness around decisions.

Improving market access will require steps to remedy inefficiencies and promote trust in the water market. Primary inefficiencies exist around buyers and sellers identifying each other, water transfer processing, and the ability to manage and protect transferred water. Through the technical analyses and stakeholder outreach, we think there is an opportunity to improve market-based reallocations through implementation of this smart market strategy.

A smart market is an electronic clearinghouse that matches buyers and sellers of water according to set rules. The rules are derived from the local water transfer rules, requirements, and procedures. This draft strategy is not a prescription for a water bank. A smart market is not a manager of water or a water banker but is a tool to streamline processes and increase market participation, particularly in drought years.

Implementation of the smart market strategy will require close coordination with basin water managers. The coordination ensures the transfer rules are being followed and the water is being protected and used as the intended.

This draft strategy was developed after reviewing market-based water transfer information, reports, and earlier recommendations for the Yakima Basin. The results of the review are encompassed in the Yakima Basin Water Market Strategy Technical Report. The final market strategy will be completed in September 2022.

What is a water market strategy?

A water marketing strategy describes a proposed approach to establish or expand a new water market or water marketing activities based on the results of the outreach, scoping, and planning activities that are performed. In different areas, a water market strategy will take different forms and provide varying location specific solutions. Strategies may be compared but ultimately should are basin specific.

Purpose:

The purpose of this document is to provide a water marketing strategy to improve upon existing water market activities in the Yakima Basin. These activities are the result of a mix of market-based transactions, shifting water needs, and natural water shortages.

The reader should consider this document as a part of a broader effort to address climate change impacts on the Yakima Basin ecosystem as described in detail in the Yakima Basin Integrated Plan. The authors recognize that many types of water resource projects in the Yakima Basin are underway, ranging from conservation measures to new groundwater and surface water storage to habitat improvement, and they may impact parts of this strategy. As these projects are more certain or complete, then the plan can be updated accordingly.

The specific water marketing strategy advanced in this document is the development of a smart market which would improve water market efficiencies by streamlining and automating key steps. It should be noted that this type of approach will not be appropriate for all types of water transfers. With various water resources projects underway and Yakima Basin market activity evolving, this smart market strategy can be updated accordingly.

The strategy is the result of significant technical evaluation of the transfer process, identification of inefficiencies, and recommendations for improvement. The objectives for the technical analyses, and drivers behind the strategy, are:

- Research past market-based transactions and efforts to identify tools and mechanisms to reduce barriers to water transactions to identify the positives and negative attributes of those efforts.

- Analyze and synthesize water marketing/banking research to develop mechanisms that increase market access and facilitate water transfers for all interested stakeholders.
- Develop a framework that will advance market-based transactions that include environmental benefits in the Yakima Basin by reducing systemic inefficiencies.
- Provide recommendations for increased stakeholder participation in market-based transactions for surface water rights in the Yakima Basin.

Water Supply Rules

The water supply in the Yakima River Basin has been established by a treaty, acts of Congress, prior appropriation, and litigation, which began in 1855 and continued until 2019. Taken together, the rights of the various water users to the water within the Yakima River Basin are now relatively certain. The water supply available to satisfy those water rights is entirely dependent on natural moisture and is therefore always uncertain.

In the Treaty of 1855, the Yakama Nation's time immemorial water right was recognized. Shortly after the Treaty of 1855, settlement of the Yakima River Basin began and between 1860 and 1905 water rights were established by a variety of individuals and entities based on territorial and State law.

In 1905, the United States Department of Interior, through the United States Bureau of Reclamation (hereinafter "USBR"), withdrew all of the unappropriated water and began the development of the Yakima Irrigation Project (hereinafter the "Project"). Over time, five different divisions of the Project were developed. In 1945, the United States District Court entered a Consent Decree in Kittitas Reclamation District, et al. v. Sunnyside Valley Irrigation District, Civil No. 21 (ED WA, 1945) (hereinafter the "Consent Decree"). The Consent Decree established two classes of non-Indian[1] water users; to wit, senior users, whose use commenced prior to May 10, 1905, and junior users, whose use commenced after May 10, 1905. The Consent Decree also established the concept of Total Water Supply Available ("TWSA") and defined it as follows:

[1] The Consent Decree designated Indian water rights. The term Indian is used for consistency with court documents.

> ... "total water supply available" is defined as that amount of water available in any year from natural flow of the Yakima River, and its tributaries, from storage in the various Government reservoirs on the Yakima watershed and from other sources, to supply the contract obligations of the United States to deliver water and to supply claimed rights to the use of water on the Yakima River, and its tributaries, heretofore recognized by the United States.

The Yakama Nation was not a party to the Consent Decree and, as a result, the Consent Decree failed to adequately deal with and allocate tribal water rights. From 1945 until 1976 the water users operated under the Consent Decree with USBR controlling the amount and timing of flows in the Yakima River and some of its tributaries through the storage and release of water stored in five (5) reservoirs. The KRD v. SVID court determined in the Consent Decree that TWSA is in part comprised of the water stored in those five (5) reservoirs.

In 1977 the Washington State Department of Ecology (Ecology), under the authority of Chapter 90.03 RCW, commenced an adjudication of all surface water rights to the Yakima River and its tributaries. The Yakama Nation joined the case and from 1977 until August 9, 2019, the Yakima County Superior Court adjudicated the rights of all water users in and to the Yakima River and its tributaries in State of Washington, Department of Ecology v. James J. Acquavella, et al., Yakima County Superior Court Cause No. 77-2-01484-5 ("Acquavella").

On August 9, 2019 the Acquavella court entered its Final Decree, which incorporated a 2,477-page Schedule of Rights (>2,300 water rights). The effect of the Final Decree is that every water user's rights are fixed—quantified and prioritized by date. The Final Decree was appealed. The Washington State supreme court issued a decision which finalized all but two issues. The two unresolved issues were remanded to the Yakima County Superior Court. On April 14, 2022, the Yakima County Superior court issued two orders amending the schedule of rights on the issues which were the subject of appeal. Entry of those orders officially completed the adjudication.

What started in 1977 and continued for nearly four decades as an acrimonious and protracted legal battle over water rights settled into a realization by the parties that it is in their best interests to cooperate on water rights issues. As a result, in 2013 the Washington legislature authorized the Yakima Basin Integrated Plan (YBIP) that was developed by and among one-time courtroom adversaries.

The goals of the YBIP are as follows:

- Provide opportunities for comprehensive watershed protection, ecological restoration, and enhancement addressing instream flows, aquatic habitat, and fish passage;
- Improve water supply reliability during drought years for agricultural and municipal needs;
- Develop a comprehensive approach for efficient management of water supplies for irrigated agriculture, municipal and domestic uses, and power generation;
- Improve the ability of water managers to respond and adapt to potential effects of climate change; and
- Contribute to the vitality of the regional economy and sustain the riverine environment.

The effect of litigation over the last half of the twentieth century was to create a river basin where water rights are known with certainty and reduced to writing. This created a certain group of water users who may benefit from participating in a formalized water market. However, several factors will impact how much water may be available to be reallocated through a market of any kind.

Yakima Basin Water Market Activity

The basic premise of a market-based water right transfer is the exchange of value between buyers and sellers that allows the buyer access to the sellers' water. There is some evidence that neighboring water users in the Yakima Basin have conducted a simple. grass-roots form of market-based transfers for a long-time. Neighbors informally transferred water on a local (e.g., water right source) level at times of water shortages. Evidence of these transfers may not have been recorded, nor documentation even considered, by the water users.

The Acquavella proceedings helped landowners become better aware of procedural steps for water transfers. As water right holders became more educated and competing demands on water increased, a market developed. Periodic droughts underscored the need for: temporary transfers; robust investment by public agencies and nonprofit conservation organizations in purchasing senior water

rights and changing their purpose of use to instream flow; Ecology's closure of the Upper Kittitas County area of the Yakima Basin to new groundwater uses; and a 2014 settlement agreement over permit-exempt water uses in Kittitas County further evolved the market.

Market participants have limited ability to accurately identify past market activity and use it to help predict future activity. Past market activity, particularly for permanent transfers, may prove a poor indicator of future activity. However, we may make several general conclusions on potential market activity based on water right transfer information from the Water Transfer Working Group ("WTWG", see Definitions, Appendix 1).

First, transfer activity increased in drought years (2005, 2015, 2019), after passage of the 2009 water banking legislation (RCW 90.42), after the closure of the Upper Kittitas County portion of the basin in 2011 (WAC 173-539A), and after settlement of litigation of permit exempt water uses in Kittitas County (2014).

Activity in non-drought years was present but the number of transfers for agriculture were fewer than drought years. An increase in the creation of water banks after and an increase in TWSA water budget neutral (WBN) applications occurred following adoption of Ecology's Upper Kittitas County rule. Depending on the year, WBN transfer applications can even dominate the number of transactions. WBN and water banking transfers are typically permanent.

These results suggest the presence of an ongoing water market more focused on 1.) temporary transfers for agriculture driven by water shortages; and, 2.) permanent transfers from agriculture for water banking/domestic/municipal purposes.

Second, inter-district transfers are prevalent in drought years but seem non-existent in non-drought years. With proratable irrigation districts, the need for water in a drought year is dictated by the amount of prorationing. In severe years, we expect more water moved from senior to junior districts.

Third, environmental and municipal buyers are active in the Yakima Basin. The level of activity varies. This activity may increase as climate changes threatens the Basin's water supply.

Finally, transfers that involve donations are not easily captured by the WTWG data. Permanent donations are uncommon but temporary donations are present and

may be the result of market activity. For example, a landowner may get an irrigation system upgrade through a grant program and need less water to irrigate. The grant program may require that the water is protected for a term of years. A temporary donation is a logical step to achieve the desired result.

Current water transfer activity requires resources from the Ecology. The more complex transfers require more resources and may take more time to process. The commitment of finite resources to complex transfers comes at the expense of simpler transfers that may be suitable for a smart market approach. As such, even if an individual water transfer doesn't occur through a smart market, other water market activity may benefit by: increasing market confidence by increasing the number of successful transfers, and focusing limited Ecology staff time on those transfers that require individual review

In summary, a water market exists in the Yakima Basin. The market is more active in drought years and for short-term transfers for agricultural purposes. The shortage of water for instream flow, growing population, and ongoing agriculture sharpens competing water demands that will likely benefit from a structured market framework that would sustain market activities well into the future.

Smart Market Strategy

Selecting a Smart Market

The presence of a Yakima water market creates an opportunity for evaluations and improvements. Various steps in the process demonstrate inefficiencies that may frustrate stakeholders and impact market activity. The goal of this water market strategy is to improve upon the existing market through streamlined functionalities, namely through the development of a smart market.

A smart market is an electronic clearinghouse that matches buyers and sellers of water by price point and regulatory constraint. Use of a smart market (this strategy) will help eliminate market access limitations and provide a pathway for greater stakeholder participation.

The water market strategy described here hinges upon the ability to streamline and ultimately automate several key processes in transferring water rights. These processes include but are not limited to:

- Identifying a party with which to trade water,
- Negotiating terms of the water transfer,
- Evaluating the extent and validity of a water right,
- Calculating the consumptive use of the water right, and
- Determining whether the transfer will cause third-party impacts.

Such processes currently require substantial time, effort, and money to complete. Also, delays in administrative processing or in an ultimate approval could delay the transfer of the water right beyond the time of need and render a shorter-term lease infeasible or moot even where the above processes have been satisfactorily addressed.

As part of the strategy's development, we considered several potential trading scenarios: (1) intra-district, or within-district, trading only; (2) trading of privately held water rights; and (3) inter-district trading, or the trading of water between districts. Note that all three of these are already occurring in the Yakima Basin. Intra-district trades are common in several of the irrigation districts. Market-based transfers of privately held water rights are handled by buyers and sellers and often involve Ecology. Water trading between districts can and has happened, such as Roza Irrigation District leasing water from Sunnyside Valley Irrigation District during the 2015 drought.

Smart markets tend to provide more value in thicker markets where large numbers of potential buyers and sellers exist. This works well for individuals: within irrigation districts that may trade district allotments, or outside of irrigation districts that may trade privately held water rights. However, because there are a relatively small number of irrigation districts, it was decided that a smart market would not be as valuable for inter-district trading. As such, the smart market strategy focuses on the trading of (1) intra-district water and (2) privately held water rights.

Smart Market Operations:

At the guidance of the TWG, the market rules were prepared both to align with the WTWG existing criteria for recommending transfers and to lend themselves to automation by a smart market. These rules are intended to identify transfers that can meet the WTWG's water budget neutral criterion and avoid impairment to the rights of third parties or existing Project operations.

As previously described, the smart market strategy is to streamline and automate key processes in water right transfers. It is noted that these rules are for smart market transfers only. Outside a smart market, individualized review, rather than these market rules, ensure that there is no increase in consumptive use and no impairments to third parties or existing operations.

As a result, the following three primary market rules were developed.

1. Consumptive use of the water right may not be increased by the transfer.
   The consumptive use was calculated through two methodologies: the Washington Irrigation Guide (WIG) and the VIC-CropSyst model. Ultimately, the WIG was selected for consistency with water transfer policy.
2. No stacked water rights may be traded.
   A stacked water right is one in which the same place of use receives water from multiple sources, such as an irrigation district allotment and a privately held water right. Any privately held water right within an irrigation district's boundary is assumed to be stacked, making the estimate of unstacked water rights in this report conservative.
3. Only downstream transfers of water use are considered for privately held water rights.The analysis limits an individual to only buying from someone whose diversion point is upstream of theirs.

Parties then would be matched based on (1) their eligibility to trade per these three constraints and (2) their price point. A price point is typically the marginal value of water for that particular purpose and place of use. Marginal values of water are heterogeneous and, for agriculture, affected by factors such as crop prices, crop yields, soil types, irrigation technology, and any specific water costs such as wheeling, among others.

Several sources were compiled to inform and used to simulate market activity, including water rights, stream hydrology, water duties and consumptive use from the WIG, cropping, and economic data. Results from the intra-district trading and private water rights trading scenarios (both as single-year leases) are described below.

Market Workflow

The following is a description of process and roles for sellers, buyers, market administrators, and regulatory authorities like Ecology or irrigation districts.

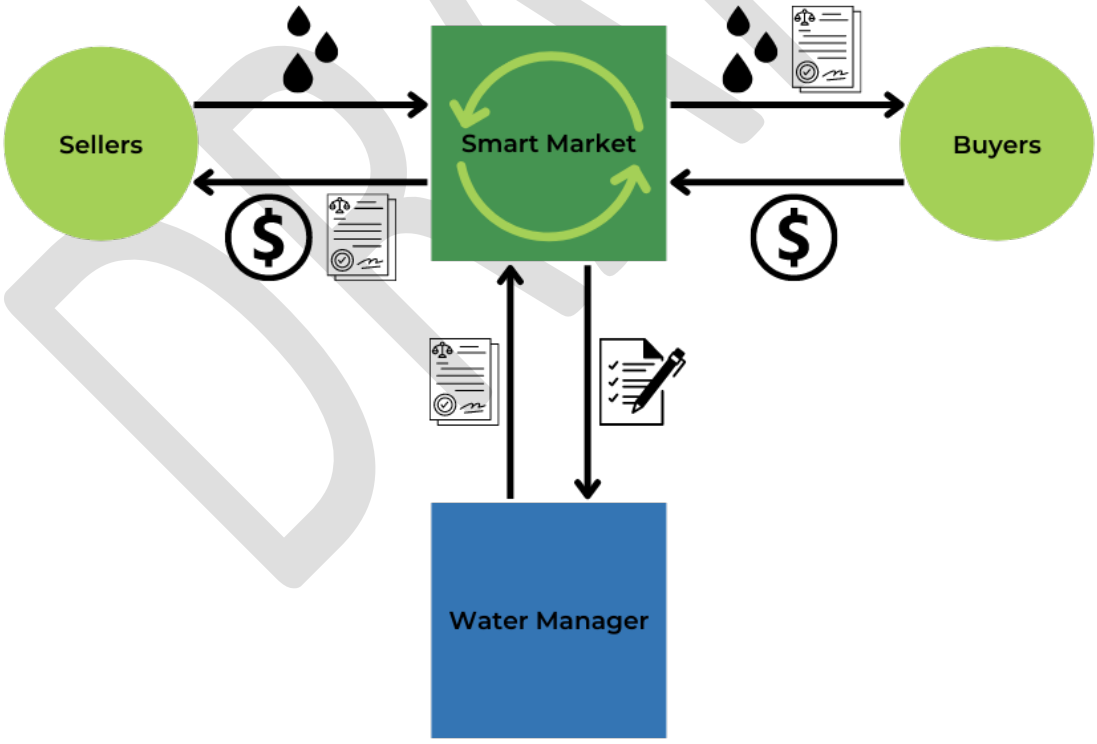


Fig 1. Simplified view of a smart market that identifies the relative roles of the smart market, buyer, seller or lessor, and market administrator/manager.

Seller Workflow

Prospective sellers would create an account and add the parcel description and water right number for which they would like to sell or lease all or a portion. They would specify how much water they want to sell or lease, up to their full consumptive use (calculated by the market platform using the WIG), as well as their price floor. Sellers would agree to terms and conditions as part of submitting an offer. Such terms would include those required from the appropriate regulator (e.g., Ecology or water purveyor), which could include additional monitoring and enforcement agreements should the transfer be approved.

After the clearing cycle, the seller would be informed whether their offer was matched. If not, they could keep their offer in the next clearing cycle unchanged; sellers could edit their offer (e.g., lower their price); or they could remove their offer altogether. If their offer was matched, they would be informed of the approval process. Once approved, funds would be transferred from an escrow account, less market administration fees, to the seller and the final pieces of the transaction would be finalized.

Buyer Workflow

Prospective buyers would create an account and add the property and diversion point for the location for which they would like to buy or lease water. They would specify how much water they are looking to purchase or lease, as well as their price ceiling. Buyers would agree to terms and conditions as part of submitting a bid. Such terms would include those required from the appropriate regulator (e.g., Ecology or water purveyor), which could include additional monitoring and enforcement agreements should the transfer be approved.

After the clearing cycle, the buyer would be informed whether their bid was matched. If not, they could keep their bid in the next clearing cycle unchanged; they could edit their bid (e.g., increase their price); or they could remove their bid altogether. If their bid was matched, they would be informed of the approval process. Once approved, funds would be transferred to an escrow account, including market administration fees, and the final pieces of the transaction would be finalized.

Environmental Buyer Workflow

The water market allows environmental buyers to acquire water rights to improve stream flow. . Should an environmental buyer participate, they would set a total

budget, a price ceiling in dollars per acre-foot of consumptive use, and select from a checklist the streams of interest. There would also be the option to select whether the streamflow would be bundled with other buyers' bids to allow that water to be consumptively used farther downstream) or if that water should be protected as instream flow. The environmental buyer would agree to terms and conditions as part of submitting a bid.

After the clearing cycle, the buyer would be informed whether their bid was matched. If not, they could keep their bid in the next clearing cycle unchanged; they could edit their bid; or they could remove their bid altogether. If their bid was matched, they would be informed of the approval process. Once approved, funds would be transferred to an escrow account, including market administration fees, and the final pieces of the transaction would be finalized.

Workflow and Roles for the Market Administrator and the Water Regulators

The smart market administrator would:

- offer customer support to market participants (customers);
- clear the market on its clearing schedule;
- communicate with trading parties;
- submit transfer applications to and work with Ecology or the respective irrigation district;
- upon approval, execute the transaction by transferring funds and finalizing documentation; and
- handle any maintenance and updates to the smart market.

The smart market administrator would largely be responsible for the financial, contractual, and technical aspects of trading, along with providing the supporting documentation. Note that a market administrator does not have legal authority to review or approve/deny a transfer, manage or update water rights records, or monitor and enforce deliveries; these are public agency functions.

The updating of the water rights records, or water accounting systems, as well as monitoring and enforcement, is a role for Ecology for private water rights or the respective irrigation district for district allotments.

Public Versus Private Data

The proper handling of data is important for generating trust in a marketplace. Data that must be made public are limited to the parties who executed transfers,

and in what volumes. Other information about the prices bid, offered, or executed are private and confidential. Parties that participate (submit a bid or offer) and are not matched are also kept private.

Administrative Structure

A key factor for market success is participant trust in the administration. Stakeholder confidence in the market requires transparent and consistent application of rules and processes.

A smart market may be administered by a private or public entity. However, prices are disclosed and public agencies such as Ecology are past and potential future market participants, which could foster stakeholder skepticism about the market. Moreover, the literature suggests administration by a trusted, transparent entity. As such, we propose running the market through a private, non-governmental entity (not-for-profit or for-profit). A private NGO, if properly setup, may help avoid actual or perceived conflicts of interest and encourage stakeholder confidence.

Initially, the workload may not demand full-time staffing. As such, the smart market strategy can be incorporated as a special project for a period of years by an existing private NGO. A predetermined period, for example 10 years, will allow the administrators to establish the smart market and evaluate the platforms robustness as its own entity.

It is expected that market administration for the Yakima Basin would not initially require year-round full-time employee(s), but that the employee(s)'s time would ramp up seasonally with the irrigation season or in drought years. Conversely, the administrative needs would diminish during the off season or in non-drought years. The professionals supporting the water market would need a combination of skills in water trading, technology, Washington real estate or water rights law, and financial transactions. Depending on the cost recovery model, a real estate broker or individual licensed to practice law may need to be involved in market administration.

Costs to finalize development and implement the market will cover numerous areas. To finalize development, there is the upfront and ongoing development costs for the smart market platform. This cost could be relatively minimal or significant depending on legislative or policy changes; additionally, development costs may increase as more complexity is added to the market through, for example, more water available or shifting demands.

Seasonal customer support and market administration are ongoing costs, as are maintenance of the platform and supporting technologies. Some funding need is expected in all years to handle maintenance and ongoing platform costs, with variable funding to support staffing capacity for administration—expected to be minor in wet years, but major in drought years. Funds could come from a combination of public funding (e.g., federal USBR funds or state YBIP funds) and private funding (e.g., administration fees paid by water market participants, private foundations).

Stakeholders and Water Rights

The smart market approach is designed to allow as many interested parties as possible to participate while still advancing the goals to streamline and automate key water rights transfer process steps. General interest in an open marketplace is wide open and there is no restriction for whom may participate. Legislative changes could limit market participants in the future, and the smart market could be quickly adjusted to accommodate.

The water rights involved in this smart market can be any[2] surface water rights awarded in Acquavella (and subsequent transfers/partitions). Groundwater rights were not adjudicated and present significant challenges to trading, especially relating to uncertainty about the water amounts.

The type of water right ownership[3] may change the steps necessary to enter the smart market. The decision to enter a market is left to each water right owner but this strategy allows each to participate to their desired extent.

A future unknown is the presence of additional surface water storage in the Yakima Basin. Presently, there are five large reservoirs that store water for irrigation, fish, and flood control purposes. The YBIP is actively engaged in efforts to develop additional surface water storage facilities. Any additional stored water could enter the market according to the terms of use for that water. Also, the Integrated Plan includes an element supporting market-based water reallocation. Potential opportunities and partnerships between the smart market manager and YBIP participants may emerge as YBIP implementation proceeds.

[2] Excluding Yakama Nation water rights as stated earlier.
[3] Publicly owned water rights will likely require additional steps to position the water right for entry into the smart market. For example, a county-owned right will need public notice and possibly approval by county commissioners.

Implementation Approach:

Phased Market Rollout

Market Rollout

The proposed market strategy recommends a phased rollout: first, with interested irrigation districts who wish to run pilot smart markets in their districts; next, working with Ecology to launch a smart market for privately held water rights; and finally, working collaboratively with YBIP stakeholders to expand, adapt, and refine the smart market as needed.

Tracking Market Success

While the strategy for smart market development includes an NGO market administrator, it is important for there to be transparency of the market's performance. Important metrics to track performance include:

1. Transaction Costs. What were the transaction costs associated with trading? What percentage was covered by public funding versus market participants? How are transaction costs changing over time?
2. Market Participation: How many individuals created accounts? How many new bids were submitted? How many new offers were submitted?
3. Market Efficiencies: Was there a surplus or deficit of water available through the market? What factors affected surpluses and deficits?
4. Traded Quantities: How many trades were executed? How much water was traded in each month and year?
5. Stream Flow Benefits: Which streams were augmented with instream flow, and for how many river miles?
6. Trading Benefits: What are the approximate benefits or gains (e.g., acres kept irrigated) of trade in each year?

These metrics will help monitor market performance and highlight any gaps that should be addressed.

Scaling the Smart Market

The Yakima Basin's water market currently serves a variety of water trades, including lease and permanent transfers and transfers across sectors (e.g., agricultural to municipal use). Rather than attempting to handle all of the current trades, the strategy for implementation is to handle the simplest trades first, with the ability to adapt and add different types of trades or more complex trades.

These "simplest trades" for the smart market to execute are ones that should also benefit the most from a streamlined process: lease transfers. Lease transfers have large transaction costs, with a short horizon of benefits. While lease transfers may have a short-term impact, there can be a large number of trades for leases, particularly in drought years, that would benefit from the economies of scale that a streamlined water market would offer. Handling lease transfers only also minimizes risks, as any transfers executed will expire and are not permanent should there be any unforeseen outcomes or consequences of trading. This combination of being simple, high-impact, and low-risk makes leases the perfect starting place for smart market development.

As there is comfort, interest, and funding to do so, the market can be adapted to add more functionalities. This modular strategy will maximize opportunity for continued outreach to, and feedback from, stakeholders. It will also allow the market to scale and grow in the ways that are best suited to Yakima stakeholders over time.

Legal Framework

Smart Market Strategy and Washington Water Law requirements

Water right transfers in Washington are regulated by Ecology under RCW 90.03.380. Permanent and temporary transfers follow the same pathway except when a drought is declared. A temporary transfer may receive priority processing in a drought year compared to standard processing for permanent transfers.

Water trading through the smart market is required to follow state water right transfer rules. The first requirement to participate in the smart market is that the seller has a valid water right. Currently, there is no "simple" review of a water right to confirm current ownership, and beneficial quantities and uses of a water right.

Absent a pathway for a simplified review of the water right, sellers will need to show a valid water right. A seller could use the pathway of adding a purpose of use for instream flow and mitigation to their water right. Although this step comes with risks because of required analysis of annual consumptive quantities, the resulting water right would be more suitable for future transfer because: (1) the right has undergone a recent tentative determination of extent and validity; and (2) the instream flow and mitigation portion of the right can be exercised in any given year in coordination with Ecology. The second reason provides a further measure of protection for the water right and would facilitate easier transfers according to the smart market and Yakima Basin rules.

Another place the smart market fits within Washington's water code (RCW 90.38.040, 90.42.110 – .130, 90.03.380) is through the Trust Water Rights Program (TWRP). The statutes allow the TWRP to function as a state-run water bank, among other roles.[4] This allows the state flexibility to manage water rights and operate as a market participant. Water acquired by the TWRP program may be redistributed under a Trust Water Rights Agreement ("TWRA"). As such, a water right holder could enter their water rights into the TWRP and the TWRA terms would help define how the owner could sell/lease the water.However, a water right holder does not need to engage the TWRP to partipate in the smart market.

[4] The TWRP is not being considered for smart market administration because of actual and potential conflicts of interest that may undermine public confidence in the market.

USBR-Ecology Storage and Exchange Contract

USBR and Ecology have an existing storage contract ("the Storage Contract") that impacts the existing market and any future smart market.. This contract is for storage of water within unused capacity of the existing reservoirs and release of it for later use before the following irrigation season. The contract allows Ecology to acquire storage space from USBR and for USBR to store water for Ecology. The significant benefit of the Storage Contract is that it allows, so long as some unused USBR reservoir capacity is available, trust water rights may be "retimed" and thus extend seasonal water rights to be used outside of the water right season of use. Water transferred through the market could, if managed within the Trust Water Right Program and agreed by Ecology and USBR, make use of the Storage Contract. Most, if not all, transfers of a seasonal use water right to a year-round use would require the use of either the Storage Contract or a new storage facility to allow the period of use to shape across the entire year.

Rules and Requirements Governing Implementation of Smart Market

Mentioned above, water transfers in Washington are governed by the Water Code (RCW 90.03.380). A water right holder may initiate a transfer by applying to Ecology or a Conservancy Board. As part of the transfer process, a seller may need to complete a SEPA checklist and follow the Washington SEPA process if the transfer is above the threshold for being exempt (add reference). Public notice....

Water Transfer Working Group

In the Yakima Basin, transfers typically require approval of the Water Transfer Working Group (WTWG) to also get Ecology's approval. The 2001 drought spurred creation of the WTWG by the Conservation Advisory Committee to the Yakima River Basin Water Enhancement Project and the Superior court during the Acquavella adjudication. In March 2001, representatives from the USBR, Yakama Nation, WDFW, USFWS, NMFS, Ecology, and irrigation districts developed a set of criteria to streamline evaluation of temporary transfers and make recommendations on the transfer to Ecology. The criteria and the WTWG are valuable tools to streamline transfers in the Yakima Basin.

The basis of WTWG's process is a checklist of the legal and operational requirements for approval of a transfer. Transfers that fit the checklist's "box" are approved but transfers that do not fit in the box are subject to further scrutiny. The checklist approach was originally intended for drought years, however the

approach's success made it useful for all transfers and it was ultimately adopted by the Adjudication Court as a form of primary review for the Court on transfers.

As identified in the Recommendations, the continued presence and input of the WTWG is key to the smart market strategy.

Agreements for Smart Market Participation

Participation in the smart market will likely require at least two forms of agreement. The first is acceptance of the terms and conditions to participate in the smart technology. This is similar to the requirements of buying many physical forms of technology (e.g., phones, computers, etc.) that require you to first accept basic terms and conditions before you can use the technology. A draft of the Terms and Conditions are included in Appendix 3.

The second form of agreement is between the buyer and seller. This may take the form of a Purchase and Sale, Lease, or other suitable form of agreement between the water right owner and the successful buyer. No detailed example is provided in this strategy for two reasons. First, the specific terms of either agreement may vary widely, based on the needs of the involved parties. Second, Washington state requires that real estate transactions (this includes water rights) must be closed by a licensed real estate professional or a licensed attorney. As a conceptual aid, we provide a basic form of a sample lease agreement in Appendix 4.

Issues to Resolve for Implementation

Water Right Ownership

To participate in any water market, the seller must bring a validly owned water right (or right to irrigation district water allotments) with known attributes to the market. Most water right holders in the Yakima Basin own their water rights and generally know the key attributes of their rights. However, for some users a critical step in the market/transfer process is identification of the water available for transfer. This requires evidence of actual ownership (including limitations on ownership like a mortgage) and then what water uses are authorized. This step is not possible through the Smart Market and could be a significant hurdle to market participation.

Streamlined Processing

Validity of a water right must be established before a trade can occur. Ecology's process for changing a water right includes an extent and validity determination and takes about a year to complete. This process could be streamlined similar to the drought year process and Ecology could provide a letter affirming the basic water right attributes.

Another possibility is to have the smart market administrator contract with (or staff internally) a Certified Water Right Examiner to facilitate investigation of the extent and validity of the water right. The statutory change to formalize its use would be a simple extension of the proof examination purpose described in RCW 90.03.665(1).

Legal Needs

The presence of market-based transfers in the Yakima Basin helps to reduce the number of issues to resolve to allow for Smart Market implementation. A primary question that must be resolved is whether the Smart Market administrator will need staff with a real estate license or a license to practice law in Washington state.

The answer to this question will help an administrator plan their implementation costs.

Transaction Tracking and Water Monitoring

Transaction Tracking

Water market participants would have records of their submitted bids and offers, as well as executed transfers, contracts, financial transactions, documentation from the water manager (such as an approval decision), and terms and conditions. After participants are matched with other trading parties, they would receive updates and documentation for each step of the process, such as submitting a transfer application, receiving the Report of Examination (ROE), and finalizing the lease contract and financial transaction.

The water market administrator would submit the necessary records to the respective water manager, the Department of Ecology or the irrigation district, such as the transfer applications. Any approved transfers would require the water manager to update the water records so that the correct diversions and deliveries are made.

Monitoring and Enforcement

The monitoring and enforcement of a water transfer would be managed as part of the current Yakima Basin monitoring and enforcement practices. If an irrigation district water right is traded, the responsibility falls upon the respective district(s) to update records and monitor and enforce water use. If a privately held water right, then Ecology is responsible for updating water rights records, monitoring diversions, and enforcing water rights.

State law requires that water users meter and record water diversions. Measuring of all water rights over 1.0 cfs also comes with a requirement to report the diversion records to Ecology. Rights less than 1.0 cfs require that diversion records are kept on a 5-year rolling basis.

Presently, Ecology employs 1.5 Water Masters for the Yakima Basin. These Water Masters receive assistance from a limited number of Stream Patrollers. Additional staff may be necessary to monitor market-based transfers in the future; however, the day-to-day need for additional monitoring/enforcement will depend greatly on the transfer specifics.

In drought years the need for monitoring is likely greater than non-drought years due to the sheer number of potential transfers. Moreover, the transfer location and

type will greatly influence the need for monitoring. For example, a transfer of a single water right that results in fallowed acreage (temporary and permanently) will likely reduce the burden at the fallowed acreage (assumes remote sensing to simplify monitoring) but may result in additional burden at the new acreage depending on the water use.

The Water Resources staff in Ecology's Central Region Office is responsible for water management beyond the Yakima Basin. This could strain staff resources in water short years. A 2005 report from the YRBWEP CAG provides recommendations for water management and enforcement. A key strategy from that report is the use of Stream Patrollers; however, this step would require additional funding and is likely impractical to roll-out only during periods of water shortages.

Recommendations for Implementation:

- Market-based transactions exist but are limited by inefficiencies (statury constraintys and competing workload priorities for water managers). We recommend adoption and implementation of a smart market tailored to the Yakima Basin.

- Determining Water right extent and validity is necessary for confidence in the market. Streamlining this determination step will allow potential market participants to gage how much time and cost is required. We recommend a simplified process for determining the tentative extent and validity of water rights for the purpose of entering the smart market.

    - Example 1. To the extent possible, Ecology could adopt a policy that allows a certified water rights examiner to conduct a review of the water right and water use to produce a statement of water use for review, modification, and acceptance by Ecology water resource permitting staff. Ecology will have a limited time to review and modify or reject the water use amounts. Ecology can accept the water use amounts by taking no action within a reasonable time. Smart market administrators can allow Ecology's acceptance/approval of the water use amounts as the first step to entering the smart market.

    - Example 2. To the extent possible, Ecology could adopt a policy that allows the WTWG members to conduct a limited review of the statement from Example 1. The WTWG review would contain a recommendation to Ecology on the water right's use. Ecology will have a limited time to review and modify or reject the water use amounts. Ecology can accept the water use amounts by taking no action within a reasonable time. Smart market administrators can allow Ecology's acceptance/approval of the water use amounts as the first step to entering the smart market.

- A part of the review of water for entry into the smart market will require water diversion records. We recommend these records be made easily accessible and not require access through a public records request of Ecology's metering database.

- To further streamline the processing and eliminate review of individual water rights, we recommend that Ecology, in coordination with the WTWG, should annually audit the smart market rules for consistency with Yakima Basin transfer rules and requirements. Upon approval, that year's smart market matches will be considered to have no third-party impacts (no impairment to other water rights).

- In non-drought years, there is a public notice requirement for Ecology to approve water right transfers. Ecology could adopt a practice and policy that allows a programmatic public notice approach of all potential water rights.

- Water use calculations must be standardized and easily determined by market participants. We recommend an updated version of the water use by crops and irrigation type. The updated version should include values for drought year.

- We recommend, in addition to the above water use values, adoption of a web-based tool like OpenET (https://openetdata.org/) as a standard tool to determine the amount of past water use available for temporary transfers. Acceptance of a common

- Monitoring and Protection of transferred water must be a priority. We recommend Ecology request assistance to develop and support more stream patrollers. If annual funding is not possible, a Stream Patroller reserve program could be developed and implemented during drought years.

- To assist with monitoring and protection, we recommend greater reliance on remote sensing technologies (e.g., satellite imagery) to reduce burden on existing Ecology staff resources.

Stakeholder Support:

The project team used a Technical Work Group for feedback on the strategy development process. The "TWG" was composed of basin stakeholders and included representatives from: Yakama Nation, KRD, Roza, NSID, Ecology, private water right holders, Kittitas County, and retired technical experts on water transfers in the Yakima Basin. A full list of TWG members is found in Appendix 1.

During the course of this project, different elements of the market strategy were presented to the TWG and feedback solicited. The project team incorporated the feedback and modified the approach to address TWG member concerns. The entire strategy will be presented to the TWG group in early May of 2022 for review and discussion. At that time, the project team will solicit and incorporate feedback on the entire strategy. More details will be covered in the updated strategy and the accompanying Technical Report.

As a key part of meeting the Market Reallocation Element of the Yakima Basin Integrated Plan, this strategy has generally received support from the TWG, which includes irrigation districts, private water users, Ecology, and the Yakama Nation. TU supports this project as an environmental group and discussions with local USBR staff have demonstrated general support.

The project team will present an updated draft to basin stakeholders in May, June, and July 2022 to receive feedback. We will address the feedback and improve the strategy where possible.

Appendix 1: Technical Work Group Members

The Technical Work Group was a subset of Yakima Basin stakeholders. The TWG provided feedback and guidance on the project. Members and their affiliations include:

- Arden Thomas, Kittitas County
- Kelsey Collins, WA Department of Ecology
- Cory Wright, Kittitas County
- Danielle Squeochs, Yakama Nation
- Trevor Hutton, WA Department of Ecology
- Jeff and Jackie Brunson, private water right owners
- Jeff Slothower, attorney (KRD)
- Justin Harter, Naches-Selah Irrigation District
- Kevin Haydon, WA Department of Ecology/USBR
- Lisa Pelly, Trout Unlimited
- Peter Dykstra, attorney
- Bob Barwin, (ret) former water resources professional
- Richael Young, ERA Consultants
- Scott Revell, Roza Irrigation District
- Tom Ring, (ret) former water resources professional
- Urban Eberhart, Kittitas Reclamation District
- Kat Satnik, Kittitas Reclamation District
- Nick Plath, private water right holder/user
- Michael Callahan, WA Department of Ecology

Appendix 2: Definitions

1. Clearing Cycle:

2. Water Transfer Working Group: a voluntary team of agency representatives, water managers, and water users who provide technical review of proposed water right transfers in the Yakima River basin. The group identifies water right transfers that could be quickly and easily approved. (from Ecology's website)

3. Proratable irrigation entity: a district, project, or State-recognized authority, board of control, agency, or entity located in the Yakima River basin that: manages and delivers irrigation water to farms in the basin; and possesses, or the members of which possess, water rights that are proratable during periods of water shortage. (from YRBWEP Phase 3 legislation -- https://www.govinfo.gov/content/pkg/CRPT-115srpt107/html/CRPT-115srpt107.htm)

4. Proratable water supply: means that portion of the total water supply available that is subject to proration in times of water shortage. (from YRBWEP Phase 3 legislation -- https://www.govinfo.gov/content/pkg/CRPT-115srpt107/html/CRPT-115srpt107.htm)

5. Stakeholders: all parties with an actual or potential interest in water use in the Yakima Basin. (Internal definition)

6. Smart market: a smart market is an electronic clearinghouse that matches buyers and sellers of water by price point and regulatory constraints. (ERA Economics)

7. Conservancy Board: a board created by the local county legislative authority, subject to approval by the director of Ecology, for the purpose of expediting voluntary water transfers within the county. (RCW 90.80.020)

Appendix 3: Terms & Conditions

TERMS AND CONDITIONS OF YAKIMA BASIN SMART WATER RIGHTS MARKET PARTICIPATION

If you are interested in being a purchaser in the Smart Market, please complete Sections 1, 4, and 5 below.

If you are interested in being a seller in the Smart Market, please complete Sections 2 and 3 below.

SECTION 1

Purchaser Name: _____

Purchaser Address: _____

Purchaser Phone Number: _____

Purchaser Email Address: _____

SECTION 2

Seller Name: _____

Seller Address: _____

Seller Phone Number: _____

Seller Email Address: _____

SECTION 3

Water Right Information:

Claimant Name: _____

Court Claim No. _____

Certificate Number: _____

Subbasin: _____

Source: _____

Use: _____

Period of Use: _____

Quantity: _____

Priority Date: _____

Point of Diversion: _____

Place of Use: _____

_____

_____

_____

Limitations of Use: _____

SECTION 4

Legal Description of Purchaser's Property on Which Water Right Will be Used: _____

_____

_____

_____

_____

_____

_____

SECTION 5

Description of Use Purchaser Intends to Put Purchased Water to:_____

_____

_____

Terms and Conditions:

1. Not all water rights are capable of being bought and sold through the Smart Market. The undersigned acknowledges that the market coordinator will make the final decision on whether this application may be accepted for participation in the market.

2. The undersigned acknowledges that if the undersigned is matched with a willing Purchaser or Seller, as the case may be, that the market coordinator is not responsible for negotiating and preparing a water purchase agreement. The parties are responsible for negotiating and consummating any transaction arising out of the Smart Market. The undersigned acknowledges and agrees that all such transactions must be reduced to writing.

3. Closing of a transaction may be contingent upon the timely satisfaction of one or more of the following events, which events may be referred to as "contingencies".

3.1 Purchaser's Review of Water Rights. Purchaser's determination, in Purchaser's sole discretion, of the condition of title for the Water Rights and such other information as may be reasonably necessary to confirm Seller's ownership of the Water Rights and showing title to the Water Rights to be free and clear of all encumbrances, which determination and approval shall be made or waived by Purchaser within sixty (60) days of the mutual execution of an Agreement.

3.2 Purchaser's determination and approval, in Purchaser's sole discretion, of the extent, validity, and prior use of the Water Rights. Seller shall undertake and diligently pursue the reasonable confirmation to Purchaser of the validity, prior use and freedom from defect of the Water Rights; provided that all costs of such confirmation shall be the responsibility of Purchaser. In the event Purchaser reasonably determines, in Purchaser's sole discretion, that such confirmation cannot be obtained, then Purchaser may terminate this Agreement whereupon the earnest money shall be returned to Purchaser.

3.3 Title Insurance. On or before the date of closing, Purchaser's review and approval of Seller's title to the Property, which shall be free and clear of all encumbrances or defects except for those which are acceptable to Purchaser. Encumbrances to be discharged by Seller may be paid out of purchase money at date of closing.

3.4 Until such time as the Transfer has been completed, Seller shall continue to use and manage the Water Rights on the property owned by Seller and/or maintain the water in the Yakima River Basin Trust Water Rights Program. Purchaser and its employees, representatives, and agents shall, at reasonable times and upon the giving of reasonable notice, have the right to enter upon said property to ensure the Water Rights are being used and managed in a manner that will not adversely impact the Transfer, and to gather such information as Purchaser deems necessary to obtain approval for the Transfer as contemplated by Purchaser.

3.5 Water Right Transfer Process. Approval by the Department of Ecology of the transfer of the Water Rights. Approval shall be deemed given when all appeal periods applicable to Ecology's decision have expired without an appeal of Ecology's approval of the transfer. In the event there is an appeal of Ecology's decision by any party then, in that event, Ecology's decision shall not be final until a complete resolution of all appeals.

3.5.1 In the event the Department of Ecology denies the transfer of Water Rights then in that event, at Purchaser's option, to be exercised in Purchaser's sole and absolute discretion, this Agreement will be null and void and Purchaser shall be entitled to a complete refund of the earnest money.

3.5.2 In the event Ecology approves the transfer in part, but not all, of the Water Right as set forth in Paragraph 1.1 or in the event Ecology attaches terms and conditions to the transfer of the water, then, in that event, Purchaser has the option, to be exercised in Purchaser's sole and absolute discretion, to cancel this sale and receive a full refund of the earnest money. Purchaser must elect to cancel this sale within 21 days of Ecology's decision becoming final pursuant to Paragraph 3.5.

3.5.3 Seller recognizes that in order to satisfy the contingencies Purchaser and Seller must go through a water rights transfer process with the Department of Ecology. Seller agrees to provide to Purchaser, when requested, any and all documents, records, or other information Purchaser may need to facilitate and accomplish the transfer when requested by Purchaser. The cost of the water rights transfer shall be based on an agreement between the Parties which will be reduced to writing.

3.5.4 The application and all matters necessary for final approval and satisfactory resolution of all appeals (hereinafter the "Transfer") shall be at Purchaser's sole cost, risk and control; provided, however, Seller shall cooperate with Purchaser, or Purchaser's successors or assigns, and shall not object to the Transfer.

4. Seller and Purchaser recognize that part of the transfer process requires the Department of Ecology to make a tentative determination of the extent and validity of the water right. Seller also recognizes that Ecology, in processing the transfer of water rights, follows certain statutes and administrative code provisions. Seller also recognizes that in applying the statutes and administrative code provisions, Ecology interprets the statutes and

administrative code provisions in a manner which is beyond the control of Seller and Purchaser. Ecology's processing of the transfer request may result in all or part of the water right being determined to be relinquished. Seller agrees to assume the risk of all or part of the water right being relinquished and agrees to hold Purchaser harmless from any and all damages, loss or water or property rights which may occur as a result of the transfer process.

5. Seller's title to the Water Rights is to be free and clear of all encumbrances or defects. Encumbrances to be discharged by Seller may be paid out of purchase money at closing. Title to the Water Rights shall be conveyed by Special Warranty Deed. Seller shall cooperate with Purchaser in executing any reasonably necessary documents relative thereto.

Appendix 4: Sample Agreement Form

OPTION AGREEMENT FOR LEASE OF WATER RIGHT

THIS OPTION AGREEMENT FOR LEASE OF WATER RIGHT (hereinafter "this Option Agreement") is made and entered into this ____ day of _____, 20__ ("the Effective Date"), by and between _____, (hereinafter referred to as "Lessee") and _____ (hereinafter collectively referred to as "Water Right Owner").

RECITALS

A. WHEREAS, Water Right Owner is the owner a legally established water right, more fully described in Exhibit A attached hereto and incorporated by this reference (the "Water Right"); and

C. WHEREAS, the Water Right authorizes use of water from the _____ River under Water Right Certificate Number _____; and

D. WHEREAS, the Water Right was confirmed for irrigation of __ acres of land from _____ through _____ annually at a diversion rate of ___ cubic feet per second ("cfs") and ___ acre-feet per year ("af/y"). The Water Right has a priority date of _____, ____; and

E. WHEREAS, the authorized point of diversion for the Water Right is located _____; and

F. WHEREAS, the Water Right is appurtenant to real property in _____ County, more specifically described as _____ County parcel number _____ ("the Property"), and more fully described in Exhibit B attached hereto and incorporated by this reference; and

G. WHEREAS, Lessee wishes to secure the ability to lease the Water Right from the Water Right Owner in years when certain water short conditions are present to access water to meet Lessee's goals for meeting water short challenges; and

H. WHEREAS, Lessee is partnering with the Washington State Department of Ecology ("Ecology") to achieve Lessee's goals; and

I. WHEREAS, Ecology, pursuant to RCW 43.83B.450(1), has the authority to enter into long-term water lease agreements with water users in select basins to access water during water shortages; and

I. WHEREAS, Water Right Owner wishes to provide Lessee with the option to lease the Water Right when certain water short conditions are present.

Agreement

NOW, THEREFORE, in consideration of Ten Dollars ($10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Lessee and Water Right Owner agree as follows:

1. **Option.** Water Right Owner grants to Lessee an exclusive and irrevocable option to lease the Water Right upon the terms and conditions set forth in this Option Agreement (the "Option").

2. **Term.** The term of the Option shall commence on the Effective Date and continue through _____, 20__ ("Option Term").

3. **Option Consideration.**

[Option 1: Pay water right owner nominal option consideration at time of signing/submitting water right change application.

Option 2: Pay water right owner nominal option consideration at time that the tentative determination of extent and validity (TEV) is complete and ROE is finalized.

Option 3: Pay water right owner option consideration of significant amount (up to 30% of Rent) which is creditable towards Rent once TEV is complete and ROE is finalized.

Option 4: Pay water right owner nominal option consideration at time of signing/submitting water right change application. Once TEV is complete and ROE is finalized, pay water right owner additional option consideration of significant amount (up to 30% of Rent) which is creditable towards Rent.

Option 5: Pay water right owner significant option consideration (up to 15% of Rent) at time of signing/submitting water right change application, which is creditable toward Rent. Obligate water right owner to agree not to divert if water short year occurs before change process is completed.]

4. **Contingency to Exercise -- Change Application.** In order for Lessee to use the Water Rights for Lessee's intended purposes, the Water Rights must be changed to include instream flow as purpose of use for the Water Rights, with said changes subject to Ecology approval, for years that Lessee exercises its Option and leases the Water Right. Lessee and Water Right Owner agree that changing the Water Right to allow for Lessee's intended must be completed prior to Lessee being able to exercise its Option. To accomplish these changes, within fifteen (15) days of the Effective Date, Lessee will prepare and deliver to Water Right Owner one or more counterpart applications (collectively, "the Change Application"), in the form prescribed by Ecology, for the change the Water Rights pursuant to this Agreement. Within fifteen (15) days of receipt of the Change Application, Water Right Owner shall duly sign all counterparts of the Change Application and deliver to Lessee all of the original signed counterparts of the Change Application.

4.1 Cooperation on Change Application. Water Right Owner and Lessee agree to provide to each other, when requested, any and all documents, records, or other information they each may need to facilitate and accomplish the Change Application when requested by the other party.

4.2 Costs Associated with Application Process. Water Right Owner is not required to pay any costs associated with the Change Application or its approval by Ecology. However, Water Right Owner will cooperate with Lessee and Ecology in all aspects of the Change Application process and will allow Lessee to defend any objections. If the change decision issued by Ecology is appealed by a third party, Water Right Owner has the right to terminate this Option Agreement, but Water Right Owner shall provide Lessee written notice of Water Right Owner's termination within ten (10) days of receiving notice of a third-party appeal.

4.3. Lessee and Ecology Responsible for Completion of Application Process. The Change Application and all matters necessary for final approval and satisfactory resolution of all appeals of the Change Application shall be at Lessee and Ecology's control; provided, however, Water Right Owner shall cooperate with Lessee or its assigns, and shall not object to the Change Application.

4.4 Lessee Not a Guarantor of the Water Rights. Water Right Owner recognizes that part of the Change Application process requires Ecology to make a tentative determination of the extent and validity of the Water Right. Water Right Owner also recognizes that Ecology, in processing the Change Application, will follow certain statutes and administrative code provisions. In addition, Water Right Owner recognizes that in applying the statutes and administrative code provisions, Ecology interprets the statutes and administrative code provisions in a manner that is subject to certain statutory and administrative appeal rights. Ecology's processing of the Change Application may result in all or part of the Water Right being determined to be relinquished. Water Right Owner agrees to assume the risk of all or part of the Water Right being determined to be relinquished and agrees to hold the Lessee and Ecology harmless from any and all damages, including but not limited to loss of water or property rights, which may occur as result of the transfer process.

4.5 Contingency Deadline. Lessee and Water Right Owner agree that the contingency described in paragraph 4 shall be satisfied, removed or waived as provided herein on or before *[April 1, 2021]*, or this Option Agreement shall become null and void.

4.6 Refund of Option Consideration. *[Need to decide whether Ecology wants a refund of Option Consideration if the contingency isn't satisfied in time. In my opinion that decision is most likely based on whether the Option Consideration is nominal or substantial, with Ecology seeking a refund if it is substantial.]*

5. <u>Exercise of Option</u>. Lessee's goal in securing the Option is have the right to lease the Water Right from Water Right Owner for drought relief purposes in any year during the Option Term when the following water short conditions exist: *[(a) a year, or a portion thereof, when the water supply for the Yakima River Basin is below seventy-five percent of normal, as confirmed by the Bureau of Reclamation, <u>and</u> "junior" (post-1905 priority) water rights are pro-rationed or curtailed, or (b) a year in which the State of Washington*

declares a drought in all or part of the Yakima River Basin pursuant to WAC 173-166-060.] Once the contingency in paragraph 4 has been satisfied, removed, or waived, exercise the Option, Lessee must provide the Water Right with written notice of their intent to exercise the Option in accordance with the provisions of Paragraph 14 hereof within the time periods specified in Paragraph 2 above ("Notice of Exercise"), no later than *[March 15]*.

5.1. Form of Notice of Exercise. Lessee is partnering with Ecology in achieving Lessee's goals, and Lessee and Water Right Owner agree that to achieve Lessee's goals and ensure the Water Right is not subject to relinquishment during the Option Term, that Lessee's Notice of Exercise shall come from Ecology in the form attached hereto as Exhibit C, which is sufficient to notify Water Right Owner of Lessee's intent to exercise the Option and to place the Water Right into the State of Washington's Trust Water Right Program under Chapter RCW 90.42 during the year in which Lessee exercises its Option and leases the Water Right.

6. Rolling Option. Lessee's exercise or non-exercise of the Option during any one year of the Option Term does not affect Lessee's ability to exercise the Option in a future year during the Option Term and the Option shall remain valid throughout the Option Term. Lessee shall have the sole discretion and right to exercise the Option during any year of the Option Term.

7. Lease Payment. If Lessee exercises the Option, Lessee will pay Water Right Owner _____ _____ Dollars ($__.00) per acre or a total of _____ Dollars ($_____.00) ($xxx.00 per acre times _____acres) ("Lease Payment") in each year that Lessee exercises the Option during the Option Term. The Lease Payment is payable in cash within fifteen (15) days of *[Notice of Exercise, proof of non-use at the end of season, or other trigger.]*

8. No Relinquishment or Abandonment. To the best of Water Right Owner's knowledge, the entire Water Right has been put to beneficial use during at least one of the last five years preceding the Effective Date and no period of five consecutive years of partial or total nonuse of the Water Right in the past five (5) years. Furthermore, to the best of Water Right Owner's knowledge, no portion of the Water Rights has been intentionally unused sufficient to constitute abandonment under Washington Law.

9. Agreement Not To Divert and Not Irrigate. If Lessee exercises the Option, Water Right Owner hereby agrees to not divert any water under the Water Right and to not irrigate the Property during the years in which Lessee exercises the Option and leases the Water Right.

10. Temporary Easement for Monitoring. Water Right Owner hereby grants and conveys to Lessee, its employees, agents, and successors, at all times during the Option Term, access to the diversion point for the Water Right and the Property. Access will be used solely for the purpose of allowing Lessee to monitor and enforce the covenants contained in this Option Agreement regarding the cessation of the diversion and fallowing of the Property during the years Lessee exercises the Option in the Option Term. Lessee will provide Water Right Owner with reasonable notice prior to accessing the diversion point or the Property.

11. **Execution of All Documents**. Lessee and Water Right Owner, individually and severally, hereby acknowledge that the execution of all documents associated with this transaction will substantially affect their legal rights and that each has the opportunity to obtain and consult with independent legal counsel for the purposes of this transaction and matters relating thereto.

12. **Attorneys' Fees.** If either party hereto is required to retain an attorney to enforce any provision of this Option Agreement, whether or not a legal proceeding is commenced, the substantially prevailing party shall be entitled to reasonable attorneys' fees regardless of whether at trial, on appeal, in any bankruptcy proceeding, arbitration matter or without resort to suit.

13. **Governing Law and Venue.** This Option Agreement shall be interpreted, construed and enforced according to the laws of the State of Washington and venue shall be in _____ County, Washington.

14. **Notices.** Subject to the requirements of any applicable statute, any notices required or permitted by law or under this Option Agreement shall be in writing and shall be (i) personally delivered, (ii) sent by first class certified or registered mail, return receipt requested, with postage prepaid, or (iii) dispatched by facsimile transmission (accompanied with reasonable evidence of receipt of transmission and with a confirmation copy mailed no later than the day after transmission) to the parties' addresses set forth above. Either party may change such address for notice. All notices which are so addressed and paid for shall be deemed effective when personally delivered, or, if mailed, on the earlier of receipt or two (2) days after deposit thereof in the U.S. mail.

Any notice or communication required by this Agreement between Lessee and Water Right Owner shall be given to the addresses set forth below:

Lessee:

Water Right Owner:

15. **Section Headings.** The word or words appearing at the commencement of sections and subsections of this Option Agreement are included only as a guide to the contents thereof and are not to be considered as controlling, enlarging or restricting the language or meaning of those sections or subsections.

16. **Invalidity.** In the event any portion of this Option Agreement should be held to be invalid by any court of competent jurisdiction, such holding shall not affect the remaining provisions hereof unless the court's ruling includes a determination that the principal purpose and intent of this Option Agreement are thereby defeated.

17. **Legal Relationships.** The parties to this Option Agreement execute the same solely as a lessor and lessee. No partnership, joint venture or joint undertaking shall be construed from these presents, and except as herein specifically provided, neither party shall have the right to make any representation for,

act on behalf of, or be liable for the debts of the other. All terms, covenants and conditions to be observed and performed by either of the parties hereto shall be joint and several if entered into by more than one person on behalf of such party, and a default by any one or more of such persons shall be deemed a default on the part of the party with whom said person or persons are identified. No third party is intended to be benefited by this Option Agreement. Any married person executing this Option Agreement hereby pledges his or her separate property and such person's and his or her spouse's marital communities in satisfaction hereof.

18. **Assignment; Successors.** Neither Lessee or Water Right Owner may sell, transfer, assign, pledge or encumber its interest in this Option Agreement without the prior written consent of the other party, which consent shall not be unreasonably withheld. A purported sale, transfer, assignment, pledge or encumbrance without prior written consent of the other party shall be null and void and of no force or effect. Subject to the restrictions contained herein, the rights and obligations of Lessee and Water Right Owner shall inure to the benefit of and be binding upon their respective estates, heirs, executors, administrators, successors, successors-in-trust and assigns.

19. **Entire Agreement.** All understandings and agreements previously existing between the parties, if any, are merged into this Option Agreement, which alone fully and completely expresses their agreement, and the same is entered into after full investigation, neither party relying upon any statement or representation made by the other not embodied herein. This Option Agreement may be modified only by a written amendment executed by all parties.

21. **Interpretation.** This Option Agreement has been reviewed by both parties and each party has had the opportunity to consult with independent counsel with respect to the terms hereof and has done so to the extent that such party desired. No stricter construction or interpretation of the terms hereof shall be applied against either party as the drafter hereof.

22. **Counterparts.** This Option Agreement may be executed in counterparts, each of which shall be deemed to be an original instrument. All such counterparts together shall constitute a fully executed Agreement. Facsimile transmission of this Option Agreement and retransmission of any signed facsimile transmission shall be the same as delivery of an original.

23. **Amendment.** This Option Agreement may not be modified or amended except by the written agreement of the parties.

IN WITNESS WHEREOF the parties have signed and delivered this Option Agreement as of the Effective Date.

LESSEE: **WATER RIGHT OWNER:**

_____ _____

By: By:_

Title: _____ Title: _____

Date: _____ Date: _____

ACKNOWLEDGEMENTS

State of Washington

County of _____

I certify that I know or have satisfactory evidence that _____ is the person who appeared before me, and said person acknowledged that she signed this instrument, on oath stated her authority to execute the instrument as the authorized agent for Lessee, to be the free and voluntary act of such entity for the uses and purposes mentioned in the instrument.

Dated: _____ Name: _____

NOTARY PUBLIC for the State of _____,

residing at _____

My appointment expires: _____

State of Washington

County of _____

I certify that I know or have satisfactory evidence that _____ is the person who appeared before me, and said person acknowledged that they signed this instrument and acknowledged it to be their free and voluntary act, for the uses and purposes mentioned in the instrument.

Dated: _____ Name: _____

NOTARY PUBLIC for the State of _____,

residing at _____

My appointment expires: _____

Exhibit A: Water Right

Water Right Holder Name:

[Certificate or Claim] Number:

Source:

Use: Irrigation of __ acres and [*include stockwater if applicable]* _____ through ___ (irrigation); *[Year-round (stockwater)]*
Period of use:

Quantity: Qi:

Qa:

Priority Date:

Point of Diversion:

Place of Use: County: Tax Parcel No.:

Legal Description:

Limitations of Use:

Exhibit B: Property

[Include Map with POU identified and Legal Description]

Exhibit C: Form of Notice of Exercise

_____, 20_

SENT VIA EMAIL

Water Right Owner
[insert address]

Lessee
[insert address]

RE: Exercise of Lessee's Option and Trust Water Right No. *[insert no from Change Application]*

Dear *[Water Right Owner and Lessee]*:

The purpose of this letter is to inform Water Right Owner of Lessee's exercise of the Option pursuant to the Option Agreement entered into by and between *[Water Right Owner and Lessee]* on *[insert Effective Date]* and to acknowledge the Washington State Department of Ecology's ("Ecology's") acceptance of Water Right No. _____ into the Washington State Trust Water rights program, under RCW 90.42.080, as summarized below.

[Insert Source]
Instream Flow
[insert Qi]
[insert Qa]
[insert Period]

Trust Water Expiration Date: *[insert end of season]*

In accordance with RCW 90.42.040(6), RCW 90.14.140(h), and RCW 90.14.215, a water right is not subject to relinquishment while it is managed within the Trust Water Rights Program.

Ecology's acceptance of the water right into the trust water rights program is not evidence of the validity or quantity of the right. When the period of trust ends, the water right will revert back to the water right holder or landowner in the full quantity accepted into the trust water rights program and as described on the water right certificate or most recent approved change authorization.

If you have any questions, please contact _____ by phone at _____ or via email at _____.

Sincerely,