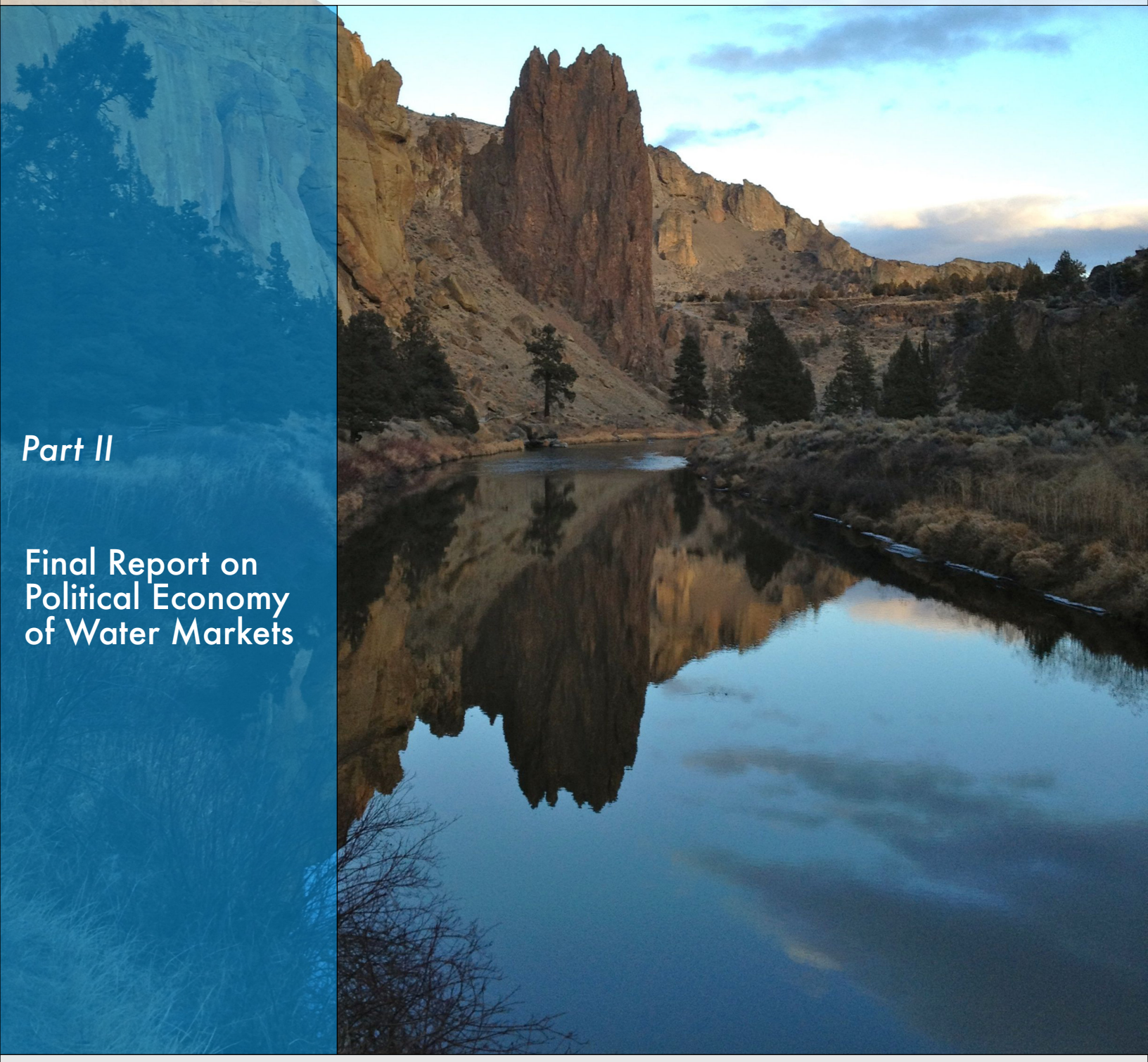
Political Economy of Water Markets in the Western United States

November 2016



Part II

Final Report on Political Economy of Water Markets

AMP Insights

ecosystem economics

The ROCKEFELLER FOUNDATION

Political Economy of Water Markets in the Western United States

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Preface

This paper is one output of a project entitled "The Political Economy of Water Markets." The project was carried out by Ecosystem Economics LLC and AMP Insights. The outputs of the project include a final report and a set of case studies.

The final report consists of three papers and an annex:

1. Healthy Water Markets: A Conceptual Framework by Bruce Aylward, Davíd Pilz, Megan Dyson and Carl J. Bauer
2. Political Economy of Water Markets in the Western United States by Bruce Aylward, Davíd Pilz and Leslie Sanchez
3. Comparative Analysis of Legal Regimes with Respect to Fostering Healthy Water Markets by Davíd Pilz, Megan Dyson, Bruce Aylward, Carl J. Bauer and Amy Hardberger

Annex: Water, Public Goods and Market Failure by Bruce Aylward

The eight case studies consist of the following.

1. The Evolving Water Market in Chile's Maipo River Basin by Carl J. Bauer
2. Addressing Overallocation and Water Trade in New South Wales, Australia: Namoi Basin Groundwater by Megan Dyson
3. Evolution of Australian Water Law and the National Water Initiative Framework by Megan Dyson
4. Opportunities for Surface Water Right Marketing in Idaho's Rapidly Urbanizing Treasure Valley by Jeff Fereday
5. Texas Groundwater Markets and the Edwards Aquifer by Amy Hardberger
6. Oregon's Umatilla Basin Aquifer Recharge and Basalt Bank by Martha Pagel
7. Truckee-Carson Surface Water Markets in Northern Nevada by Leslie Sanchez, Bruce Aylward and Don Springmeyer
8. Smart Markets for Groundwater Trading in Western Nebraska: The Twin Platte by Richael Young

The report and case studies can be downloaded from the AMP Insights website at http://www.ampinsights.com/rock-report.

For further information on this work please contact Bruce Aylward at bruce@ampinsights.com.

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Executive Summary

This paper explores the conditions, policies and laws that lead water markets in the western US to function as a useful counterpart to other tools for sustainable water management. The paper begins with a brief review of some of the contextual elements of water management and water markets in the western US. The paper goes on to a brief review of the conceptual framework (from Part I of the final report) and then applies this framework to water markets in the western US. Beginning with analysis of the enabling conditions for markets, the paper examines how well market failure is resolved through collective action. It then considers the presence or absence (and degree) of the conditions for competitive markets in western water markets. The aim of this assessment is to illustrate the range of potential issues that can affect market activity and efficiency, as well as social and environmental outcomes. As institutional failures, political and bureaucratic shortcomings, economic inefficiencies and other stumbling blocks are identified, an effort is made to summarize potential solutions, be they policy reforms or other actions. The penultimate section summarizes policy responses to promote healthy water markets, before conclusions are presented. This executive summary provides an overview of the main findings and conclusions of the paper.

Water Markets

In common usage a market is a place where buyers and sellers meet to buy and sell goods. In most parts of the world when you go to a market it is a physical space where a large number of sellers display and hawk their wares to a large number of buyers. In developed economies, when shoppers go to the supermarket for their groceries it is just one store, albeit one displaying similar products from many producers (at a fixed price). Another important market is the real estate market. In this market there are many property owners with properties for sale and many interested buyers, but no real physical marketplace. In the real estate market, brokers representing a seller and a buyer facilitate the real estate transaction. The physical marketplace, if there is one, is the trek from house to house with your broker or a virtual trek on an online marketplace like Zillow™. The trade in the real estate market is simply the aggregate sum of these many real estate transactions. Underlying a market in real property is a body of real property law that sets out the nature of the property and the rules that govern the exchange of this property. Similarly, any marketplace will have its own set of rules, for example, the terms and conditions on eBay™.

A *market* then, is a set of rules that govern the voluntary exchange of property, or *transactions*, between buyers and sellers. A *marketplace* is a physical or other (e.g., online) place that is organized by a buyer, a seller or some intermediary for the purpose of facilitating transactions. *Trade* is simply the aggregate number and amount of transactions in the market. These concepts can be usefully applied to clearly define water markets.

A *water rights market* is a set of rules, set by the appropriate authority, to govern the exchange of water rights between willing buyers and sellers. The rules define the property involved – the water rights – as well as the process by which the temporary or permanent transfer of water rights from one use/user to another is accomplished. Creating a water market refers to the establishment of rules and agreements that govern transactions in water rights within a given jurisdiction and hydrographic setting.

A *water marketplace* is a specific mechanism developed as a place where market participants can obtain market information and/or conduct transactions. Examples of water marketplaces include water brokers, water banks/exchanges, water auctions and smart markets. A water marketplace may promulgate its own

rules for eligibility, participation and market clearing, but the laws and regulations governing the water rights market give the marketplace transactions legitimacy. Marketplaces may involve manual or online bidding and manual or automated clearing

Trade in a water rights market represents the set of water right transactions in unregulated (natural) flow, regulated or stored water, or groundwater. Trades in a water rights market are executed between willing sellers and willing buyers for the purpose of meeting unmet, new or different demands from existing permitted water supplies. Purchase of water rights with the sole intent of renting them out for income and or holding them for capital appreciation is also a potential source of market activity, at least in well-developed and liquid markets.

A water market may be defined more broadly than just a water rights market. Trade in a water market may extend beyond merely transactions in water rights per se, to include water management agreements, as well as real estate markets for land and water rights.

The distinction between water rights transactions and water management agreements is worth explanation. *Water rights transactions* consist of the sale of the water right itself or some form of temporary trade of the water available under a water right. Temporary trade may involve either the lease or rental of a right and the water that will be available under it over a specified future time frame, or the outright sale of an allocation of water already assigned to the water right holder (e.g., water already stored in a reservoir).

In the face of increasing water scarcity and conflict over human and ecosystem uses of water there is a need for effective or healthy water markets to achieve a balancing of the following outcomes:

- *efficacy*: effectively managing supply and demand for water, and where possible, managing conflict over water, in response to driving forces and changing circumstances;
- *economic efficiency*: achieving efficacy in a cost-effective and timely manner; and
- *environmental and social sustainability*: avoiding adverse impacts and providing pathways to social inclusion and equity, as well as environmental conservation and restoration and ecosystem resiliency.

How this balance plays out in a given location will depend on the setting and history amongst other factors and what a market is asked to do.

Conceptual Framework for Understanding Water Markets

A conceptual understanding of water market relies on appreciating that while water is an economic good, it has public good characteristics. As water is not a purely private good, water itself should not be, and generally is not, treated as private property and left to the free market to allocate. Instead, water is asserted to be public property managed for the benefit of the people. In capitalist economies this generally means extending property rights for the use of water and allowing these to be exchanged in some fashion in a water rights market. Using markets to reallocate water rights must therefore logically be set firmly within the bounds of collective action with the rules for market interactions set to meet the public good not just private and commercial needs.

In jurisdictions that grant use rights to water the three generally accepted conditions required to enable markets, including water markets, are scarcity, well defined and secure property rights, and the ability to trade. *Scarcity* is required to enable a market in a good or service because if the good or service is not scarce then no one will take the effort to find someone who has the good and offer to purchase it. In other words, scarcity drives demand. Second, in order for a buyer to expend resources in the market the buyer

must obtain something of value. A *well-defined and secure property right* provides assurances that what a buyer purchases is for their own consumption – that the buyer can exclude others from enjoying it – and that the good or service is as advertised. Finally, in order for *trades* to occur a key question is whether the relevant governing institutions recognize trades and confirm that buyers may use the good they purchase for their intended use. The final condition for a market then is that there be rules that allow for and govern the *trade* of goods.

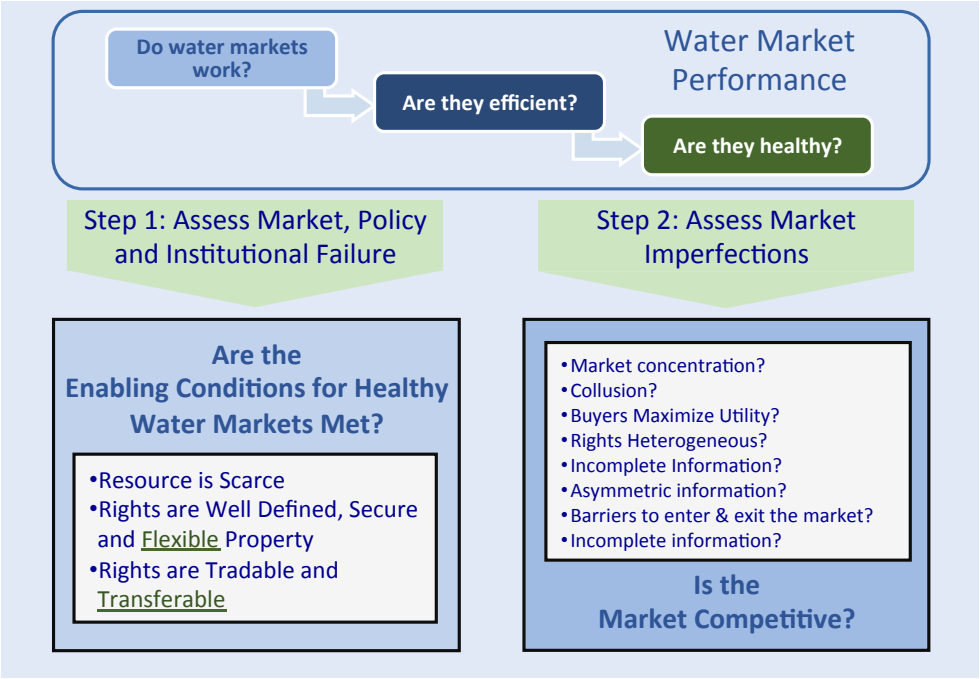
To more fully capture the concept of *healthy* water markets two more concepts are necessary: not just secure but flexible property rights and transferability (along with tradability).

Enabling healthy water markets requires *flexibility* in laws and policies. A regime in which the governance of rights and uses is inflexible leaves no room for adaptation. In such cases water rights themselves, or water right regimes more generally, risk being out of step with society's changing values for water, with climate and other hydrologic realities, or both. Flexibility in water rights and the water right administration systems is essential for public policy to adapt water management to changing values and changing circumstances. By implication the security of rights, from the right holders perspective is lessened, but this reflects the necessary balancing act between collective action and property rights.

Second, the ability to trade may be assumed to necessarily include the ability to *transfer* acquired rights to new uses. Under Prior Appropriation the act of renting or purchasing a water right from a willing seller does not necessarily imply that the water can be put to the buyer's use. When trade in water rights takes place, the new user may want or need to change one or more the parameters of the water right they purchased (place of use, type of use, location of use, and others). This is referred to as *transferability*. The relevance of this to healthy markets is that transfers that may erode environmental or social uses and values must be properly reviewed, assessed, and modified as necessary. This is a regulatory function generally speaking. For markets to be healthy these regulatory protections must be effective, meaning that the necessary capacity in the regulatory entities and civil society must be present to ensure this function is carried out. It is therefore vital to be clear that tradability of rights involves both the trade and the transfer of these rights, and that the transfer requires the necessary regulatory protections and capacities.

Each of these enabling conditions represents a set of rules that either leads towards or away from market activity and/or market activity that can be deemed healthy. To some extent the degree to which these enabling conditions are in place reflect how well (or how poorly) collective action has resolved the problem of water governance and management in the context of public goods characteristics. Nonetheless, like any marketed good there is another layer of conditions for a competitive market that can be identified and analyzed. These are summarized in the figure below, along with the general approach of the conceptual framework. The remainder of the paper applies this framework to water markets in the western US.

FIGURE ES-1: HEALTHY MARKETS FRAMEWORK



Scarcity

It is a fundamental tenet of economics that resource scarcity drives trade. Whether and to what extent water is in scarce supply is a fundamental precondition for water markets and water trade. The first topic addressed is therefore how physical conditions interact (or don't) with the legalities of surface and groundwater rights systems in the western US. But questions of scarcity and the likelihood of water trade go beyond simple questions of limits. The degree of scarcity drives economic behavior and the search for water to meet needs. The perception of scarcity as felt by a prospective water user (or buyer) is driven by the availability of alternatives and loopholes. In addition, scarcity may exist for a given user, but fail to materially affect market trade if the user is excluded from the market. Each of these topics is examined in the context of apparent physical and legal water scarcity in the western US.

Prior Appropriation relies on full or over-appropriation of legal rights to surface water. As such it is the physical scarcity of surface water to fill these rights that drives market activity. However, water is not scarce if groundwater is freely available. Thus, scarcity and the incentive to engage in markets to meet water demand rests with the groundwater code. Here there is considerable diversity across the western states, with some handing out rights only up to some notion of an annual pumping limit and others allowing new uses without regard to any limit. A further issue is where states administer surface water and groundwater as separate resources. In this case new groundwater users not only avoid the need to turn to the surface water market to obtain water, but their pumping eventually takes water from senior surface water users. The trend over the last couple of decades is to move towards conjunctive management and to allow new groundwater uses only when they are offset by reductions in surface or groundwater uses. Closing both resources to new appropriations and allowing groundwater offsets represents a step towards prudent management and creates legal scarcity that enables market activity.

The physical or legal aspect of scarcity varies across jurisdictions and basins. Scarcity not only motivates markets, but the search for other innovative supply and demand management alternatives. Many such

alternatives exist and may appear less expensive than the market. Add to this the many imperfections and inefficiencies of the market and it is not surprising that much demand goes to these alternatives or towards finding loopholes to enable new supply. The result is that market activity is less than might be expected. Further it is likely that with regard to alternatives and loopholes one of two situations applies:

1. The resource costs of satisfying new uses through supply and demand management alternatives is unnecessarily high given the lower value of marginal uses of water in many basins (and therefore the lower resource costs if markets were enabled).
2. The cost of satisfying new uses through loopholes appears low to those meeting new demands, but this gives a false picture of the costs of this activity as the loophole externalizes costs onto other water uses and users, particularly the environment.

And finally, the exclusion of demands from markets will reduce scarcity and market activity. More to the point, closing markets to environmental and other demands leads to unmet demands and pressure to convey these demands through other routes, including litigation and policy reform. Given the political economy of water, the shutting down of one avenue, i.e. markets, simply leads actors and unmet demands to pursue other avenues. Closing of the economic route forces the demand into the political and judicial arenas.

Well Defined, Secure and Flexible Property Rights

A system of well-defined and enforceable property rights is foundational for a functioning water market Whether or not a water right can be defined, enforced, and transferred is directly related to whether the right is measurable and excludable. In general the right to use water is well defined in the western states. In theory the rights are also extremely secure. However, there are a series of practical issues which when present in a particular jurisdiction or basin undermine the security of these rights and therefore may undermine market activity. While security of rights will enhance market activity it does necessarily promote healthy markets. The extreme degree of security provided to water rights in western states suggests that these rights are not flexible from the perspective of public policy, potentially putting private interests over that of public interests and limiting the ability of public policy to adapt to changing circumstances.

Western water rights are generally well defined and secure, suggesting positive enabling conditions for market activity. The elements of appropriative rights are well enumerated, granted in perpetuity, administered effectively and protected from takings by the US Constitution. A number of situation-specific caveats and exceptions include:

1. Consumptive and non-consumptive portions of rights are not defined as part of the water right and, thus, must be discovered through transfer processes.
2. Depending on the context, the Public Trust Doctrine may undermine the security of water rights, permitting their regulation or expropriation without compensation.
3. The absence of adjudication is an important factor that can limit the security of water rights, particularly with respect to permanent transfers.
4. Effective administration of water rights within an irrigation community does not necessarily mean that they will be equally well administered once changed to other uses, particularly environmental uses.
5. Specific threats to water right security come from exempt uses, open access groundwater use, poorly regulated queuing for new permits and sleeper rights.

And finally, the high degree of security of appropriative rights means that from a policy perspective they are fixed and not flexible. This pushes public policy towards incentive-based fiscal policy and legal reform as tools for shaping water use and reallocating water rights.

Tradability and Transferability of Entitlements and Allocations

Water rights in the western US reflect the permission granted by the state (or relevant authority) to the right holder to use the water resource according to the terms and conditions of the right. As the state retains ownership of the water on behalf of the public it remains responsible for administering the use of rights under the water code. The trading of a water right therefore typically must accomplish not just a change in ownership but also an administrative change to the right to use water. Trading in western water rights is a two-step process. The transaction costs and impacts on water right values (for the buyer and the seller) associated with these two steps are critical to the availability of gains from trade in a market and thus have an important impact on the level of trade.

Not surprisingly given the nature of water rights in the western US as private property, the ability to trade water rights is well established. A significant constraint on market activity arises when the buyer goes to consummate a water right transaction by changing the elements of the water right so as to put the water to the new use. Carrying out this step with the relevant administrative or judicial authority can be costly and time consuming. This raises the transaction costs borne by the buyer and seller. The outcome of the process can also result in the transfer of an amount of water less than that on the original water right, reducing the gains from trade. Both outcomes will limit activity in the water market.

A number of specific findings can be made with respect to the tradability and transferability of western water rights:

1. Flexibility in administering temporary trades of appropriative groundwater rights is beneficial, i.e., allowing senior users to make out-of-priority trades of allocations to junior users.
2. While seemingly restrictive and often onerous in terms of process, requirements of appurtenancy for irrigation rights and a proper injury review seem inescapable given the way appropriative rights are defined.
3. Though injury protections are essential to protect existing uses, including environmental rights or residual waters, and thus important to healthy water markets, the administration of transfers often errs in favor of avoiding any risk of injury to junior users.
4. Historic consumptive use approaches to transfer end up favoring minimal transfer quantities and may undervalue environmental transfers and efforts to implement conserved water transactions.
5. This tendency towards risk avoidance ultimately increases the transaction costs and lowers the gains from water trade and therefore favors existing junior users over prospective new users wishing to participate in the water market.
6. The ability of environmental buyers to participate in markets and consummate their trades with transfers to environmental use is still circumscribed in many jurisdictions and basins.

Market Imperfections

An imperfect market is one where the economic conditions for a perfectly competitive market are not present. Based on the standard neoclassical economic model of competitive markets, a number of market imperfections to which water markets in the western US are susceptible include:

- market concentration and collusion;
- heterogeneous products;

- incomplete information;
- asymmetric information; and
- barriers to market entry.

A number of these imperfections limit market activity by closing markets or by reducing the potential gains from trade:

1. Market concentration in one irrigation entity, or amongst a few irrigation entities, often exists at the basin scale. This enables these entities to individually or collectively (through collusion) concentrate political power and exercise market power to control and limit access to their patrons and water marketing. This may lead to the extraction of higher than efficient prices when rights are sold, thereby satisfying fewer demands, but just as often it leads to a market closed to outside interests.
2. Asymmetric information favors market insiders and large entities that are frequent participants in the market skewing pricing in favor of the former leading to low participation rates or remorse and distrust of the market by the casual participant.
3. The endowment effect leads potential sellers to focus on the loss they will experience from giving up the right and not on the gains from trade in the market, implying that a significant price premium is needed to tempt these water users into the market.

There are also a number of market conditions that adversely affect trade by limiting the efficiency of the market:

1. The heterogeneity of water right priorities make due diligence on the expected reliability of a water right and appraisal of value more difficult and costly for the prospective buyer. This complexity is magnified when a buyer wants to purchase and remove a water right from an irrigation entity where there are multiple classes of rights but by customary practice available water is shared without regard to priority. Where different sources of water are layered on for a given irrigation use disentangling these sources is another complicating factor.
2. Incomplete information, e.g., a lack of, or poor, data on water rights, their extent, validity and transferability creates uncertainty for buyers and sellers reducing market participation.
3. Barriers/high costs to entry (and exit), e.g., fees, qualifications and the need for specialized advice in order to participate in the market impede the efficient entry/exit of buyers/sellers to the market.

A few potentially constructive ways of addressing these imperfections or using their existence to advance market activity include:

1. Market concentration may also be useful in increasing leverage on the buy side of markets. Where public or public interest organizations represent the unmet needs for water for municipal, industrial or environmental purposes they may also band together to exercise political and market power. This may assist in opening up markets and can keep costs down for new water users where there are willing sellers.
2. Just because rights are heterogeneous with respect to priority date does not necessarily imply that each class of priority is a distinct product. When set against the available water supply and when the full range of sources used in irrigation are considered the system may reduce to a lesser number of products with their own reliability, which may reduce the transaction cost burden of heterogeneity.
3. Smart markets (or automated, algorithmic trading platforms) provide an intriguing opportunity to limit the inequities that emerge due to asymmetric information and thus may encourage higher participation in transactions programs.

Policy Responses

The picture that emerges from the conceptual framework is of an appropriative system of water rights that was designed to foster the development of water resources but that was not constructed with the reallocation of water rights in mind, and often not with groundwater sustainability or the water needs of ecosystems in mind. The basic conditions for market activity are present due to the underlying presence of scarcity, well-defined and secure rights, and the ability to trade and transfer rights. However, there exist a raft of issues and loopholes with respect to these conditions that limit or impede market activity. Diving more deeply into market conditions a number of market imperfections are present which lead to further restraint of trade and inefficiencies that impede trade.

Perhaps the most significant finding is that the high degree of security afforded to water rights in the western US is accompanied by a corresponding low degree of flexibility in the rights. While security empowers markets, the lack of flexibility constrains collective action. There is only a limited ability of public policy to intervene and directly reallocate water, set limits or adjust allocations, i.e., to deploy a command and control approach to water allocations. Policy responses to water management and markets are then going to be largely incentive-based. These responses fall into one of two arenas:

1. Using fiscal policy – or changing incentives and allocations while working within the rules of the game.
2. Engaging in policy reform by changing the rules of the game, but doing so in a way that adds to the rules of the game rather than taking away rights from those already in the game (existing users).

Incentive-based fiscal policy consists of three main instruments: water charges, subsidies and buy-backs. Fiscal policy always remains an option for government, even if water markets are not performing well. Charges on water use and subsidies for water use efficiency are two administrative approaches to incentivizing efficiency and changes in water use. The alternative to achieving a change in water allocation is for government to simply buy-back water rights and retire them or dedicate them to new (and public) uses. While markets are theoretically a more pleasing approach to the economist all three fiscal instruments are potential policy tools. In the western US, however, the political economy of water charges are a difficult prospect and have yet to be deployed. Subsidy programs are very much in vogue in the western states, but do not always lead to healthy outcomes. By design or by a lack of proper design these funds can end up subsidizing additional private consumptive use of water, leaving less residual water for the environment. Buy-backs for the environment and other purposes are also a frequent tool of public policy, particularly to address endangered species issues.

Upon careful analysis it seems that the old adage about *use it or lose it* is now a bit dated. There are many circumstances in which there are incentives for irrigators and irrigation delivery entities to improve their water use efficiency. These include policy reforms that encourages efficiency through the trading of saved water or, at least, eliminating the chilling effect of partial forfeiture. It can be argued that the inflexible nature of water rights has led to induced innovation. In practical terms, this blockage has led people to find *workarounds*. Creating new flexibilities in the administration of water rights system is an avenue to address the lack of flexibility inherent in the water rights themselves. Examples include reforms to authorize:

- Conserved (salvaged) water programs that enable savings from water use efficiency projects to be permitted as new rights creating new incentives for conservation.
- Restrictions/elimination of partial forfeiture to allay irrigator fears that they must always use the full rate and duty under their right or lose a portion of their right.

- Dual-purpose irrigation and instream rights that create new flexibility in moving from one use to another and back again.
- Expedited leasing programs that proceed in a timely fashion yet provide the state the ability to rescind leases should problems arise.
- Surface to groundwater mitigation programs that enable new groundwater demands to be met by offsetting pumping impacts with instream transfers and other water projects.
- Local water plans that enable water users to jointly manage water to a set of planned performance targets, while flexibility managing water between users within the plan.
- State-run administrative water banks that provide a flexible means of unbundling and bundling short-term water leases, as well as convenient withdrawal for new uses of banked rights.

Continued innovation in technology and policy should continue to address these problems in a proactive manner. State-by-state experimentation with creating this flexibility is ongoing and there is constant activity across the states to find new pathways to enable water marketing. Unfortunately, these efforts by their very nature originate and are applied in a single state, often with little investment in evaluation and learning from these experiences within the state. Some efforts have been made to foster interstate communication and cross-fertilization but arguably not to the extent desirable, and this exchange is also limited by the underinvestment in learning. The result is that when a new state takes up policy reforms they often reinvent the wheel. Even within states that share common policy approaches such as temporary instream leasing or conserved water programs, no two programs are the same. Rather than replicate what is working in another state, each successive reform often starts from scratch. Greater cross-state communication, exchange and coordination would therefore be useful.

Conclusions

This paper applies a conceptual framework for understanding how water markets function to water markets in the western US. The effort is ambitious given the wide-ranging geographic settings across the west, as well as the variety of federal and state (and county, irrigation district, etc.) rules governing water. In the face of such a diverse range of contexts and in the face of the legal, economic and socio-political complexity of water rights and water markets, the process of developing a deep understanding of a given context, assessing current market conditions against desired outcomes and identifying paths towards healthy water markets will never be reducible to a formula (or a formal diagnostic). Understanding the multi-disciplinary issues involved is as much art as science, and like any craft requires long hours of time spent in the shop. And, for better or worse, each basin and each set of stakeholders seem to need to follow their own inquiry to come out on the other side with ideas, proposals and solutions that meet with the general acceptance necessary to move forward.

But this cautionary note is as much about the stream-by-stream, watershed-by-watershed and basin-by-basin process of searching for better and improved ways of managing water as it is about water market design. Indeed, a healthy market must sit in the context of collective action around managing water sustainably. Markets are means not ends. Water transactions are a powerful tool and water transactions programs therefore need to be carefully designed and evaluated. With that said the big question is how can western water be managed more sustainably and what is the role of markets? Markets surely can play an important role in mediating between the changing needs for water, whether in the form of long-term reallocation of water or in meeting drought year needs. Deploying the power of markets within the scope of political agreement over water transactions programs remains a challenging but desirable objective. Using policy reform to add to the rules and create flexibility in water marketing, particularly for temporary transactions, is likely to be integral to such an effort.

However, there are two shortcomings in the management of water quantity in the West that markets will not solve on their own: unsustainable extraction of groundwater and meeting environmental flow needs. Meeting these policy objectives without resorting to clawing back rights through condemnation, means relying on one or more of the following three incentive-based fiscal policies.

First, government and civil society can allocate funds to use markets to buy-back water rights for retirement or dedication to environmental flows. The success or failure of this approach rests on the extent to which the market is active, efficient and healthy.

A second option is to allocate funding and subsidize water use efficiency. This is an attractive and valuable option. But such programs need to be much more carefully designed, projects vetted more carefully and program evaluations carried out in an independent, participatory and transparent fashion. Importantly, such programs need to avoid adverse affects to what environmental flows still remain in western waterways. The idea that public funds should subsidize private benefits and create costs to the public should be untenable in the 21st Century. While promising if well carried out, it is critical to recall that efficiency improvements simply move water around the system differently, they do not create new units of water. So, ultimately the utility of such investments is limited. It is also worth recalling that adopting policy reforms to encourage conserved or salvage water brings these funds into the market for water, as efficiency gains become permitted uses that can be traded. There is ample room for demand management strategies and markets can work together if so designed.

A third and final fiscal option is charging for water. This alternative appears difficult politically and perhaps even unnecessary (at least if markets are working).

It is useful then to consider two futures for the western states. In the first, healthy markets flower across the west. Active markets reallocate water amongst private and public interests in an efficient and healthy manner. In this case the limiting factor on sustainability is the amount of funds necessary to incentivize water use efficiency and buy-back water to address over appropriation and environmental flows. As the scale of the problem in the western US is unknown, it is not even possible to hazard a guess at the price tag. Given the prospect of limited funding such efforts will need to be prioritized. But all in all, under this scenario the prospect for an all out crisis is abated as economic needs are met and longer-term problems are chipped away at over time.

A second less rosy *business as usual* scenario is of course possible. The crux of the matter is that water rights are very secure in the western US and offer little flexibility for public policy to support water allocation that meets the changing needs for water, to say nothing of the demands of a changing climate. If policy does not evolve towards more competitive and healthy markets the utility of the market tool is called into question. For example, if reforms do not level the playing field between seller and buyer then irrigation entities may continue to deploy their market power to close markets, restrict trading and broker excess profits for their constituents. As a consequence the cost of buy-back programs simply go up.

At the end of the day, if markets don't function or are never allowed to function in an active, efficient and healthy manner, water ends up locked in traditional uses and is not available to meet changing needs. Buy-backs are nigh impossible and hugely expensive. Subsidy programs for water use efficiency would no doubt be deployed but won't close the gap for new consumptive demands or address climate change. Should such a stalemate persist, policy makers really only have two options in the business as usual scenario. First, is simply to assess large charges on water use and let the economics determine which users have high enough value water uses to actually call on their water right. At that point perhaps interest in selling rights to new high value users would be piqued leading to a renewed effort in creating functional water markets. Second, policymakers still have the option of condemnation of existing water rights in

order to make water available for new consumptive demands, sustain groundwater resources over the long run and provide for environmental needs.

The point of painting this dark scenario is not to suggest that any of the business as usual scenario is desirable but to make the point that developing healthy water markets is not really an optional exercise if the goal is sustainable water management. Functional markets are vital to avoiding chaos and dysfunction. The good news is that efforts and experimentation with improving markets is underway. The bad news is that the level and quality of the effort and the seriousness with which the effort is taken in some quarters does not engender optimism as to the ultimate outcome. Further, the time that is available to improve the situation is not clear, but seems to be shrinking with the unrelenting pace of climate change.

There is a saying in Silicon Valley that people often mistake innovation for effectiveness. Innovation for innovation's sake does not always produce desired outcomes. Water markets are innovative and can be effective at meeting specific water management outcomes. However it often seems like there is more pressure to try new things in the water market realm in the western US than to simply work hard to replicate what has already proved effective. Based on the case studies and analysis in this report, many things are obviously not working to facilitate healthy water markets. But a number of things are, or could be effective, with a concerted effort at cross-pollination, education, and sharing of implementation experiences. To be sure, the political economy of the changes necessary to adopt effective policies in the many contexts that currently lack them does not mitigate in favor of easy success. But as noted here, the alternatives (most notably the status quo) leave the West's water trapped where it is today – in places that do not uniformly maximize value for the economy, the environment and broadly, the people of the western US.

Contents

Figures

Tables

Boxes

1. Introduction

This is the second of three papers that make up a final report on the political economy of water markets. The report is part of a larger effort that includes a set of case studies of water markets in the western US, Australia and Chile. A group of authors with expertise and a mix of academic and professional experience in their particular markets and jurisdictions, either as attorneys, economists or geographers carried out these case studies. The final report therefore aims to build on the experiences of those directly involved in the *practice* of water markets. This practice includes the sometimes-messy job of just *making things work* in the best way possible given a difficult set of circumstances. The opportunity to step above this grind and write about the bigger picture and the rules of the game is gratifying but also intimidating.

The primary aim of the overall report is to identify and understand the economic incentives and the enabling political and legal conditions that lead water markets to function as a useful counterpart to other tools for sustainable water management. To that end, a central objective is to identify market, policy, institutional, and legal failures that impede water market function. The premise is that poor (and unhealthy) markets lock up water in traditional uses despite opportunities for beneficial trades that promote the productivity of water in its many economic, environmental or social guises.

Water markets are embedded within a particular basin geography and an evolved jurisdiction-specific governance framework.

Part I of this report describes water markets generally and locates them within the frame of the full suite of water management strategies. A conceptual framework is then proposed for understanding and evaluating water and water markets, not just in terms of whether markets for water work or not and how well or efficiently they work, but whether markets are healthy. In other words do water markets contribute not just to private gains between buyers and sellers, but do markets support and reinforce environmental and social outcomes of water governance. The framework puts forward a set of conditions and criteria on which water markets may be examined drawing on neoclassical economics, political economy and institutional economics.

One of the main messages emerging from Part I is that water markets are embedded within a particular basin geography *and* an evolved jurisdiction-specific governance framework. The context for markets is driven by geography and the rules of the game. Assessment of market activity, efficiency and outcomes for the purpose of recommending reforms or other solutions need to emerge out of the application of a multidisciplinary conceptual framework to this context. One-size-fits-all solutions are generally not effective in natural resource management and with water it is particularly difficult to drop a solution down from above on what is ultimately a local resource allocation problem. The best practice alternative is to work collaboratively from within the setting and the historical context to arrive at a shared understanding of the problem and issues, and develop tailored and appropriate solutions with broad stakeholder acceptance. This is a tall order indeed, given the multi-functionality of water as a resource, the diversity of stakeholders and sectors that must be involved and the number of scales from local to national to global that may hold stakes in a particular basin. The implication of the discussion in Part I is however, that markets should not be seen as somehow separate from or apart from the larger tug of war over water in a basin. They should not be an add-on that comes at the end of a planning process, but rather as a potential tool that needs to be included along with other alternatives in the assessment of how to meet agreed upon outcomes for water allocation, management and use.

This paper then attempts to apply the framework from Part I to the panoply of circumstances and situations found in the western US. The goal is not an exhaustive or comprehensive analysis of the western US. Rather an attempt to provide color and depth to the framework by illustrating the framework with examples from the case studies, the literature and the authors' experience.

Of course, papers (and editorials) about water markets in the western US practically write themselves these days. They begin (logically) with the idea that water scarcity exists and is growing almost everywhere due to population growth, climate change, and overall increasing demand for water. Next, they (accurately) describe how the historical set of tools water managers use in the face of scarcity are running the course of their usefulness. And finally, they (rightly) set the stage for the need for innovative new tools including, and especially, water markets. From there authors either double down on Prior Appropriation as the best (or only) way to move forward or, alternatively, propose that Prior Appropriation should be condemned to the dustbin of history. In the former case the solution is to tweak policies opportunistically to promote markets, add private capital, invest more in water conservation, set instream flow prescriptions and let the market make the best of the situation (Culp, Glennon, and Libecap 2014; Gray et al. 2015). In the latter case a radical overhaul of western water law to underpin active and efficient water markets is recommended typically involving the adoption of policy reforms in Australia over the last few decades (M. Young 2015).

The division of labor with respect to the choice of incremental or revolutionary change in the western water code between Part II and Part III of this report is as follows. Part II does its best to stick to understanding the strengths and weaknesses of the way water is currently governed and managed in the West. Part II therefore examines the incremental opportunities for change. In some cases this means assessing the utility of adopting or deploying particular approaches and legal elements that seem to work in other regimes (based on Part III). Part III provides a comparative analysis of legal elements that enable water markets in a number of international legal regimes. Part III thus provides reflection and discussion on the advantages and disadvantages of a broad suite of legal regimes for water management and, in particular, water markets, and offers a note of caution with respect to the wholesale regime change argument.

This paper begins with a brief review of the context in the western US. This moves from a characterization of the basics of hydrology and water withdrawal and use to a brief summary of water management settings in the western US, supplementing the more detailed examination of water management in Part I. This first, background section, is rounded out by a summary discussion of the governance framework in the western US and an articulation of the political economy of western water. These sections skim somewhat lightly over the legal details as Part III of this report takes an in depth and comparative look at the legal elements enabling water markets under Prior Appropriation and other regimes.

In the ensuing sections the conceptual framework put forth in Part I is applied in the context of the western US. This begins with analysis of the enabling conditions for markets, including how well market failure is resolved through collective action, and moving on to a consideration of the types of market imperfections that emerge in the western US. The aim of this assessment is to illustrate the range of potential issues that can affect market activity and efficiency, as well as social and environmental outcomes. In each section, as institutional failures, political and bureaucratic shortcomings, economic inefficiencies and other stumbling blocks are identified, an effort is made to summarize potential solutions, be they policy reforms or other actions. In a final section before concluding thoughts are offered, the paper summarizes the broader policy responses available to address water markets and their role in sustainable water management in the western US.

2. Western United States Water Markets: Setting and History

The term western United States is used in this paper as a loose approximation for western states that govern water rights at least in part using the Prior Appropriation doctrine. A rather simplistic overlay of hydrologic regions and states is provided in Table 1. The regions are not true basins but based on a division of the 50 states and Puerto Rico into twenty-one hydrologic regions by the USGS (Seaber, Kapinos, and Knapp 1994). Getches (1997) distinguishes between nine western states that practice *pure* Prior Appropriation and nine others that originally recognized riparian rights but then converted to a system of appropriation. Hawaii is the lone state in the western portion of the country that is not included as it has a hybrid system of recent statutory and ancient Hawaiian kingdom code. As argued in Part I of this report water markets inevitably respond to the context in which they are found, that is the setting and history in a given locale. The overlay of semi-arid and arid areas in the western US and the uptake of Prior Appropriation in the early days of settlement of these areas reflects this thesis. This section lays the foundation for examining water markets in the context of Prior Appropriation by briefly characterizing the setting and history, including hydrology, water management, law and political economy.

TABLE 1: WESTERN BASINS AND STATES

	Water Resource Regions	"Pure" Prior Appropriation	Hybrid with Prior Appropriation
Gulf Basins	10 Missouri	Montana Wyoming	North Dakota South Dakota Nebraska
		Colorado	Kansas
	11 Arkansas-White-Red		Oklahoma New Mexico
			Texas
	12 Texas Gulf		
	13 Rio Grande		
		Colorado	New Mexico
Pacific Basins	14 Upper Colorado	Wyoming Utah	
	15 Lower Colorado	Arizona Nevada	
	16 Great Basin	Utah Nevada	
	17 Pacific Northwest	Montana Idaho	Washington Oregon
	18 California		California
	19 Alaska	Alaska	

Note: The Great Basin does not discharge into the Pacific, as do the other Pacific Basins
Source: Getches (1997) and Seaber et al. (1994)

2.1 Water and its Withdrawal and Use

A brief recap of general points made in Part I is provided before focusing this sub-section on the western US. This report uses the term *water* to refer to *surface water* (lakes, streams, rivers, etc.) and *groundwater* (the water held underground in aquifers). When society intervenes in the water cycle to dam or divert surface water or pump groundwater this alters the hydrologic cycle. The report refers to such alterations as *withdrawals* of water from the system. From an economic standpoint water bodies can be regarded as *renewable* or *exhaustible* resources, depending on a comparison of the rate of withdrawal with the rate of replenishment. Aquifers that store large amounts of water but also discharge to surface waters may represent a hybrid of these two resource types.

Of critical importance to water management and markets is that the withdrawal and use of water by humans is often only partially consumptive.

Withdrawal of water typically leads to one or both *evaporation* (from reservoirs, soil or human uses) and *transpiration* (from crops). Taken together these form *evapotranspiration* (ET). Irrigation is the largest single water use in terms of withdrawal and consumptive use in the western US. According to the US Geological Survey irrigation accounts for 63% of total water withdrawals in the eighteen states identified earlier. If aquaculture and livestock are included the total comes to 69%. (The withdrawal of water in these states by source and type of use is summarized in Figure 1 and Figure 2.) As a result of its predominance in use, discussions about water and water use often focus on the use of water to grow crops (and this report is no exception).

Of critical importance to water management and markets is that the withdrawal and use of water by humans is often only partially consumptive. In other words, the act of using water in the home, for irrigation, or industry leaves some portion of the water for return to the hydrologic system. This *return flow* may run immediately to water bodies or percolate to groundwater where it changes the pressure of the groundwater system affecting groundwater discharge in days or over decades or centuries, depending on the hydrogeology. Apart from issues of water quality and treatment that this may pose, what is significant for this paper is simply that some portion of the water continues on down gradient and is therefore available for use by other water users.

In some cases the water lost through seepage back into the ground goes into deep storage. If this occurs or if the water use is in another drainage system (as in an inter-basin water transfer) then the return flows never returns to the original source. In these cases, the entire withdrawal is said to be *consumptive* with respect to the original source. The proportion of ET to return flow from irrigation water varies tremendously from site to site. In the case of extremely efficient pressurized irrigation, as much as 95% of water withdrawn for irrigation may be consumed, with only a minor amount going to seepage. In case of open canals running for miles through fractured basalt, combined with unsophisticated flood irrigation this might reverse to where up to 80% of the water diverted for irrigation ends up as return flow. However, even in the case of higher efficiency, irrigation water users nonetheless *consume* only a portion of the water they withdraw. In the arid and semi-arid west this return flow often underpins the water right of another user downstream or down gradient.

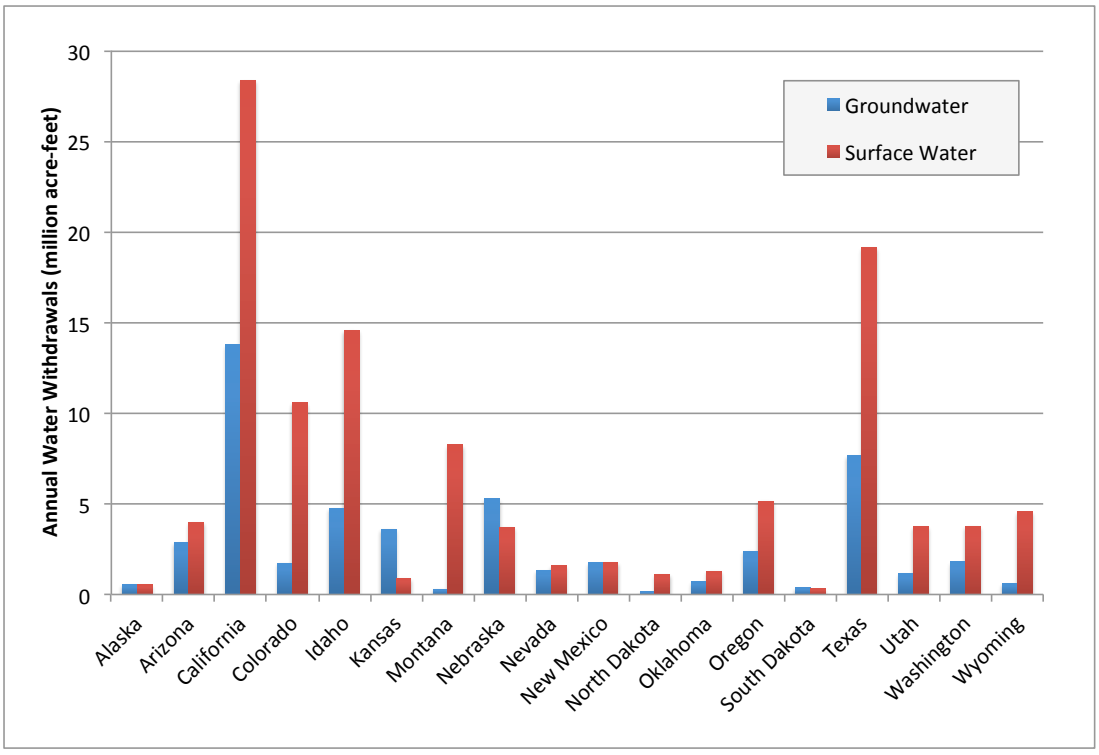
Surface water diversions may come from natural flow or water that is stored in reservoirs for later release. As storage water is taken out of natural flow, its release is generally at the disposition of the individual or entity that manages the storage facility. There is therefore in many western jurisdictions a somewhat nuanced legal distinction between the reliance by another user on the return flow from the use of natural flow and the return flow resulting from the use of stored water.

This discussion and the figures that accompany it are largely about the withdrawal of water for human use. Freshwater (and saline) ecosystems support an abundance of life, life that is often adversely affected by water withdrawals. Concerns about the loss of biodiversity and functioning ecosystems, as well as simply the loss of running streams and rivers is not just a global issue but an issue in the western US. In Part I a system used internationally for classifying the services provided by freshwater ecosystems is reviewed and adapted to the purpose of the report, as follows (Millennium Ecosystem Assessment 2005):

- Human provisioning services or human uses of water refers to:
  - Withdrawal of water from freshwater ecosystems and aquifers to meet human uses for domestic, industrial, commercial, irrigation, thermoelectric and hydropower uses.
- Freshwater ecosystem services or ecosystem uses of water refers to:
  - provisioning services such as habitat for fish and wildlife;
  - regulatory functions of ecosystems such as maintenance of hydrologic regime and water quality;
  - supporting functions such as habitat for species; and
  - cultural functions such as sacred sites, tourism and recreation.

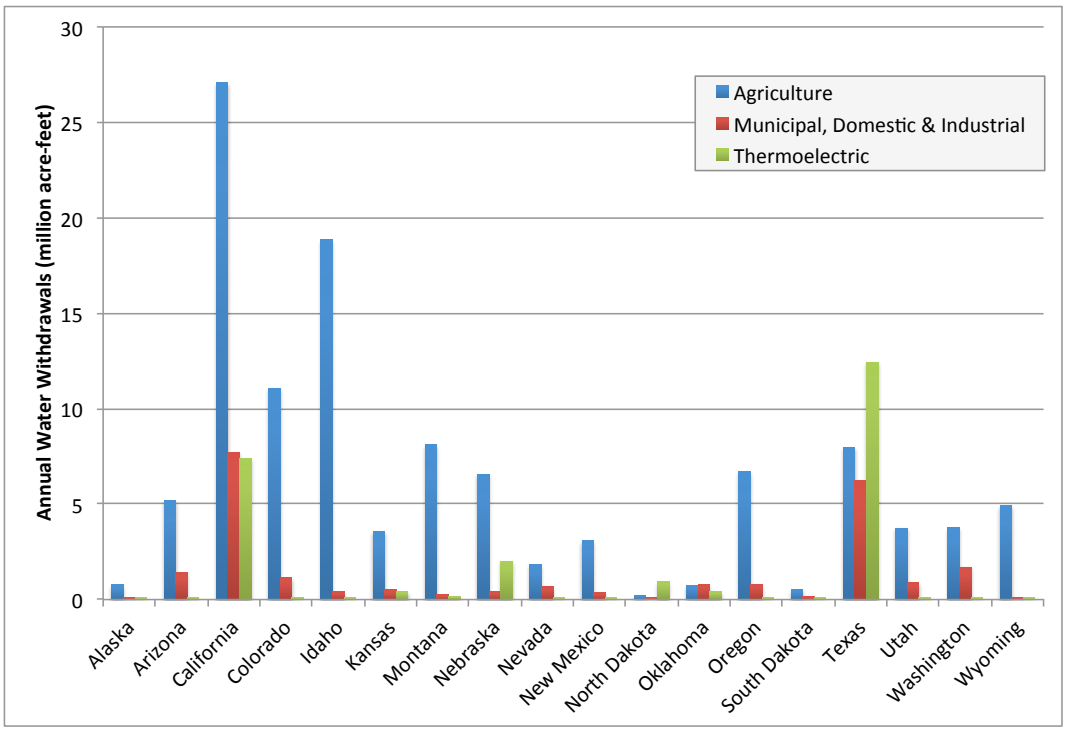
It cannot be emphasized enough that the particular hydroecology of a watershed when overlain with human socio-cultural and economic activity produces a huge range of settings in the western states in terms of precipitation, elevation, temperature, population density, economic activity, etc. From mountainous headwater streams, through mid-elevation valleys and population centers, to floodplains, deltas and estuaries the setting for water use and management changes significantly.

FIGURE 1: WATER WITHDRAWALS BY SOURCE WESTERN US



Source: Maupin et al. (2014)

FIGURE 2: WATER WITHDRAWALS BY TYPE OF USE WESTERN US



Source: Maupin et al. (2014)

2.2 Water Management

Part I of the report examines strategies for managing water in some detail. There are a wide variety of strategies available to manage water and achieve the development or sustainable management of water resources. These can be grouped as: supply, demand, or reallocation strategies (see Figure 2). In the figure the strategies are laid out left to right in the order in which they have evolved as scarcity of the resource has grown. Within each set of strategies, it is also possible to identify, somewhat generically, from top to bottom of the graphic, how innovation within a group further develops and evolves these strategies.

As scarcity increases … society will have to find a way to reallocate water from one use to another.

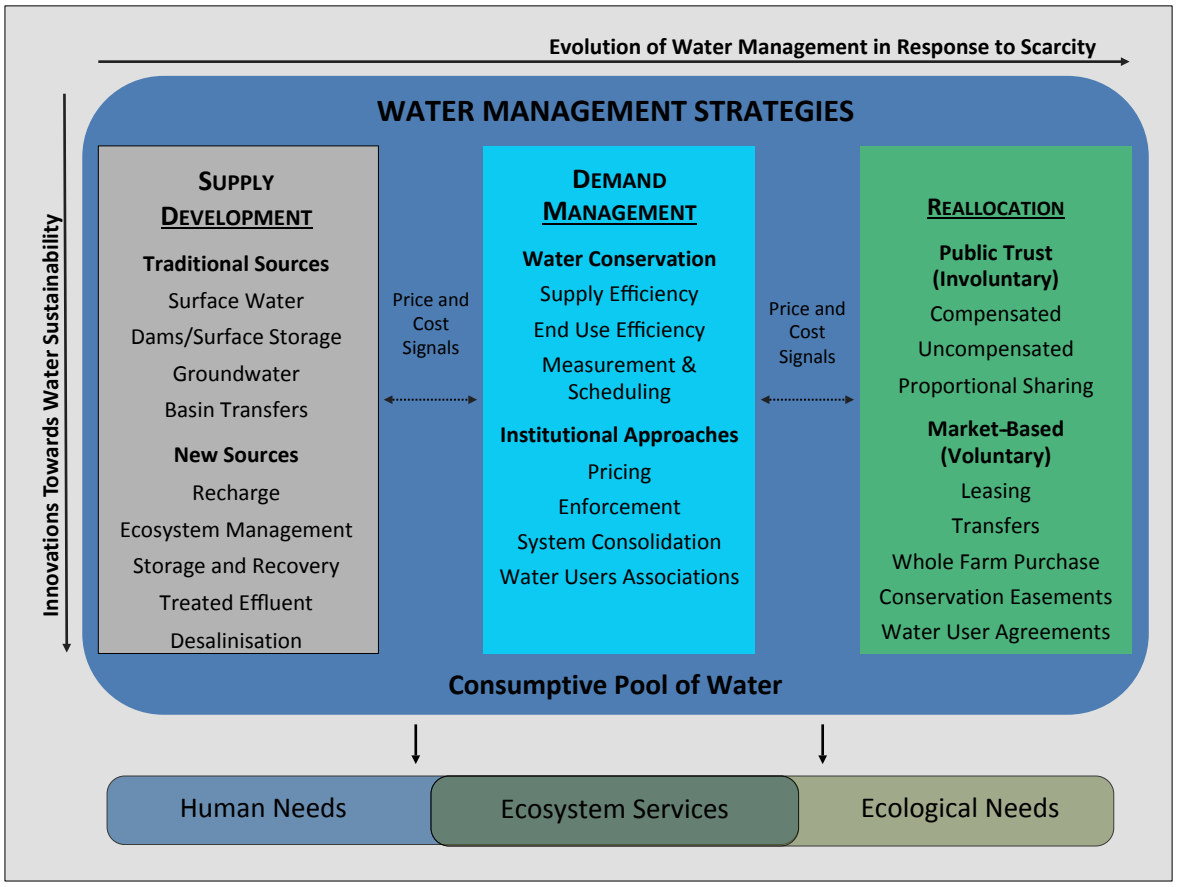
In the western US, as elsewhere, vast amount of effort and resources have been expended over the last one and a half centuries to *supply* water in the quantity needed and at the time and place required. These efforts are devoted to meeting the human uses summarized above. As the cost of developing new supply increase efforts turn to *demand management*, in order to meet growing needs from the same source of supply. Demand management, also called water conservation, can include direct, often technological or infrastructure solutions that drive greater water use efficiency.

The difficulty comes that there is only so much water and as it flows and percolates downhill from the headwaters to the sea it is used and returned, used and returned, over and over again until ultimately there is little left – as when the Colorado River goes dry just a few miles across the US-Mexican border, or when the Rio Grande goes dry below El Paso. The ability to divert and store large quantities of water and to pump even more out of the ground, mean that the molecules of water in western basins are increasingly

spoken for, or allocated to uses and users. This means that demand management and innovative new supply technologies, like aquifer recharge can only do so much to meet new out-of-stream demands, particularly when many states now have laws in place to protect the water that goes to ecosystems. As scarcity increases due to climate change, increasing population and economic growth, society will have to find a way to *reallocate* water from one use to another.

As is discussed in the next section, in the western US there are limited opportunities to carry out reallocation without compensating the prior owner and user of the water. The question is more a question of whether this reallocation can be made to work on a voluntary basis, through water markets and marketplaces, or whether and to what extent government has to weigh in and use its authority to compel needed change. Examples of both compensated and uncompensated involuntary reallocation exist in the western US. These are often the result of regulatory action to implement water settlements with tribal (indigenous) governments, or to remedy water management practices within the context of major environmental legislation such as the Clean Water Act or the Endangered Species Act. This paper does not review that experience but rather attempts to understand the role that voluntary trade has implicitly or explicitly been asked to play and how this has worked out. Given the large variety of settings and water management strategies each and every basin varies in its need for reallocation of some kind and the extent to which water markets have ended up serving as a tool for water management has also varied.

FIGURE 3: WATER MANAGEMENT STRATEGIES



2.3 Governance and Law

As the west was settled over time, the federal government gave states broad autonomy over managing natural resources on lands that the federal government did not keep for itself. In particular, water law became primarily a matter covered by state law. Except for rivers that cross borders and federal water infrastructure projects, most water in the west is regulated according to the system of state water law in place in that jurisdiction. As noted earlier the eighteen western states are primarily Prior Appropriation states. However, there are vestiges of other rights systems that predated or emerge from the state water code in place in a number of states. For example, in California, the Water Education Foundation lists eight types of water rights, of which just three relate to Prior Appropriation or *appropriative rights*, along with their relative place in the priority order (see Box 1).

Box 1: Water Rights in California

Water rights found in California include the following seven types:

1. Pueblo rights established under Spanish and Mexican law: paramount to all others.
2. Riparian rights established under common law): senior to appropriative rights.
3. Appropriative rights established by developing uses: priority by date of use defines order.
4. Dual rights are a blending of appropriative and riparian rights.
5. Federal reserve rights established with federal reservation of land: senior to all state claims.
6. Public Trust Doctrine or the application of common law to protection of waterways: puts duty to administer for the benefit of the people above privately owned rights.
7. Prescriptive rights establish adverse possession to water on behalf of junior users when openly and notoriously using water adverse to a senior user: provides juniors equal priority to seniors.

Overlying rights to groundwater enables landowners to use groundwater beneath their parcel without a permit subject to reasonable and beneficial use.

Source: Water Education Foundation (n.d.)

Varying systems of rights that affect water here or there in a particular state are outside the remit of this paper. Of interest in this paper are the major legal regimes and water right systems by which the rights to withdraw and use surface water and groundwater are allocated and regulated. Prior appropriation dominates the western landscape in this regard. Prior appropriation serves as the primary regime in the western states when it comes to governing surface water. Groundwater, on the other hand, demonstrates some diversity of approach including appropriative, reasonable use, correlative and rule of capture regimes.

Part III of this report a comprehensive comparison of legal regimes for governing water resources is provided. Prior appropriation is introduced below so that the reader unfamiliar with this system does not need to refer to Part III for this information. For the regimes that govern groundwater these are only briefly introduced, based on Part III, in order to lay the groundwork for following discussion and in order to compare the use of the different regimes in the western US.

2.3.1 Prior Appropriation and Surface Water

The doctrine of Prior Appropriation is a unique system of water management that developed in the western US beginning in California in the 1850s. The basic elements of the doctrine were imported to the water context by gold-rush miners. In the mining context, the primary mechanism for excluding other miners from a potential mine site was to stake your claim—literally to post a sign warning other

prospectors that a given location had been claimed by another. The first person to stake a claim to a given site had the exclusive right to prospect at that site. These same basic rules were imported into the water context and have held sway in the western US ever since.

The result was a priority system commonly referred to as *first in time, first in right*. The first person to make use of water, and give notice of their use to other potential users on a given stream is given the first (highest priority, also called *senior* priority) right, meaning that they are entitled to take their full claimed right before anyone else is allowed to take theirs. Subsequent claimants (*junior* priority rights) are placed in line to take their fill according to when they effectuated their own claims. However, because water in the arid western US is a scarce resource, and water is generally required to make any productive use of arid lands, additional rules and restrictions developed over time to spread the benefits of water use as widely as possible.

The most important restriction that was added to the basic tenet of *first in time, first in right* was the concept of *beneficial use*. Today, the concept of beneficial use is enshrined in Prior Appropriation jurisdictions as the *basis, measure, and limit* of the right to use water. Beneficial uses are generally those that are widely agreed upon as socially, economically, or otherwise in the best interest of the public. Many states specifically define what uses of water are beneficial but courts have long held that the concept of beneficial use is not static and that beneficial uses can and should be added and changed as the public's definition of what is beneficial changes over time.

Western rivers are not all fully dewatered up and down their length by Prior Appropriation, rather they come and go, as water is diverted, partially used, returned to the channel and then diverted again

At this point, it is critical to note the important role that the public interest plays in Prior Appropriation water law. Most state constitutions or laws explicitly say that the people of the state, or the public, own water. The right to use water is therefore referred to not in terms of owning water, but of owning the *right to use* water (the legal term is a *usufructory right*). The concept of beneficial use is directly tied with this public ownership concept—in order to maintain the right to use publicly owned water the use of water must be beneficial in some way to the state and its people as a whole. Beneficial use then, not only prescribes the types of uses to which the public allows water to be put, but also to the way water is used. Wasteful uses of water are not considered to be beneficial. Though the specific definition of waste varies, there are generally accepted rules about how much water it should take to achieve a specific beneficial use.

In the early nineteen hundreds, most states in the West began to enact statutory schemes – water codes – to enshrine the Prior Appropriation laws into their legal frameworks. Doing so resulted in systems of water right permitting and certification. Through various complex legal processes, states set out to solidify claims to water rights made before their water codes were enacted and to govern the issuance of water rights in the future. These processes, called adjudications, also set in stone the relative priorities and quantities of existing rights and form the basis for quantification and prioritization of future rights. Some states in the west are still in the process of sorting out the quantity and priority of their water rights through these legal processes. Once relative priorities and water right quantities are known and certified (recognized by a water right certificate), state regulators then oversee the distribution of water. During times when water availability is less than the overall demand for water, regulators enforce the priority relationship between rights on shared water sources by requiring junior users to shut off their diversions to leave water for senior users.

In addition, the codification and certification of water rights allows for states to regulate formal changes to water rights. Water rights are assigned to specific lands (called *appurtenancy)* in Prior Appropriation jurisdictions. The result of appurtenancy is that water rights change hands automatically if the land they are attached to is sold. However, ownership of water rights can also be transferred separate of land by going through a process generally referred to as a *transfer*. Other changes, such as changes in where a water right is diverted, are also allowed with review and oversight in Prior Appropriation jurisdictions. Due to the interrelationship of water rights on shared sources in the Prior Appropriation system, transfers and other formal changes to water rights require careful analysis to avoid injury to other water users. While injury is a complicated legal term of art, it generally refers to maintenance of identical conditions (of flow amount, timing, and location) in the water source before and after changes are implemented.

With regard to surface water the general impression is that in the western states more water rights for withdrawal and storage of water for human uses were appropriated than flow was available, leaving western streams and rivers bereft of water. Certainly, provision for instream and environmental uses (or *environmental flows*) were not made until the second half of the twentieth century, when arguably it was too late for any such rights to accrue anything but residual water in the system. However, given the development imperative in the late nineteenth and early twentieth century, a system of handing out rights up to or exceeding the maximum flows was exceedingly effective in meeting growing human uses of water. Recall of course that that each withdrawal of water is only partially consumptive. Therefore, in order to fully utilize the resource up and down a river it would be necessary to allocate more rights than the maximum flow in order to fully consume the water in human use. In other words, western rivers are not all fully dewatered up and down their length by Prior Appropriation, rather they come and go, as water is diverted, partially used, returned to the channel and then diverted again.

2.3.2 Groundwater Regimes

There are four regimes used to govern groundwater in the western US:

1. Prior Appropriation.
2. Rule of Capture / Ownership in Place.
3. Reasonable Use.
4. Reasonable Use and Correlative.

These are each briefly summarized with respect to their application in the US West. An attempt to classify each state in accordance with these regimes and whether or not rights are subject to statutory limits on permitted rights or allocations made to these rights annually is included in Table 2.

Prior Appropriation. The Prior Appropriation Doctrine is also the dominant regime for groundwater in the west with thirteen states regulating water in this fashion. Groundwater was generally developed much later than surface water due to a variety of factors including the cost, power and availability of alternatives. As the dam building era drew to a close in the second half of the twentieth century and with the spread of rural electrification programs groundwater use became both a new source of water for bringing new lands under production as well as a supplemental source of water where surface water and stored water were still not sufficient.

Rule of Capture / Ownership in Place. Texas is the lone western state that holds to the Rule of Capture (also known as the Absolute Ownership Doctrine). A detailed review and analysis of the legal history of groundwater in Texas is provided in the Texas groundwater case study associated with this report and is only summarized here (Hardberger 2016). For over one hundred years, the Rule of Capture in Texas has meant that landowners may capture any amount of water under their land, even if it affects others, as long as that harm is not caused maliciously or by willful waster. The use must be reasonable in economic terms or otherwise publically beneficial.

TABLE 2: REGIMES FOR GROUNDWATER IN THE WESTERN STATES

Legal Regime	Subject to Statutory Limits (Cap)	Permit Required		Permit not Required
Rights not related to Land Ownership				
Prior Apropriation	Subject to Limits	Alaska Idaho Montana New Mexico Oregon Utah Wyoming	Colorado Kansas Nevada North Dakota South Dakota Washington	
Rights derived from Land Ownership				
Reasonable Use	Subject to Limits	Nebraska	Arizona (urban)	
	Not Subject to Limits			Arizona (non-urban)
Reasonable Use and Correlative	Subject to Limits		Oklahoma	
	Not Subject to Limits			California*
Rule of Capture / Ownership in Place	Subject to Limits	Texas (Edwards Aquifer)		
	Not Subject to Limits			Texas (other)

Notes: *Recent 2014 legislation in California sets the stage for limiting use to sustainable yield
Source: Getches (1997) and Roshi (2005)

Reasonable Use. The Reasonable Use Doctrine for groundwater is prevalent in the eastern US, with just Nebraska and Arizona employing the doctrine in the west. The right to extract groundwater is again dependent on land ownership. Reasonable uses are beneficial uses of water on the overlying land. Such uses may deplete the aquifer or cause others to have difficulty in pumping water.

Reasonable Use and Correlative. This adaptation of the Reasonable Use Doctrine acknowledges that when supplies are scarce water should be rationed in equal proportionate shares. These shares will be based on land owned (and so are correlative to land rights are not to water rights). This approach is adopted by just two states, California and Oklahoma (Getches 1997).

2.4 Political Economy

As with water generally, western water is governed and managed both from above (by government and other regulatory actors) and below (by water users and groups of users). The state water code, and to a lesser degree national policies and laws create a set of rules and institutions (or governance) that drive water management from the top down. The allocation of property rights to the use of water is largely a matter of state government, although bi-state and international basins fall under interstate compacts and international treaties with recourse through federal courts and federal agencies. Property rights empower water right holders (called water uses from here on for simplicity sake) to withdraw and use water, effectively managing the storage, diversion, extraction and flow of water through the basin, above and below ground.

Over time the overlay of rights, uses and rules with the social and economic setting leads in turn to the evolution of customary rules and practices that influence water management from the bottom up. For example, even though surface water rights are typically filled in order of priority, within some shared conveyance systems the total water available to the group of users is simply shared equally. As one

proceeds from national to local scales of governance and management water users either adapt to inconvenient rules or change them to their benefit. Rules from above combine with the fact situation on the ground to drive the selection of water management strategies by water users and stakeholders in a given locale. This equilibrium is disturbed when changing needs leads to water marketing. Reallocation of water rights changes the pattern of water use and flow across the landscape. When local custom led to adaptation – that is where water was no longer managed according to the formal rules in place – then the marketing of rights and subsequent changes in use in accordance with the formal rules runs into various obstacles and hurdles and will disrupt evolved local institutional arrangements. For example, where priorities are not strictly observed this may complicate the purchase and transfer of water rights out of such an arrangement.

Rules from above combine with the fact situation on the ground to drive the selection of water management strategies by water users and stakeholders in a given locale.

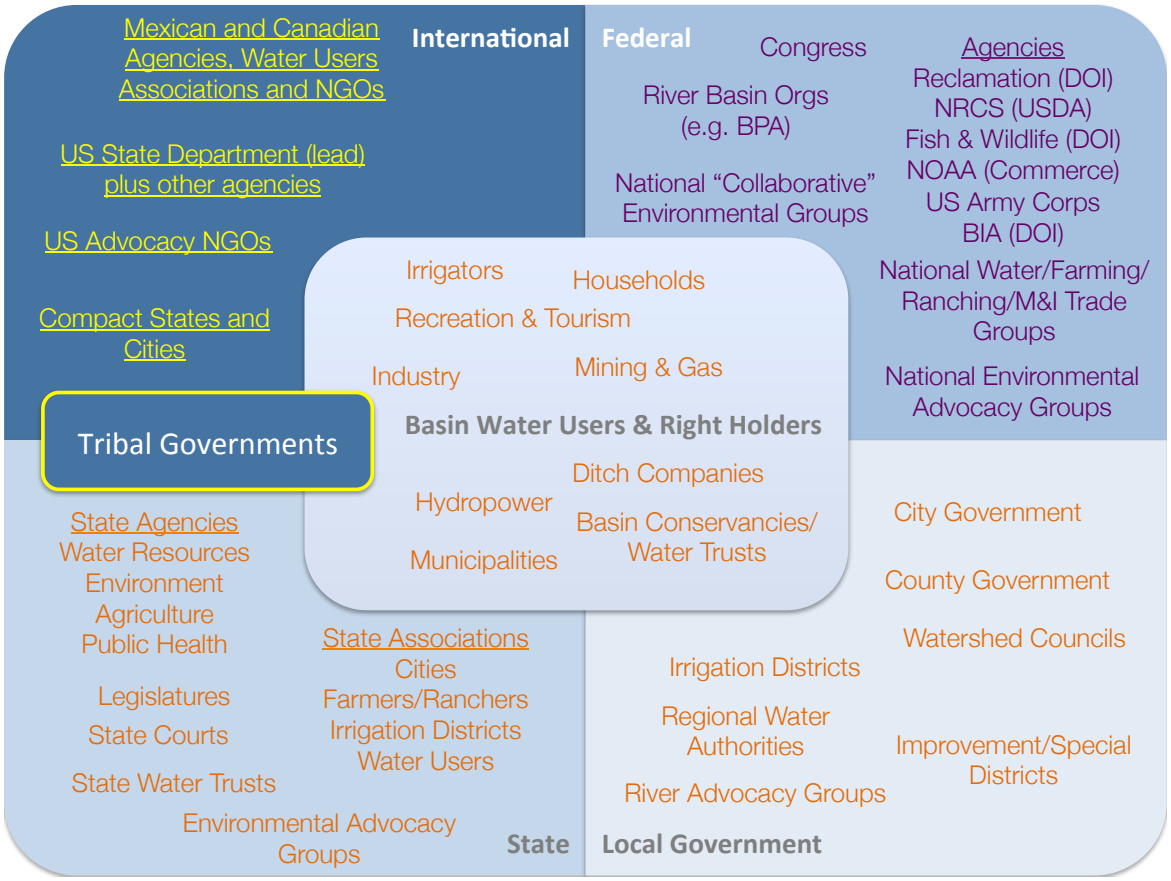
A complex web of actors (or stakeholders) thus drives the political economy of water from place to place. Figure 4 attempts to list out and group a number of these types of actors across jurisdictional scales. In a given basin the types of water users and their relative economic might, social position and political influence will greatly influence the rules of the game, and this applies for water markets as well as other water management strategies. There can be no *a priori* expectation about the relative importance of actors across and between scales. A large municipality or irrigation district may be a local government, but may have the economic or political capital to drive market rules and institutional outcomes in their favor. Similarly a federal entity may simply go along with the wishes of basin stakeholders even when this appears to contravene their own rules. In the Treasure Valley case study, the reissuance of Reclamation contracts to entities with a demonstrated history of non-use is one such example (Fereday 2016).

Economic might, social position and political power matters in water management under Prior Appropriation. Water is managed and water rights are reallocated via a set of rules. Power to influence those that make the rules and those that administer them is valuable. The power to change the rules, seek positive interpretations of the rules or to bend/ignore the rules is an important rent seeking opportunity. Successful rent seeking activity creates the opportunity for financial profit for the actor or their group.

Rules that affect water rights and water markets are typically set at the state level, however, higher level authorities and local level authorities also have their domain within the scope of rights that they manage, such as Reclamation projects, municipal water providers and local irrigation districts. While setting the rules of the game is probably the most significant contest in terms of the interplay of economic, social and political forces, statutes governing water rights and markets change only occasionally. In between these periods the existing set of rules, however imperfect, drives the behavior potential participants in the water market. Thus, the majority of rent seeking behavior comes with the day-to-day administration of rights and markets by the relevant authorities, or regulators. This occurs in the form of seeking advantage, either by bending or breaking the rules.

It is worth pointing out that the rules that underpin rights, water use and markets, and the interplay of such are rarely fully specified. There is usually some degree of wiggle room in interpretations and decisions made by regulatory entities (at whichever scale). Add to this that information about the use and exercise of water rights or the hydrogeology that shapes the regulation of priority dates on a system is neither perfect, nor often transparent, and the room for interpretation only increases. As noted above, this can lead to circumstances such as those in the Treasure Valley where actions taken may merely be interpretations, creative bending of the rules or outright non-compliance with the rules.

FIGURE 4: ACTORS IN POLITICAL ECONOMY OF WATER IN THE WESTERN US



Inevitably, there is disagreement on decisions made by regulators at different levels about the application of the rules in place. In the western US this often leads to litigation. While some basins have seen more litigation than others, these disagreements often end up in front of state and federal courts, all the way to the US Supreme Court. The Truckee-Carson case study from northern Nevada provides one such example with litigation in the Truckee over water rights and water use extending from the original adjudication in 1944 through to a decades long political effort at settlement (Sanchez, Aylward, and Springmeyer 2016). In this case the Truckee River Operating Agreement, which received final approvals in 2016, was the end result. The agreement enables sensible yet innovative and flexible management of basin storage facilities to meet urban and fish water needs. Key to the settlement however were a series of actions that addressed long-ignored tribal and environmental flow concerns and validated long term reallocations of surface water from agriculture to municipal use using the Truckee-Carson water markets.

As discussed in Part I of this Report an interesting question is how the balance of power varies between economic and political interests and the degree to which the economics of water drives the politics of water or vice versa. The same applies to whether economics or politics drives water markets. Clearly, both matter. Individual transactions reflect the willingness to pay and the willingness to accept of the buyer and seller, respectively. So economics would appear the main driver at the transaction level. Economic interests also play an important role in arguing for rules and decisions that move water to their highest and best financial use. Certainly, powerful urban, municipal and industrial interests have succeeded in driving markets to their ends. In the most infamous examples, such as the Front Range of Colorado, Las Vegas and the Los Angeles and Owens Valley cases water has surely *moved uphill to money* and the

economics of developing large population centers has driven state politics over water and the water market.

However, if politics and policy, as an expression of collective action, provides money for the purchase of water then the driver is politics not economics strictly speaking. The dedication of public funding to acquire water rights for the environment is one such salient example of how politics not economics can drive water trade. But if the curtain is pulled back from merely the transaction to the rules that lie behind the market and the regulatory decisions as to how these rules are applied, then markets and how they unfold are obviously shaped by the will of the people as expressed through legislative bodies and administrative agencies. These are likely to be shaped by political considerations as well as economic considerations.

And finally, as much as water is an economic good it is also a social good. While water is an input to economic production and underpins the livelihoods of many it is also central to meeting basic human needs for sustenance and hygiene, and integral to the lifestyle of farmers and ranchers that rely on irrigation. It is therefore also the case that social needs expressed through classes and groups of water users are part of the equation. These can affect water trade at the transaction level and in the making and applying of market rules. At times these social interests may even argue against markets and contest the idea that market forces should be left to reallocate water amongst and between economic interests.

In sum when it comes to water and water markets there is no obvious conclusion that liberal, realist, or structural perspectives on political economy best portray water markets across the western US. That said, the analysis in the next section proceeds to identify the obstacles and barriers faced by markets and considers how these reflect the interplay of economic, social and political forces.

3. Water Markets Framework

Part I of this final report provides a detailed normative and conceptual discussion of a framework for understanding healthy water markets. A first task covered in the paper was to clearly define what is meant by various terms that are often used around water markets and to define "healthy" in the context of water markets. A summary of these definitions is provided in Box 2 and Box 3. Part I then builds a conceptual framework for understanding markets by first considering the question of market failure and collective action with respect to water and then identifying the enabling conditions for water markets, as well as the imperfections that can impeded their function. Part III of this final report builds on this framework to examine the legal elements that underpin the enabling conditions in much greater detail and to compare how different legal regimes have met (or not) these conditions. The essentials of the framework are repeated here before moving on to apply the framework to the western US.

The water market framework emerges from understanding that water is an economic good, but one with public good characteristics. As water is not a purely private good water itself should not be, and generally is not, treated as private property and left to the free market to allocate. Instead, water is asserted to be public property managed for the benefit of the people. In capitalist economies this generally means extending property rights for the use of water and allowing these to be exchanged in some fashion in a water rights market. Using markets to reallocate water rights must therefore logically be set firmly within the bounds of collective action with the rules for market interactions set to meet the public good not just private and commercial needs.

The water market framework emerges from understanding that water is an economic good, but one with public good characteristics.

In jurisdictions that grant use rights to water the three generally accepted conditions required to enable markets, including water markets, are scarcity, well defined and secure property rights, and the ability to trade. *Scarcity* is required to enable a market in a good or service because if the good or service is not scarce then no one will take the effort to find someone who has the good and offer to purchase it. In other words, scarcity drives demand. Second, in order for a buyer to expend resources in the market the buyer must obtain something of value. A *well-defined and secure property right* provides assurances that what a buyer purchases is for their own consumption – that the buyer can exclude others from enjoying it – and that the good or service is as advertised. Finally, in order for *trades* to occur a key question is whether the relevant governing institutions recognize trades and confirm that buyers may use the good they purchase for their intended use. The final condition for a market then is that there be rules that allow for and govern the *trade* of goods.

To more fully capture the concept of *healthy* water markets two more concepts are necessary: not just secure but flexible property rights and transferability (along with tradability) (Aylward et al. 2016).

Enabling healthy water markets requires *flexibility* in laws and policies. A regime in which the governance of rights and uses is inflexible leaves no room for adaptation. In such cases water rights themselves, or water right regimes more generally, risk being out of step with society's changing values for water, with climate and other hydrologic realities, or both. Flexibility in water rights and the water right administration systems is essential for public policy to adapt water management to changing values and changing circumstances. By implication the security of rights, from the right holders perspective is lessened, but this reflects the necessary balancing act between collective action and property rights.

BOX 2: WATER MARKETS: DEFINITIONS

A *water rights market* (or water market) is a set of rules, set by the appropriate authority, to govern the exchange of water rights between willing buyers and sellers. The rules define the property involved – the water rights – as well as the process by which the temporary or permanent transfer of water rights from one use/user to another is accomplished. Creating a water market refers to the establishment of rules and agreements that govern transactions in water rights within a given jurisdiction and hydrographic setting.

Trade in a water market represents the set of water right transactions in unregulated (natural) flow, regulated or stored water, or groundwater. Trades in a water rights market are executed between willing sellers and willing buyers for the purpose of meeting unmet, new or different demands from existing permitted water supplies. Purchase of water rights with the sole intent of renting them out for income and or holding them for capital appreciation is also a potential source of market activity, at least in well-developed and liquid markets.

Environmental water transactions (EWTs) are water market trades undertaken to protect additional water in waterways or water bodies for environmental purpose.

A *water marketplace* is a specific mechanism developed as a place where market participants can obtain market information and/or conduct transactions. Examples of water marketplaces include water brokers, water banks/exchanges, water auctions and smart markets. A water marketplace may promulgate its own rules for eligibility, participation and market clearing, but the laws and regulations governing the water rights market give the marketplace transactions legitimacy. Marketplaces may involve manual or online bidding and manual or automated clearing.

A *water transactions program* is an explicit act of collective action by stakeholders to set up the policies, rules, plans, funding and/or capacity to achieve an agreed upon set of objectives in terms of water allocation and use. Such programs may be driven primarily by environmental objectives. So an environmental water transaction program is a program set up to carry out environmental water transactions, e.g. the Columbia Basin Water Transactions Program funded by Bonneville Power Administration to carry out EWTs across the Columbia Basin. But transaction programs may be set up by any group of stakeholders to meet their needs. The Palo Verde Land Management, Crop Rotation and Water Supply Program is set up to facilitate rotational fallowing and trading of water between irrigators in the Palo Verde Irrigation District and the Metropolitan Water District. Multi-sector transactions (or trading) programs are relatively novel but should serve to meet changing needs across sectors in an orderly fashion as part of larger political agreements on watershed, water resource or basin management.

Source: Aylward et al. (2016)

BOX 3: HEALTHY WATER MARKETS

In the face of increasing water scarcity and conflict over human and ecosystem uses of water there is a need for effective or *healthy* water markets to achieve a balancing of the following outcomes:

- *efficacy*: effectively managing supply and demand for water, and – where possible – conflict over water, in response to driving forces and changing circumstances;
- *economic efficiency*: achieving efficacy in a cost-effective and timely manner; and
- *environmental and social sustainability*: avoiding adverse impacts and providing pathways to social inclusion and equity, as well as environmental conservation and restoration and ecosystem resiliency.

How this balance plays out in a given location will depend on the setting and history amongst other factors and what a market is asked to do.

Source: Aylward et al. (2016)

Second, the ability to trade may be assumed to necessarily include the ability to *transfer* acquired rights to new uses. Under Prior Appropriation the act of renting or purchasing a water right from a willing seller does not necessarily imply that the water can be put to the buyer's use. When trade in water rights takes place, the new user may want or need to change one or more the parameters of the water right they purchased (place of use, type of use, location of use, and others). This is referred to as *transferability*. The relevance of this to healthy markets is that transfers that may erode environmental or social uses and values must be properly reviewed, assessed, and modified as necessary. This is a regulatory function generally speaking. For markets to be healthy these regulatory protections must be effective, meaning that the necessary capacity in the regulatory entities and civil society must be present to ensure this function is carried out. It is therefore vital to be clear that tradability of rights involves both the trade and the transfer of these rights, and that the transfer requires the necessary regulatory protections and capacities.

Each of these enabling conditions represents a set of rules that either leads towards or away from market activity and/or market activity that can be deemed healthy. To some extent the degree to which these enabling conditions are in place reflect how well (or how poorly) collective action has resolved the problem of water governance and management in the context of public goods characteristics. Nonetheless, like any marketed good there is another layer of conditions for a competitive market that can be identified and analyzed. These are summarized in Box 4.

The ensuing sections use the case studies, the literature and the author's experience to apply this framework to understand western water markets, what they do well and what they do poorly. In the process of this analysis potential ideas for improving market efficacy and efficiency, and moving markets towards positive social and environmental outcomes are identified.

Box 4: Market Imperfections in Water Markets

Economists have a well-developed list of items that lead to an imperfect market, i.e., one where the economic conditions for a perfectly competitive market are not present. Aylward et al. (2016) parse out these items with respect to water markets and categorize them as to whether they affect the gains from trade or the efficiency of the market (i.e., how they affect transaction costs). Each of these represents a potential obstacle or hurdle to effective and efficient markets.

Imperfections in water markets that affect willingness to pay and willingness to accept include:

- Market concentration, e.g., one or few producers (monopoly or oligopoly) dominate the market and concentrate power so that they may control the water market and sell at higher than efficient prices extracting excess profit from buyer, thereby reallocating less water then would be good for the economy.
- Collusion based on market concentration or other affiliations may also be deployed to limit access to water markets or exclude unwanted buyers.
- Buyers on behalf of the government or the environment are often simply trying to buy water at the best price possible. They are not maximizing utility since in this case the use is a public use that defies the logic of profit and loss maximization; this can push market prices up over time.

There are also a number of market conditions that will affect the efficiency of the market:

- Heterogeneous products, e.g., water rights of many different types and classes make due diligence on the expected reliability of a water right and appraisal of value more difficult for the prospective buyer.
- Incomplete information, e.g., a lack of, or poor, data on water rights, their extent, validity and transferability creates uncertainty for buyers and sellers reducing market participation.
- Asymmetric information, e.g., insiders or those with market power may be much better informed than the casual market participant, skewing pricing in favor of the former and leading to buyer/seller remorse and distrust of the market.
- Barriers/high costs to entry (and exit), e.g., fees, qualifications and the need for specialized advice in order to participate in the market impede the efficient entry/exit of buyers/sellers to the market.

Source: Aylward et al. (2016)

4. Scarcity

It is a fundamental tenet of economics that resource scarcity drives trade. Whether and to what extent water is in scarce supply is a fundamental precondition for water markets and water trade. The first topic addressed is therefore how physical conditions interact (or don't) with the legalities of surface and groundwater rights systems in the western US. But questions of scarcity and the likelihood of water trade go beyond simple questions of limits. The degree of scarcity drives economic behavior and the search for water to meet needs. The perception of scarcity as felt by a prospective water user (or buyer) is driven by the availability of alternatives and loopholes. In addition, scarcity may exist for a given user, but fail to materially affect market trade if the user is excluded from the market. Each of these topics is then examined in the context of apparent physical and legal water scarcity in the western US.

4.1 Physical and Legal Scarcity

Scarcity reflects levels of supply and demand for a resource. The higher the demand for a given supply, the more scarce the resource and the higher the price that a buyer needs to pay. The physical supply of water varies within a year and across years, and is now recognized to be in flux over the long term due to climate change (R. G. Taylor et al. 2012; Dawadi and Ahmad 2012). Within the limits and patterns of this physical supply, however, society has found many ways to manipulate the supply of water to meet economic demands be they human or ecosystem needs. These supply and demand management technologies vary in the cost of their application. Thus, although the physical supply of water is limited, the supply of water to meet economic demands is expandable. On the demand side, the willingness to pay for water supply varies with the economic use but at the higher end, such as domestic and industrial uses, the demand for water is inelastic meaning that the buyer will pay what is needed to meet the need. Due to population growth and economic development, water scarcity has increased. As a result the price of water paid in markets and the unit costs of supply and demand management alternatives deployed have also increased. Scarcity of water drives the willingness to pay for water, which in turn drives the market.

Physical scarcity is resource scarcity, implying that there is not enough water to meet economic demands. Legal scarcity is scarcity created by ruling a portion of the physical supply off limits to users.

Two types of scarcity are useful in discussing water: physical and legal. Physical scarcity is resource scarcity, implying that there is not enough water to meet economic demands. Legal scarcity is scarcity created by ruling a portion of the physical supply off limits to users. Legal scarcity is not in and of itself sufficient to drive market activity. It is still necessary that there be economic demand that exceeds the legal supply. In western US jurisdictions a variation on physical scarcity can be identified due to full or over-appropriation. In this case the amount of water rights granted legally exceeds the physical supply (at some time in the year and in dry years). The physical supply is then allocated in order of priority date with senior rights served first. In surface water systems, full (or over) appropriation along with the allocation of water available by priority date leads to physical scarcity of reliable water rights. Prior appropriation rights to surface water thus provide the critical enabling condition of scarcity for a water market.

However, the groundwater resource relative to annual demands presents an alternative source of supply to the surface water market. This is one of a number of potential explanations of limited trade in water in

the western US. Before exploring the variety of ways that scarcity is, or is not, created in surface and groundwater systems the mechanisms for creating legal scarcity are briefly summarized.

4.1.1 Mechanisms for Creating Legal Scarcity

Legal scarcity of water is created through limiting the amount of rights to the resource that are appropriated, or by regulating the annual allocations of water (below the amount of rights). Legal limits provide regulators with the opportunity to make some amount of naturally available water off-limits to entitlement holders, leaving that water in the system for environmental or other management goals, or merely reducing the overdraft on a groundwater system. Before discussing the particulars of scarcity in the western US it is useful to specify these in general terms. For a more nuanced discussion of how these mechanism are developed and applied in other regions of the world and how this compares with the western US please see Part III of this report (D. Pilz et al. 2016).

Limiting Rights. A legal limit on rights is a statutorily or other administratively defined limit on the amount of water that is permitted for diversion or extraction. In the western US this is typically referred to as *closing* rivers or aquifers to further issuance of rights. While the concept of a *closed basin* is generally well understood by water managers, many river basins and aquifers in the western US were not closed to further permitting until the resource was fully appropriated or over-appropriated. As pointed out earlier, the development imperative in the western US meant that the objective was to make maximum use of water and thus full or over-appropriation would be expected. More to the point, when it comes to surface water systems, the priority date system of allocation means that over-appropriation is more an annoyance than of consequence to water markets. The interruptible nature of junior rights mean that over time they typically fall out of use and are likely forfeit. Once market activity picks up these are often the first rights made available to unsuspecting buyers and simply serve to clutter the landscape. The real impact of over-appropriation is that felt by ecosystems as environmental flows are often the residual, unpermitted water user on the system.

Limits on groundwater rights are an important determinant of overall water scarcity. In the western US such limits are often based on the concept that only the annual groundwater recharge should be available for permitting. Such limits effectively aim for full appropriation of available water, leaving no recharge available – at least in theory – for non-permitted uses such as vegetation and springs. Such systems are less than ideal but still superior to those were no limits on groundwater rights are in place. Creating legal scarcity for groundwater is vitally important given that the groundwater resource represents a long term storage account and is linked to surface water flows. When the issuance of rights is unlimited, groundwater withdrawals may exceed recharge rates which will increase costs for other users in the short term as wells are deepened and pumping heads increased, lead to reduced streamflow and impacts on senior surface water users and residual environmental flows and eventually result in absolute resource scarcity when the resource is consumed. Further, if obtaining a groundwater right is always an option then this creates a large loophole for new water users that would otherwise need to turn to the market to meet their demand.

The real impact of over-appropriation is that felt by ecosystems as environmental flows are often the residual, unpermitted water user on the system.

A final observation with regard to limits on new rights is that even when such restrictions are in place, through statute or rule, the rights given out may exceed these limits. This can occur for a number of reasons including that the rules were put into effect after the rights were handed out, a lag between the

rule and the quantification of the limit, or contingencies and conditions that enable exceptions to the rules.

Limiting Use. If too many rights were issued then one obvious option is to limit the annual allocations of water to these rights. The Oregon case study provides an example of these statutory authorities with respect to surface water and groundwater, including their hydrologic connection (Box 5). With Prior Appropriation surface water rights this is achieved in basic form by regulating water rights in order of priority. But, this does not really constrain water use below physical availability. Limiting surface water use below the minimum of physical availability and issued rights occurs typically in the presence of specific regulations. These emerge, for example, in the case of actions under the Endangered Species Act or the Clean Water Act.

Box 5: Regulation and Curtailment of Authorized Use in Oregon

After a water right has vested, the state has only limited authority to regulate or curtail the water use. Under traditional principles of Prior Appropriation, during times of shortage, OWRD may regulate and distribute water in priority date order among users holding water rights for the same source (ORS 540.045). The principle applies to both surface and groundwater rights but, obviously, is more readily and easily accomplished with respect to surface water uses. Groundwater may be regulated in favor of senior surface water rights when OWRD can demonstrate a clear hydraulic connection between the two sources (OAR 690-250-0120(2)). However, because of the difficulty of establishing the extent and timing of groundwater impacts to surface water, groundwater to surface water regulation occurs infrequently. Groundwater-to-groundwater regulation is similarly infrequent, but for different reasons. Oregon requires a groundwater user to fully penetrate the aquifer before the state will take action to curtail groundwater use by a junior user. Thus, even when the pumping of a junior well is shown to interfere with pumping from a senior well, the senior user may be required to deepen the pump or reconstruct the well before OWRD will intervene to regulate.

In addition to its authority to regulate and distribute based on priority dates, OWRD holds substantial regulatory authority to address or prevent excessive groundwater declines by establishing a "Critical Groundwater Area" (ORS 537.730-537.742). The process requires findings to document excessive declines in groundwater quantity or quality, or to prevent over-appropriation of the groundwater source (ORS 537.730(1)). The determination is made through formal rulemaking procedures that include public notice and opportunities for comment by affected groundwater users and the general public (ORS 537.730(2)). The rules may include various types of corrective actions including closure of the area to new groundwater appropriation and limitations on the total quantity of groundwater that may be withdrawn per year, regardless of priority date (ORS 537.735(3)). Thus, even senior wells can be curtailed under rules implementing the Critical Groundwater Area determination.

Source: verbatim from Pagel (2016, 4)

In the case of groundwater the imposition of limits on granting rights is effectively an action to constrain the annual use of the resource. The ability to limit pumping below the level of issued rights will depend on the authority of the state to curtail groundwater use. Typically such curtailments will be driven by a designation of an aquifer as *critical* based on one of two cases. The first would be authority to manage groundwater use against a varying aquifer yield (or recharge) amount reflecting some desired level or state of the aquifer. The second would be authority to regulate groundwater use in favor of downstream surface water uses that rely on discharge from the aquifer.

Retiring Rights. A more permanent version of regulating water use is to permanently retire issued water rights. This can be done in one of two ways. First is to cancel existing rights to bring appropriations in line with the desired limit. The second is to buy and transfer rights to environmental flows. Buying junior rights shores up the residual use by the environment. Buying senior rights restores environmental

flows in a more proactive fashion. The main point is that in the western US, options under current state and federal law as well as the US Constitution, are limited in the way of involuntary and uncompensated retirement. The expropriation of a right or reduction in the amount of water available to a right is largely barred under bedrock principles of law, including constitutional prohibitions on taking property without just cause and/or compensation.

4.1.2 Legal Limits on Surface Water

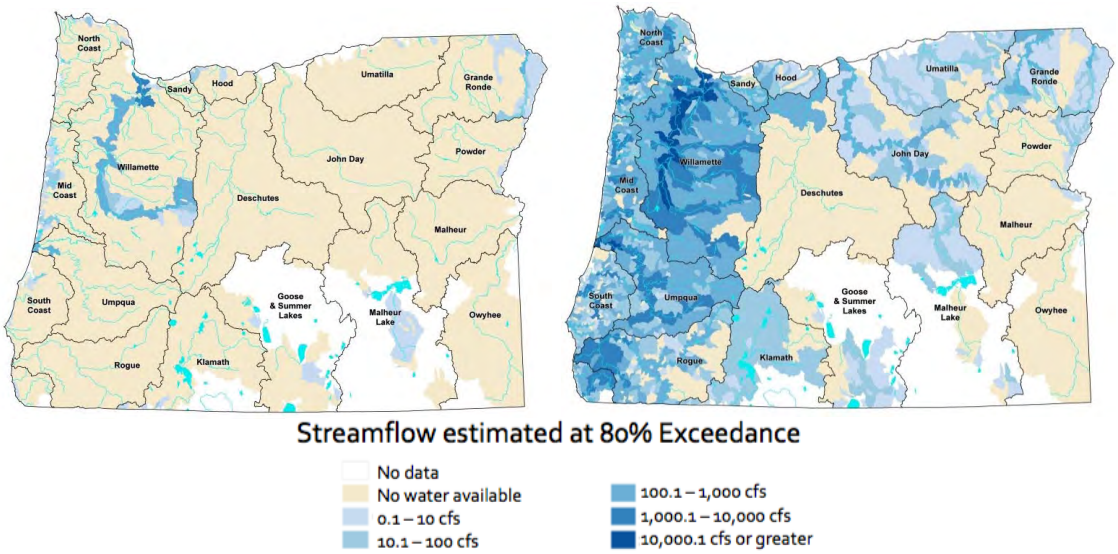
Across the western US the relative success of the early attempt to fully (or over) appropriate surface water varies with the basin context. Prior appropriation does not mean that rights necessarily were (or had to be) issued ad infinitum. In practice this varied by jurisdiction as a number of examples demonstrate.

The case of the Deschutes River in Oregon demonstrates that the idea of closing a basin is not a new idea. The main stem of the Deschutes was closed to further appropriation in 1913 by the state. The closure was made at the request of the federal government, which reserved future rights for irrigation development. These 1913 natural flow rights were not permitted until a Reclamation project was developed after World War II. However, no subsequent permits were issued on the river above Bend, Oregon after that point. Despite the closure the river is fully or over-appropriated at Bend. Ample winter storage on the Deschutes, however, ensures that most surface water users are well supplied with water in all but dry years.

Many years later the state of Oregon instituted a statutory obligation to limit appropriations based on water availability. A regulatory process, as well as the data and formulae for determining if further surface water rights were available, was developed setting the rules by which a stream or river was closed to further appropriation (Cooper 2002). The Oregon procedure also incorporates the junior instream water rights on the stream in the determination. As Oregon is generally regarded as a well-watered state the application of these water availability methods confirm the proposition that water is scarce in the western US (Figure 5). Maps for water availability show that most of the state is closed for summer rights and that water may only be available in the winter west of the Cascades where winter rainfall is abundant. Efforts in Oregon have now proceeded to investigate how to protect winter peak flows. While such efforts by states like Oregon have obviously come late in the day, this example highlights that transparent and replicable rules and procedures for closing basins exist and can include explicit efforts to limit the continued erosion of environmental flows.

Despite the implementation of statutory limits on appropriation in some states, others have adopted systems that make such a proposition hard to effectuate. For example, Colorado enables a class of rights called *conditional rights*. These are rights filed in anticipation of some future need, effectively serving as placeholders rights (G. J. Hobbs 2015). The language governing the requirements for extension of conditional rights was tightened somewhat in 1990 (Grantham 2016). But as with water right applications in many states these filings tend to stay on the books. Absent formal complaints to the contrary, state administrators rarely take the time to scrutinize the progress of permits towards proof of beneficial use and cancel those permits not making satisfactory progress. As if enough developed rights, or *absolute* rights as they are called in Colorado, have not been granted on streams and rivers across the state, many more conditional rights lie in waiting. In sum, the extent to which streams and rivers are fully or over-appropriated and the implications for environmental flows varies across the western US.

FIGURE 5: SURFACE WATER RIGHT AVAILABILITY IN OREGON: AUGUST (LEFT) AND JANUARY (RIGHT)



Source: OWRD (2012)

4.1.3 Legal Limits on Groundwater

By the 1950s streamflow issues due to surface water appropriation were a known issue. It is therefore not surprising that as states began permitting groundwater rights, concern over the possibility of allocating too many groundwater rights and groundwater mining emerged. Prior appropriation states therefore generally include some form of statutory authority to limit either the granting of groundwater rights or a regulatory mechanism to limit annual allocations. Examples below, drawn from the Nevada and Oregon case studies, illustrate limits on rights and allocations. Meanwhile, brief review and examples of groundwater limits in states that administer groundwater by means other than Prior Appropriation is provided in Box 6

In Nevada just approximately half of the hydrologic basins have *designated* status, meaning that the basin is in need of further administration, typically due to over appropriation (Nevada Legislative Counsel Bureau 2016). In the Truckee and Carson hydrologic regions all but three of the basins are designated and almost two-thirds of these are over appropriated (at 110% of perennial yield estimate or higher). A specific example comes from the Tracy Segment Basin just downstream from the Reno-Sparks metropolitan area. In 2012 the State Engineer approved a permit for 2,700 acre-feet out of a total of 11,000 AF of requested groundwater rights. The permit application came from the Tahoe Reno Industrial Center (TRIC), the future site of a Tesla Motors battery plant. In the ruling the State Engineer determined that the amount applied for, along with a number of applications, exceeded the sub-basin perennial yield and denied all but 2,700 AF of the TRIC application (T. Taylor 2007). In other words, the Tracy Segment Basin in which TRIC is located is now closed to further groundwater appropriation, souring the prospects for other pending groundwater applications. This example also demonstrates the practical difficulty of quantifying such perennial yield limits. Studies of recharge amounts using a variety of methods suggested that perennial yield could be anywhere from 2,000 AF to 22,000 AF. The State Engineer's decision – that the perennial yield should be 11,500 AF – ultimately emerged from a somewhat unavoidably subjective application of simple statistics to just a handful of data points. The firm limit drawn by the State Engineer also drew on a Ninth Circuit Court decision supporting the Pyramid Lake Paiute Tribes claim that approving additional groundwater rights would represent a takings of the Tribes senior downstream surface water rights (Sanchez, Aylward, and Springmeyer 2016).

The case study from the Umatilla Basin in Oregon illustrates how existing rights may be curtailed in the face of rapid decline in aquifer levels (Pagel 2016). The Umatilla Basin lies alongside the Columbia River in northeast Oregon and is the most productive agricultural area the state, apart from the wet Willamette Valley. Large-scale development of groundwater led to the designation of four critical groundwater areas over a fifteen-year period starting in 1976. The designations affected some 63,000 irrigated acres of permitted rights. Over time, tribal concerns over flows and salmonid populations in the Umatilla River and the listing of 13 species on the Columbia River only accentuated the need to limit groundwater use. In recent years the annual cutbacks in allocations have been on the order of 70% of existing rights, a curtailment of 127,000 AF. The curtailments are designed to satisfy an annual determination of the sustainable annual yield. Irrigators must apply each year and a number of factors, including priority date, are taken into account in making annual allocations. Remarkably little trade in these allocations has emerged. In part this is due to rigidities in the applicable law. A senior right holder could sell their allocation to a junior right holder, however when the junior right holder attempts to extract the groundwater the use would be deemed out of priority by the state watermaster, and therefore an illegal use. As noted in the case study, this impediment drove stakeholders to pursue a series of alternatives most recently including an ill-fated and expensive groundwater recharge and recovery project.

These examples from Prior Appropriation states, as well as those from other states cited here and in Box 6 demonstrate that holding the line on firm levels of groundwater appropriation or allocation often are linked to regulatory actions or judicial cases. It is therefore not clear whether states hold the line quite as well in basins that do not have endangered species or downstream compact delivery issues. In other words legal limits seem to apply where downstream users are affected by and take notice of groundwater use upstream. Limits for the sake of groundwater users per se seems to be another task entirely.

4.2 Alternatives to Markets

In choosing how to meet their water needs most users will evaluate their alternatives and choose the method that meets their needs at the lowest cost, taking account of the inconvenience of doing so (i.e., the transaction costs that must be borne). If viable and low cost supply alternatives exist the buyer will likely develop a new water use and right in place of purchasing an existing right. If the buyer can improve the efficiency of their existing uses and meet new needs that is also a potential solution. Scarcity is therefore not just a question of physical and legal scarcity but also a question of the scarcity of viable and affordable alternatives for supply and demand management (as per Figure 3). This suggests one reason why trade in many water markets in the western US is limited or infrequent. There may simply be too many other alternatives that, when all things are considered, are more attractive than attempting a water rights transaction. The root cause then may arise from the perceived advantages of the market versus the alternative.

As the market price of water increases so will the economic viability of remaining supply and demand management alternatives.

On the market side, reluctance to engage may stem from high offer prices; unduly high transaction costs in the market, or simple fear of and unwillingness to engage in water marketing. For example a municipality fearing a socio-political backlash to engage in buy and dry transactions may choose a much more expensive water reuse alternative. This is a different case entirely than when a municipality includes the costs of addressing third party effects of buy and dry into the municipality's cost calculations and concludes that the reuse alternative is less expensive, other things equal. In the former case it is hard to know if using the market would have been better for ratepayers. In the latter case the water market was not the best, or healthiest, choice and the selection of the reuse alternative is logical

Box 6: Limits on Groundwater Use in non-Prior Appropriation States

Right of Capture. Despite the common law history of Rule of Capture in Texas the legislature has over time attempted to regulate groundwater use leading to questions as to exactly how or where the legislature can limit common law rights (Hardberger 2016). In the case of the Edwards Aquifer a lawsuit in the early 1990s under the Endangered Species Act led to a court order to restrict pumping from the aquifer to benefit species reliant on springs fed by the aquifer. The legislature created the Edwards Aquifer Authority and instructed the authority to develop a system of permit capped at the pumping limit. The market in the resulting permits is a widely cited example of successful market-based reallocation of groundwater to protect the environment in the western US, and an instructive case for the analysis in this paper.

Unfortunately, a recent court finding against the Authority has raised questions as to whether capture is required to establish groundwater rights under common law as applied in Texas. The primary difference between the pure Rule of Capture and the Rule of Capture with the modification of Ownership in Place is that land ownership, not capture, is the basis for, and genesis of the legal entitlement to groundwater (Hardberger 2016). When landowners have an inherent right to water underlying their land without first capturing it, regulations that might restrict groundwater use may be challenged by landowners who have not captured and used any water even though these regulations have yet to impact the landowner. This could mean that efforts to regulate groundwater and limit pumping, as in the Edwards, may come in for large takings cases in Texas.

Reasonable Use. Statutory limits to these rights may be imposed. For example, Arizona's 1980s Groundwater Management Act establishes designated urban Active Management Areas. In these areas municipalities in overdraft are to carry out long term plans to return to safe yield. Water users outside the AMAs are left to pump without permits or limits. In Nebraska, natural resource districts administer groundwater permits. As described in detail in the Twin Platte case study, rights to withdraw groundwater in the High Plains aquifers in Nebraska may be limited due to groundwater-surface water interaction and the state's downstream compact requirements on the Republican River. As with the Edwards, in the Twin Platte District this regulatory action has led to market activity, in this case trade in permanent groundwater rights. Outside of these conjunctive management responsibilities, Nebraska districts are free to consider the rate to which they deplete the aquifer.

Reasonable Use and Correlative. In Oklahoma, the 1972 Groundwater Management Act allows aquifer depletion over a twenty-year time frame. In California, excess groundwater supply may be used on other than overlying lands, but this export of water is subject to priority date and not correlative shares (as is the use on overlying lands). The 2014 passage of the Sustainable Groundwater Management Act in California creates the institutional authority and the objective for the state to require groundwater management districts to manage towards sustainable yield over the long-term. How this will be implemented remains to be seen.

Sources: Blomquist (2016), Getches (1997), Hardberger (2016), R. Young (2016)

The availability and cost of supply and demand management alternatives will also greatly influence the level of market activity. It could be argued that once all feasible and low cost such alternatives are taken advantage of that then market activity will be robust. However, more likely is that such supply and demand management alternatives will never be exhausted, just as the number of potential sellers is never exhausted. Rather as the costs and benefits of engaging in market transactions vary over time so will the costs and benefits of the alternatives. For example, the cost of leasing water from alfalfa farmers will vary with the price of hay, which in turn is influenced by the price of beef, which in turn responds to population growth and culinary preferences. Similarly, the cost of piping of canals or ditches with high density polyethylene pipe will vary over time with the price of oil, given the resins that are used in production of the pipe. In some cases the market will be the most cost-effective alternative, in others it will

not. Over time the advantage will likely swing back and forth. As the market price of water increases so will the economic viability of remaining supply and demand management alternatives. The question of course is whether the costs and benefits of the alternatives are well accounted for, or if they are low cost because they involve loopholes in the system.

4.3 Loopholes: Escaping the Market

Loophole is a common term denoting the opportunity to avoid cost or pain by finding a way around a problem or a regulation. Finding loopholes to meet water need in a water scarce world is an art of sorts and, indeed, resembles a rent seeking activity. Find a way for a potential buyer of water rights to avoid having to make that purchase and the effort will be well rewarded. Loopholes are usually assumed to be legal as implemented but they are not necessarily healthy. Loopholes with respect to water rights resemble an externality, where the new user meets their need at low cost, while shifting the burden onto other uses and users.

One example is the constant push in the western US by state agencies and irrigators to build more storage facilities to address the expected shortfall in water supply due to climate change. The difficulty of course is that stored water is not necessarily *new* water but often water that previously went to another human or ecosystem use. If these uses were formally permitted then the building of storage would rest on some form of market trade, for example in winter rights. In many states winter flows are not permitted or protected and thus such projects are feasible on water rights grounds, even if they seem unlikely in terms of other regulatory permitting issues and construction costs. In other words the water market may be healthy, but if new storage can be built and a storage permit obtained (largely for free) then there is no incentive to engage in the market. Instead a supply option may be built and one that is itself not healthy in that it may lead to winter flow issues for fish and wildlife. An obvious step therefore, to turn this demand towards the market, is to permit these instream uses of water. This is the approach that a number of states have pursued including Oregon, Washington and Colorado. This eliminates an important loophole and makes the water market both more robust and in effect healthier.

Stored water is not necessarily new water but often water that previously went to another human or ecosystem use.

Permit exempt wells are a water use that falls outside the permitting system. The phrase *death by a thousand cuts* is evocative of this problem. While a few household wells here and there are relatively insignificant, the rapid development of peri-urban and rural areas in the west has often led to hundreds to thousands of such wells. Again these wells are in effect an external cost borne by those permitted groundwater right holders, a source of leakage from the aquifer and draw on streams that typically goes unmonitored and unreported. The connection between surface and groundwater and the impacts of these wells is increasingly a topic of litigation in the western US. With many states managing the two as separate resources, drilling wells is a simple end run around the need to buy water.

The state of Washington is perhaps in the vanguard of such efforts with respect to addressing the permit exempt well issue and conjunctively managing surface and groundwater. The state is developing instream flow rules basin-by-basin that protect streams from these deprivations. Importantly, the household demand represented by a permit exempt well is not denied entirely, rather it is redirected towards groundwater mitigation banks, which are not-for-profit or for-profit marketplaces that sell mitigation credits and use the proceeds to address the impacts of the wells on instream flows.

Another loophole is reported in the Treasure Valley case study from Idaho, where an active market has yet to emerge despite growing physical scarcity of water. As large areas of formerly irrigated land are

being converted to housing developments in Boise and surrounding cities and towns, the state and Reclamation have looked the other way as irrigation water rights have been used to meet lawn and other outdoor water uses (Fereday 2016). Rather than market and transfer the irrigation rights to M&I use, the irrigation districts continue diverting the irrigation water to developments. As the rate and duty of the old and new rights do not match up well this customary practice has not only forestalled the development of local water trade but creates questions about the long term security of these rights (Fereday 2016; Fereday and Creamer 2010)

There are of course many other such loopholes present that affect market activity in the western US. While they are legal they may represent a zero sum activity, in that they simply transfer costs to other parties. Protecting remaining environmental or community uses of water through permitting, recognizing the hydraulic connection between surface water and groundwater, and providing market-based mitigation opportunities would be proactive steps to address these loopholes.

4.4 Demands Omitted from the Market

Another way in which scarcity is reduced, leading to lower water trade – whether intentionally or unintentionally – is to sideline important demands from the market. In many basins in the west, a century of water resources development has left streams and rivers dewatered, along with a host of other environmental issues. Environmental uses of water or *environmental flows* were often not historically recognized as a legitimate use of water. For example, even today the constitution of the state of Idaho requires that in order to obtain a water permit, the prospective water use must be developed by diverting water from a watercourse. In many states there is a lack of statute, precedent or clarity about whether or not and how buyers may acquire water rights to rewater these streams and rivers (Szeptycki et al. 2015).

If environmental uses are not deemed to be permissible uses of water then it is not possible to protect existing environmental flows or, where streams and rivers are already dewatered, to use the water market to restore flow. A key enabling condition is therefore policy reform to ensure that water entitlements for environmental purposes can be created, held and exercised. Otherwise the environmental buyer cannot hold a right or transfer the right to the desired instream or environmental use and they will not participate in the market. If there is no path for such buyers to navigate within the federal hierarchy or within local irrigation districts to successfully complete transactions they will likewise be excluded from local markets.

For example, Congress typically authorized Reclamation storage reservoirs for irrigation use only. Such designations may also apply for the underlying states rights to store or release water. Anticipating the need for these rights to be temporarily transferred to other purposes, legislation in the 1920s provided a pathway for short-term leasing (see Box 7). Unfortunately, this work around can be difficult and time consuming to implement. A century later, with pressing water demands, this limitation on use of federal contract water seems out dated. A solution to enabling long-term changes to other uses would be ideal. A reservoir-by-reservoir solution would be an inordinately and unnecessarily difficult undertaking. That said any blanket reauthorization would need to be carefully studied in order to avoid unintended consequences for existing contract holders.

Another example of demand that is omitted from the market is the case of irrigation district or ditch company policies, whether explicit or implicit, that prohibit the sale and transfer of water rights to non-irrigation uses. These policies reflect concern over the impacts of taking water out of agriculture and putting it to municipal, industrial and environmental uses. These concerns arise from both practical and less practical considerations. Practical concerns include operations questions of maintaining the necessary flow in canal and ditch systems given transmission losses if water rights are removed. A further concern is the financial burden of running the operation with fewer members and the possibility that this will lead to increasing assessments paid by patrons. Economic concerns include the potential impact on the local

economy and tax base, though these are often overstated (MacDonnell 2008). Less practical considerations run the gamut from overblown concern for the world food supply to philosophical concerns about the use of water for fish and wildlife. While these concerns are more or less of a substantive nature they are largely based in uncertainty and fear over the future and the change that it might bring. Efforts to address these concerns take time and effort. If robust and healthy markets are desired, policy solutions that clearly set the rules of the game for these types of transactions would be useful for all concerned. Box 8 provides a discussion of the potential to address the financial concerns through exit or termination fees. As noted in the box, a straightforward business-like solution is simply to require a reasonable payment to remove water from irrigation districts and ditch companies. Similar efforts to address the other concerns of irrigators and rural communities are necessary, however, there is a difficult balance to be struck between the expressed needs and the policy imperative to meet changing needs for water that reflects somewhat the question of security versus flexibility of water rights as discussed in later sections.

Box 7: 1920s Act: Temporary Reallocation of Federal Contract Water in the Western US

The Reclamation Act of 1902 led to the establishment of the Bureau of Reclamation as a means to fund and construct large storage, hydropower and irrigation projects across the western states. Congress has typically authorized these reservoirs for a purpose of use that is irrigation only. Changing this authorization in order to move water to municipal, industrial or environmental uses therefore requires Congressional action, serving as a considerable hurdle to market-based reallocation of these stored waters to new uses.

In 1905 the Elephant Butte project was authorized by Congress. The project is on the Rio Grande River in New Mexico, located upstream from the city of El Paso, Texas. The project was completed in 1915 and was authorized for irrigation only. Concerns over the water supply for El Paso soon after the reservoir was built led to plans to attempt to meet municipal demands from Elephant Butte reservoir. To this end the Congress passed the 1920 Act that amended Reclamation law. The text of the provision is often referred to as the 'Sale of Water for Miscellaneous Purposes Act of 1920.' The legislation authorizes the Secretary of the Interior (the presidentially appointed director in charge of the government arm that manages the Bureau of Reclamation) to enter into contracts to supply water from any project irrigation system for purposes other than irrigation, subject to the following conditions:

- the use is not detrimental to irrigation:
- there is no other practicable source of water supply:
- there is prior approval by the appropriate water district; and
- money from such contracts is put into the Reclamation Fund, crediting the project supplying the water.

In 1988 the Department of Interior issued a set of principles that govern voluntary water transactions that involve or affect facilities owned or operated by the Department of the Interior. These lay out a series of principles, criterion and guidance for entities considering such transactions. While originally intended for thirsty municipalities, in recent years the Act has also been deployed to assist in temporarily transferring water to environmental flows. In Oregon, the Oregon Water Trust and the Deschutes River Conservancy have deployed the 1920s Act as part of efforts to restore environmental flows. These entities have worked with Reclamation and irrigation districts to lease stored water that is authorized for irrigation purpose only to an instream purpose under state administrative procedures. The process involves meeting the four requirements listed in the Act.

Source: Bureau of Reclamation (1995)

Box 8: Exit or Termination Fees

The idea of an exit or termination fee for moving water rights off a shared conveyance or out of an irrigation district or ditch company is relatively straightforward. Entities that deliver irrigation water incur a variety of fixed costs associated with operating the infrastructure and depend on water right holders to cover these costs. Therefore, the payment of an exit fee would assist the operator to defray these costs and provide a time frame over which adjustments could be made to the assessment fee structure so as to minimize the impact on other members. Establishing the actual the terms of an exit fee can be more complicated, however, particularly as relates to the future time frame over which assessments would be covered and the rate at which these future assessments are valued at the time of payment.

Actual implementation of exit fees in the western US is limited. Non-irrigation entities buying water rights in irrigation districts may agree to continue paying assessments as the simplest approach. Irrigation districts and ditch companies are often reluctant to allow the purchase and transfer of rights off of their systems. In the Deschutes Basin in Oregon an exit fee was set up with two irrigation districts for the extraction of water by municipalities and the local river conservancy. The water rights went for groundwater mitigation and instream transfers. The fees were high, almost as much or more than the costs of buying the water from willing district patrons.

Montana currently has in place a rule that includes a present value formula for calculating exit fees for the exclusion of lands from future irrigation district assessments (ARM 36.12.109). The present value formula is based on:

- Proportional share of present value of any debt owed by the district; and
- Present value of O&M expenses calculated as follows:
    - based on average of O&M costs for prior three years (before exit);
    - inflation of these costs at the average growth rate of CPI over prior ten years;
    - a time horizon of 20 years; and
    - a discount rate equal to the prior ten-year period for the 10-year Treasury notes.

Another example comes from Australia. In 2009, Australia established Water Charge (Termination Fees) Rules, which are intended to cover the fees payable by irrigators when they terminate their right to access an irrigation delivery operators' system. These rules cap the exit fee amount that can be charged, requiring that it be equal to or less than 10 times the total network access charge for the year in which termination of rights occurs. The justification for this choice is that it delivers the operator between 12 to 15 years of access fees, which provide "an extended period of revenue stability for IIOs [operators] and fee stability for irrigators."

Source: ACCC (2009, xvi), Aylward (2006)

4.5 Summary

Prior Appropriation relies on full or over-appropriation of legal rights to surface water. As such it is the physical scarcity of surface water to fill these rights that drives market activity. However, water is not scarce if groundwater is freely available. Thus, scarcity and the incentive to engage in markets to meet water demand rests with the groundwater code. Here there is considerable diversity across the states, with some handing out rights only up to some notion of an annual pumping limit and others allowing new uses without regard to any limit. A further issue is where states administer surface water and groundwater as separate resources. In this case new groundwater users not only avoid the need to turn to the surface water market to obtain water, but their pumping eventually takes water from senior surface water users. The trend over the last couple of decades is to move towards conjunctive management and to allow new groundwater uses only when they are offset by reductions in surface or groundwater uses. Closing both

resources to new appropriations and allowing groundwater offsets represents a step towards prudent management and creates legal scarcity that enables market activity.

The physical or legal aspect of scarcity varies across jurisdictions and basins. Scarcity not only motivates markets, but the search for other innovative supply and demand management alternatives. Many such alternatives exist and may appear less expensive than the market. Add to this the many imperfections and inefficiencies of the market and it is not surprising that much demand goes to these alternatives or towards finding loopholes to enable new supply. The result is that market activity is less than might be expected. Further it is likely that with regard to alternatives and loopholes one of two situations applies:

1. The resource costs of satisfying new uses through supply and demand management alternatives is unnecessarily high given the lower value of marginal uses of water in many basins (and therefore the lower resource costs if markets were enabled).
2. The cost of satisfying new uses through loopholes appears low to those meeting new demands, but this gives a false picture of the costs of this activity as the loophole externalizes costs onto other water uses and users, particularly the environment.

And finally, the exclusion of demands from markets will reduce scarcity and market activity. More to the point, closing markets to environmental and other demands leads to unmet demands and pressure to convey these demands through other routes, including litigation and policy reform. Given the political economy of water, the shutting down of one avenue, i.e. markets, simply leads actors and unmet demands to pursue other avenues. Closing of the economic route forces the demand into the political and judicial arenas.

5. Well Defined, Secure and Flexible Property Rights

This section explores whether property rights to water in the western US are well defined and the degree to which they are secure and/or flexible. A system of well-defined and enforceable property rights is foundational for a functioning water market (Coase 1960; Culp, Glennon, and Libecap 2014; Grafton et al. 2010; Libecap 2005; Libecap 2010; National Water Commission 2011). Whether or not a water right can be defined, enforced, and transferred is directly related to whether the right is measurable and excludable (McCann and Garrick 2014). In general the right to use water is well defined in the western states. In theory the rights are also extremely secure. However, there are a series of practical issues which when present in a particular jurisdiction or basin undermine the security of these rights and therefore may undermine market activity. While security of rights will enhance market activity it does necessarily promote healthy markets. The extreme degree of security provided to water rights in western states suggests that these rights are not flexible from the perspective of public policy, potentially putting private interests over that of public interests and limiting the ability of public policy to adapt to changing circumstances. This topic is explored at the end of the section.

While security of rights will enhance market activity it does necessarily promote healthy markets.

5.1 Property Right Definition

In the western US, rights to divert or store surface water, and to extract groundwater, are typically described by a number of elements, including:

1. The name of the owner of the right; and
2. The parameters of the permitted use, including:
    a. the source of water (e.g., river, lake, aquifer);
    b. the location of the withdrawal from the water system (e.g., point of diversion, location of well, location of dam);
    c. the amounts of the withdrawal specified as one or more of the following:
        i. a maximum instantaneous flow rate (e.g., in cubic feet per second);
        ii. for irrigation, a duty or volume per unit area (e.g. acre-feet per acre); and
        iii. a total volume per year (e.g., in acre-feet);
    d. the period during the year in which the withdrawal is permitted or a 'season' of use;
    e. the type of use (e.g., domestic, irrigation, commercial);
    f. the place of use (i.e., the fields on which irrigation water will be used, the service area of a municipality);
    g. for irrigation, the extent of use in terms of the area to be irrigated (e.g., in acres); and
    h. the priority of the use or users in relation to other uses/users (i.e., rules for how the burden of shortage is shared/distributed among users or uses).

The use of these elements dates back to the first certificates issued in the early 1900s. Examples of a surface water irrigation right certificate from the Deschutes Basin of Oregon and a municipal groundwater right certificate from the Truckee River Basin of Nevada with these elements outlined are provided in Figure 6 and Figure 7. States have used these elements to administer water uses and regulate transfers for over a century. Clearly defined property rights define the unit of trade in a market, reduce transaction costs, and reduce uncertainty. In the Truckee-Carson water market, as with other markets,

water transfers are in part possible because water rights quantities, locations, types of use, and priorities for water are well defined (Sanchez, Aylward, and Springmeyer 2016). While Prior Appropriation has its issues these do not originate from lapses in the description of the water entitlements. These property rights are well defined.

Still, the manner in which these rights are defined may, or may not, favor market activity. Issues of cost and timeliness, and hence market efficiency, in administering transfers (as discussed in Section 6.2) originate in part from the definition of these rights. Perhaps the best way of putting it is to ask the question of whether altering how the rights are defined might make them easier to transfer and then to trade.

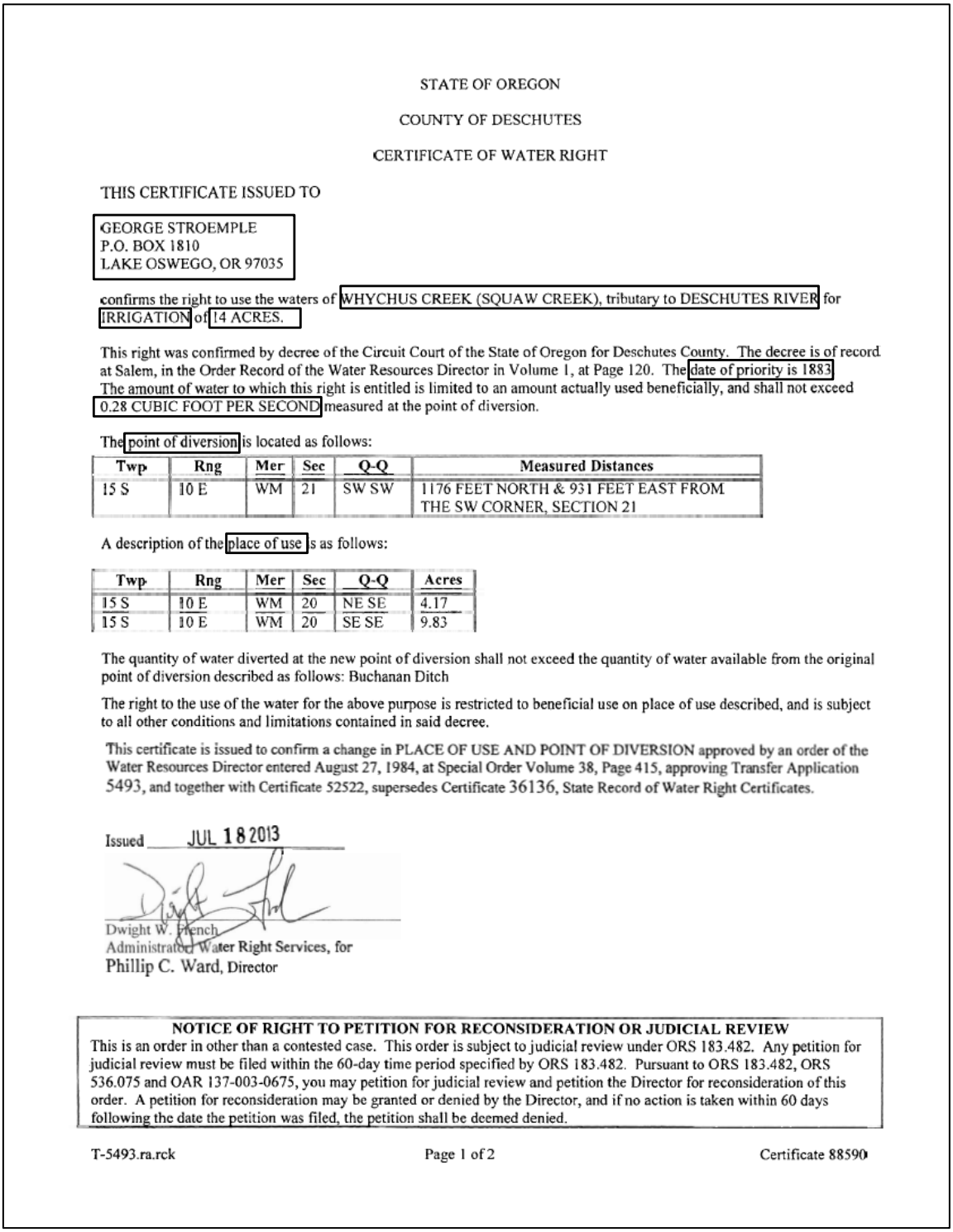
For example, as discussed in Part III of this report, Australia defines irrigation rights as consumptive volumes at the point of diversion (or "take"). This greatly simplifies water trading as the consumptive use amounts are made explicit when the right is issued. All trades are then by definition in consumptive units and water can be moved from one point of diversion to another with only an adjustment for channel loss. This is not the case with irrigation rights in the US and indeed arguments over consumptive use and injury can bedevil water rights transfers in the western states. However, as pointed out by Pilz et al (2016) the ability to define rights this way in Australia emerges from the entire history of, and framework for, managing water in Australia, as well as the hydroecological setting.

Moving to a consumptive volume basis at the point of diversion within the context of Prior Appropriation and associated groundwater regimes would be a very significant undertaking, perhaps implying a revamping of the entire water code. Thus while an alternative definition of appropriative rights would make western water rights easier to transfer and trade, the feasibility of changing the entire water right system at this stage is very low.

The idea of consumptive rights, however, is valuable, particularly with respect to whether there are ways to take advantage of this idea in adapting aspects or portions of the current system to such an approach short of a full rewrite of the water code (Culp, Glennon, and Libecap 2014). To some extent, the specification of the consumptive use that accompanies rights may occur organically in locations where repeated transfers of similar rights take place. In these cases, the quantification of the amount that is transferable is generally known and, exceptions aside, provides a degree of predictability that enables trade. The Australian system is certainly elegant in that no effort need be expended to understand the tradable and transferable amount under a water right. Under Prior Appropriation more effort is needed to develop this information, but once the investment is made and the information is available the issue may be minimized.

In sum, the nature of irrigation rights in the US west is that they are separable into consumptive and non-consumptive portions. However, these portions are not defined in the right itself. The non-consumptive portion represents supply to other rights in the system. The transfer of this portion will then be conditioned to avoid injuring other existing rights. The problem is not the science or the need for the exercise of injury review. In terms of the interplay of hydrology and property this review is necessary, and healthy, however arduous it may be. The issue is rather that these quantities are not well defined, and thus subject to back and forth between users and regulators. This can lead to costly and time-consuming transfer processes. There is thus a tradeoff between protecting the rights of existing users and the cost and time required to do so, and the impacts of this process in terms of increasing transaction costs and serving as a brake on market activity.

FIGURE 6: EXAMPLE OF AN IRRIGATION SURFACE WATER RIGHT (FROM OREGON)



STATE OF OREGON

COUNTY OF DESCHUTES

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

GEORGE STROEMPLE
P.O. BOX 1810
LAKE OSWEGO, OR 97035

confirms the right to use the waters of WHYCHUS CREEK (SQUAW CREEK), tributary to DESCHUTES RIVER for IRRIGATION of 14 ACRES.

This right was confirmed by decree of the Circuit Court of the State of Oregon for Deschutes County. The decree is of record at Salem, in the Order Record of the Water Resources Director in Volume 1, at Page 120. The date of priority is 1883. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.28 CUBIC FOOT PER SECOND measured at the point of diversion.

The point of diversion is located as follows:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
15 S	10 E	WM	21	SW SW	1176 FEET NORTH & 931 FEET EAST FROM THE SW CORNER, SECTION 21

A description of the place of use is as follows:

Twp	Rng	Mer	Sec	Q-Q	Acres
15 S	10 E	WM	20	NE SE	4.17
15 S	10 E	WM	20	SE SE	9.83

The quantity of water diverted at the new point of diversion shall not exceed the quantity of water available from the original point of diversion described as follows: Buchanan Ditch

The right to the use of the water for the above purpose is restricted to beneficial use on place of use described, and is subject to all other conditions and limitations contained in said decree.

This certificate is issued to confirm a change in PLACE OF USE AND POINT OF DIVERSION approved by an order of the Water Resources Director entered August 27, 1984, at Special Order Volume 38, Page 415, approving Transfer Application 5493, and together with Certificate 52522, supersedes Certificate 36136, State Record of Water Right Certificates.

Issued JUL 18 2013

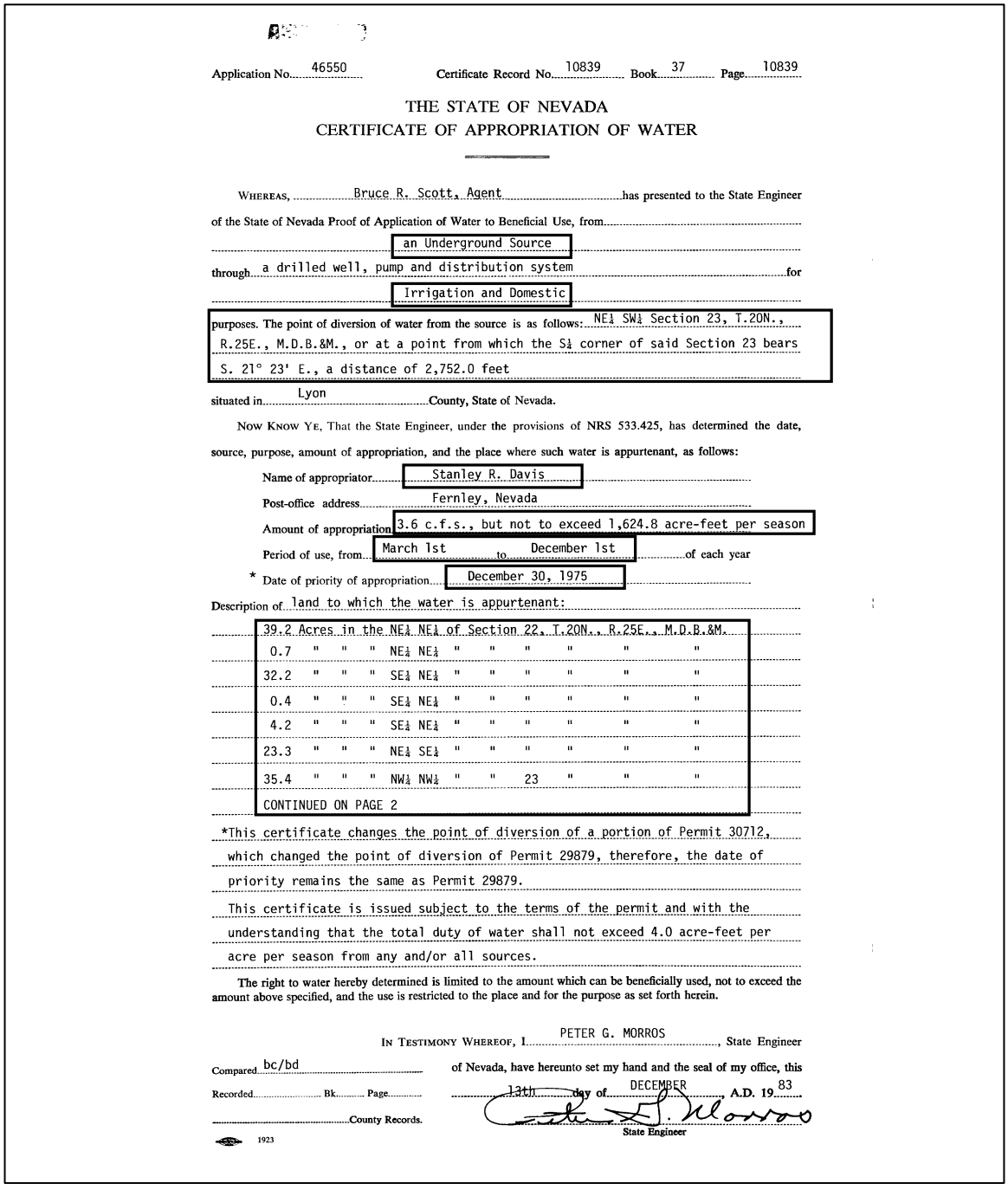
Dwight W. French
Administrator, Water Right Services, for
Phillip C. Ward, Director

NOTICE OF RIGHT TO PETITION FOR RECONSIDERATION OR JUDICIAL REVIEW

This is an order in other than a contested case. This order is subject to judicial review under ORS 183.482. Any petition for judicial review must be filed within the 60-day time period specified by ORS 183.482. Pursuant to ORS 183.482, ORS 536.075 and OAR 137-003-0675, you may petition for judicial review and petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

T-5493.ra.rck Page 1 of 2 Certificate 88590

FIGURE 7: EXAMPLE OF A MUNICIPAL GROUNDWATER WATER RIGHT (FROM NEVADA)



Application No. 46550 Certificate Record No. 10839 Book 37 Page 10839

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Bruce R. Scott, Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from an Underground Source through a drilled well, pump and distribution system for Irrigation and Domestic purposes. The point of diversion of water from the source is as follows: NE¼ SW¼ Section 23, T.20N., R.25E., M.D.B.&M., or at a point from which the S¼ corner of said Section 23 bears S. 21° 23' E., a distance of 2,752.0 feet situated in Lyon County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator: Stanley R. Davis
Post-office address: Fernley, Nevada
Amount of appropriation: 3.6 c.f.s., but not to exceed 1,624.8 acre-feet per season
Period of use, from: March 1st to December 1st of each year
* Date of priority of appropriation: December 30, 1975

Description of land to which the water is appurtenant:

39.2	Acres	in the	NE¼	NE¼	of Section	22,	T.20N.,	R.25E.,	M.D.B.&M.
0.7	"	"	NE¼	NE¼	"	"	"	"	"
32.2	"	"	SE¼	NE¼	"	"	"	"	"
0.4	"	"	SE¼	NE¼	"	"	"	"	"
4.2	"	"	SE¼	NE¼	"	"	"	"	"
23.3	"	"	NE¼	SE¼	"	"	"	"	"
35.4	"	"	NW¼	NW¼	"	"	23	"	"

CONTINUED ON PAGE 2

*This certificate changes the point of diversion of a portion of Permit 30712, which changed the point of diversion of Permit 29879, therefore, the date of priority remains the same as Permit 29879.

This certificate is issued subject to the terms of the permit and with the understanding that the total duty of water shall not exceed 4.0 acre-feet per acre per season from any and/or all sources.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I PETER G. MORROS, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 13th day of DECEMBER, A.D. 19 83

Peter G. Morros
State Engineer

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5.2 Security of Property Rights

Security of rights is underpinned by a number of factors. First and foremost is the strong protection for property under the US constitution and the duration of water rights in perpetuity. Secondly, the security of rights depends on the adjudication of rights, and the effective administration and enforcement of the priority system.

5.2.1 Property Rights and Takings

The Fifth Amendment to the US Constitution, along with many individual state constitutions, provides strong protections for private property rights. Not only does the Fifth Amendment to the US Constitution protect against outright takings or physical occupation of property by the government, but in some cases it also protects against government regulations that render private property economically worthless (Echeverria 2014). The extent to which regulations can be found to be takings is a critical analysis when thinking about changes to water rights allocations in the western US

While a full elaboration of regulatory takings is outside of the scope of this paper, there are several important concepts to understand. First, the burden of a regulation must be evaluated "in relation to the parcel as a whole" as well as in relation to amount of economic harm caused by the regulation (*Penn Central Transportation Co. v. New York City 1978*). In other words, it is critical to define the property at issue, and what exact impact a regulation has on that property before applying a takings analysis. And, while the protection of property rights afforded by the Constitution is strong, regulatory takings are generally only found in "extreme circumstances" (*United States v. Riverside Bayview Homes, 124 1985*). It is also important to note that state and federal constitutions do not completely bar takings, but rather require that takings must be compensated.

To date, there has been one federal court case that found a government restriction on water withdrawals to be a taking. In *Tulare Lake Irrigation District v. United States (2001)*, a federal claims court upheld takings claims based on ESA-imposed restrictions on water deliveries from the Sacramento-San Joaquin Delta. This case was not appealed and has not been addressed by a US Appeals Court or the US Supreme Court. A Texas case found a regulatory taking when the Edwards Aquifer Authority refused to issue a groundwater permit under newly enacted Groundwater Conservation District legislation (*Bragg v. Edwards Aquifer Authority 2010)*. In the Bragg case, after an appeal and a remand on the issue of compensation, the court found that the Braggs were owed $4 million dollars for the regulatory taking based on the difference in value between land with full water rights and land without water rights (Hardberger 2016).

Takings are not barred, but rather constrained by the requirement that the government compensate those whose property has been taken.

On the other hand, state courts deciding cases in the water resources context have found that the so-called *public trust doctrine* can be a defense against regulatory takings claims. The essence of the public trust doctrine is that there are background limitations on the use of private property interests in public trust resources like water (Echeverria 2014). In National Audubon Society v. Superior Court, the California Supreme Court found that the state's "continuing supervisory control" over water resources in the public trust "prevents any party from acquiring a vested right to appropriate water in a manner harmful to the interests protected by the public trust" (*National Audubon Society v. Superior Court 1983*).

Based on this brief discussion, several important conclusions emerge. First, the application of regulatory takings jurisprudence to water allocation in the western US is far from settled law. It can vary by state and

even the US Supreme Court has not made a definitive modern judgment on the application of the Fifth Amendment to water regulation. While some courts have found regulatory takings for changes in water laws, others have found such changes to be prevented by the public trust doctrine. Thus, in addition to analyzing federal takings law, each state's laws are critical in predicting whether changes to water law will amount to regulatory takings. It is also important to emphasize that takings are not barred, but rather constrained by the requirement that the government compensate those whose property has been taken. Based on the outcome of the Bragg case in Texas, this may operate as a bar because most states cannot afford large-scale compensation for takings challenges.

5.2.2 Duration of Rights

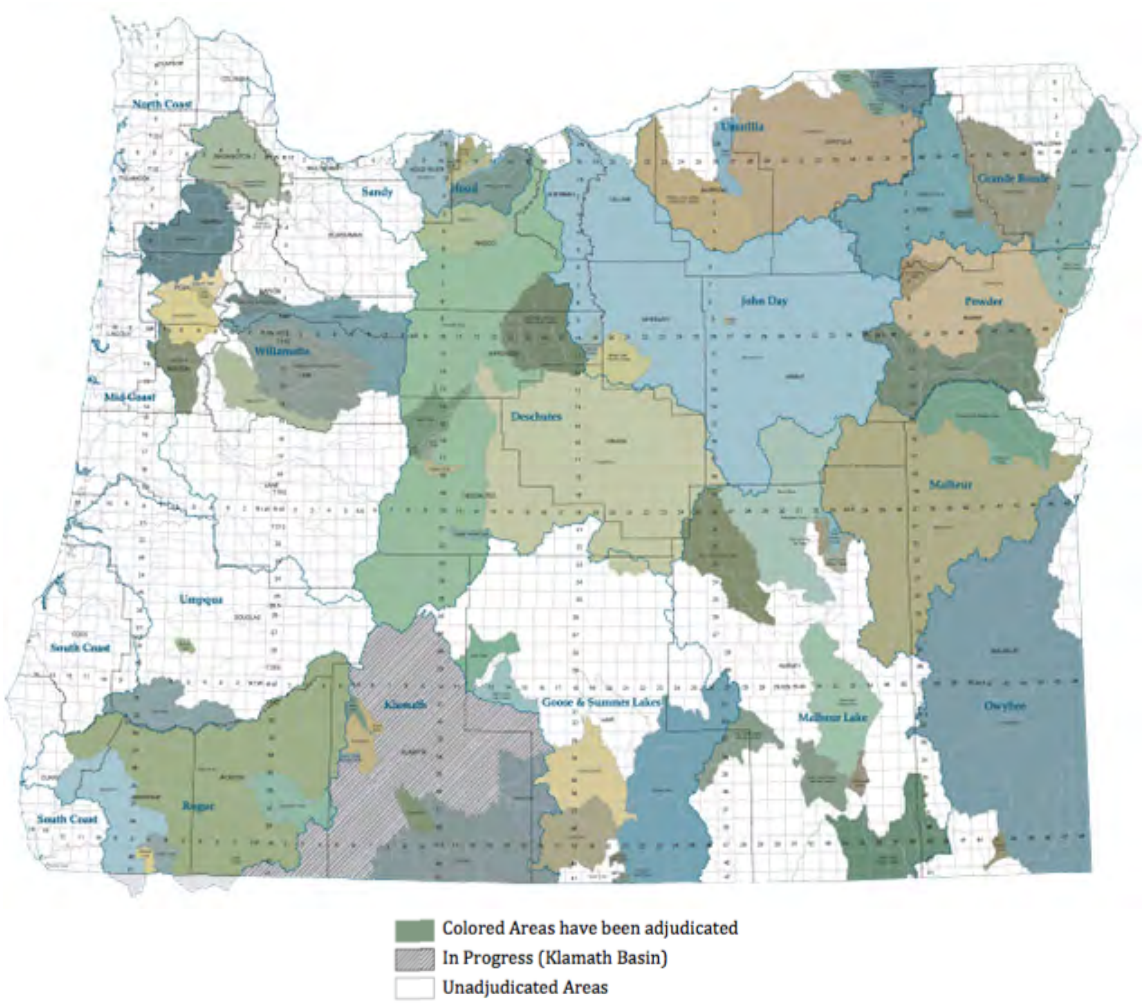
In theory water rights can be of any duration. In practice in the western US most rights are granted in perpetuity. This is similar to other countries that have emphasized water markets as a means of managing and reallocating water, such as Chile and Australia (D. Pilz et al. 2016). Other countries have opted for a different approach to entitlements to water. For example, the Republic of South Africa grants rights only for human uses and ecological use, or *The Reserve* (DWAF No Date). Commercial users of water can apply for and obtain licenses to use water. These licenses can be granted for no more than forty years, and may be granted for shorter durations (Department of Water and Sanitation 2016). The duration of entitlements-as-permitted goes to the security of the property right. Generally, shorter durations are expected to create economic uncertainty and dissuade investment in infrastructure necessary to develop water for a range of human uses. Conversely, longer durations create entrenched entitlements and may make it difficult for the state to *claw back* water as policies and needs change over time. Rights granted in perpetuity then increase the security of rights and limit their flexibility. The granting of perpetual rights under Prior Appropriation therefore maximizes the security of the rights and contributes to their marketability.

5.2.3 Adjudication

The security of a property right depends on its formal recognition by the relevant authority. In the case of a use right this is typically the authority charged with regulating permits and use. In the western US, river basins with established historic uses go through a court-administered process of filing and reconciling all claims that results in a court decree establishing the adjudicated water rights (J. G. J. Hobbs 2006). An unadjudicated claim is not a secure property right as its various elements are not confirmed by the state. It could be sold, or at least all potential rights associated it could be granted to another, but its transferability and hence its value would be speculative.

The time needed to undertake adjudications is often measured in decades, and there are many ongoing general stream adjudications in the western US (Gerlak and Thorson 2010). For example, much of the state of Arizona is unadjudicated, with ongoing adjudications in the Little Colorado and Gila Rivers. Other states have made considerable progress. For example, many of the river basins in Oregon, particularly the drier basins to the east of the Cascade Mountains are adjudicated (see Figure 8). The state of Idaho began the Snake River Basin adjudication in 1987. The adjudication involved 175,000 water rights in 53 sub-basins and consisted of 275,000 pages when it was signed in 2014 (Vonde et al. 2016; Fereday 1999). While it took 17 years longer than expected, it settled claims to 80% of Idaho's water sources (Fereday 1999).

FIGURE 8: STATUS OF ADJUDICATIONS IN OREGON



Source: OWRD (2012)

The absence of adjudication can severely impede trade, but it does not mean there cannot be market activity of some kind. Land is still bought and sold and the claims go with the land. Water management transactions in which water users are paid to alter their water use behavior can still occur. Marketing of federal contract water and storage that is allocated can still occur. For example, simply because most of Arizona is unadjudicated does not mean that there is no water trade in Arizona. Much of the water consumed in Arizona is delivered via the Central Arizona Project from the Colorado River and there is an active market in this water as it is stored water delivered under Reclamation contracts. In Idaho, the state has operated rental pools since the 1930s despite the lack of adjudication on the Snake River.

The absence of adjudication can severely impede trade, but it does not mean there cannot be market activity of some kind.

In unadjudicated basins it is the permanent purchase and transfer of claims that is an uncertain venture. Even in unadjudicated basins there can be workaround measures. For example, prior to the recent adjudication in the Yakima Basin in Washington the state formed a working group comprised of the main stakeholders. Proposed transfers were discussed and vetted by the group. If any single stakeholder had concerns about a

proposed transfer Ecology would not consider the transfer further. If all stakeholders were on board with the transfer Ecology would allow the process to proceed. There are then creative and cooperative mechanisms of managing transfers in unadjudicated basins. That said, it is far preferable to be adjudicated. The Orr Ditch decree that adjudicated the Truckee Basin dates to 1944 and extensive transfers from irrigation to municipal, and later to environmental purposes, have occurred fairly continuously since that time (Sanchez, Aylward, and Springmeyer 2016). This would be unthinkable in the absence of adjudication.

5.2.4 Water Rights Administration: Regulation and Enforcement of Priority

Prior Appropriation is designed with water scarcity in mind. Wet and dry years, as well as wet and dry times of year are accommodated under the doctrine. The priority date system accomplishes two things: it rations water when it is in short supply and it does so based on the date of application for the development of the water use. The benefits of this approach are considerable. First, early water rights are secure with respect to latecomers to the resource. Along with the duration of the right, confidence in the reliability of the water right underpins the willingness of the permit holder to invest in developing the diversion, well or storage infrastructure. Second, when it comes to surface water the well defined priority order allows for orderly regulation of water users off and on to the resource as flows decline or increase. The key element to the security is the ability to exclude other users from taking water out of order. This involves the ability to call on water rights, to complain when it is perceived that the water rights are not being administered in order and to take grievances to court if the administrator is failing in their duties. In order for a potential buyer to pay money for a water right, the right must be backed by assurances that when it is called upon and when it is in priority, the water will in fact be available at the point of diversion, pumping or storage.

This implies a number of things. First that there is a person, whether an employee or contractor of the state or of the water users, charged with regulating water on the system, that is making sure that the rules for allocating, sharing, and using water are followed. Second, that this responsible entity or person has access to the necessary information about the water source and the actual use of entitlements to parse out the available water in the proper order. This is not easy if the order is complex and the stream is long with various gaining and losing sections (sections where water naturally accrues to or leaves from the channel as by discharge from adjacent springs into the channel or infiltration out of the channel into porous soils, respectively). It is also made more difficult if water users do not measure and report their actual use. Failure of these assurances creates uncertainty over the ability to call on and obtain water and will serve as an obstacle to trade or erode the value of rights in the market.

Interestingly, while water theft is a topic of western lore, the security of rights in traditional irrigated areas in this regard is generally quite good. The explanation is simply that without these assurances and the resulting predictability of water supply the fabric of the irrigation community would fall apart. The primary issue here with respect to healthy water markets is more one of the need for environmental buyers to work with regulators to develop monitoring and accounting systems for water rights that are changed to environmental use instream. These non-traditional uses can upset the finely tuned regulation of rights within the irrigation community, particularly when the historic paradigm viewed any water left instream as water going to waste.

5.3 Threats to Water Right Security

The items examined above provide the underpinning for the security of water rights in the western US. Beyond these there are a number of issues that may pose threats to the security of water rights in particular contexts. These concern the way in which Prior Appropriation rewards speculation and rent-seeking behavior, as well as the gaps in the permitting of new water uses that create leakage from the system and thus undermine the security of existing rights.

5.3.1 Exempt Uses and Groundwater as Leakage

Another role of the state in governing water is clarifying which uses require a formal entitlement and which do not. Minor uses (in terms of quantity) such as individual domestic withdrawals and withdrawals for livestock are examples of categories of use that are often excluded from permitting or licensing requirements. In the western US most states allow for stock and domestic uses by the household up to some nominal amount, typically including irrigation of an acre or less of land. These needs are typically met from household wells and the use of groundwater. New and innovative supply options and efficiency savings may fall in this category as well, or at least require the development of new permitting regulations. And, finally as noted earlier, in some jurisdictions all groundwater uses may have been left out of original permitting or licensing processes. Uses that fall outside the permitting process may create loopholes and externalities, are typically not regulated by the state, and may lead to a two-track system thereby making it difficult to manage water sustainably. More to the point, if exempt uses or unpermitted groundwater rights are an option for new users, then their demand will not be driven to the water market. Instead, new users will effectively do an end run around the market and access the water resource for free. In other words, these instances of unpermitted water use represent a threat to the security of the rights and the value of permitted rights.

5.3.2 Queuing for Rights, Sleeper Rights and Speculation

Water is a public resource that is permitted for private and public uses that generate private and public benefits. While speculation in financial markets is expected and perhaps healthy it can be argued that speculating in water rights is less of a desirable social or economic phenomenon. The existence of a water market, the prospect of a future market or the prospect that a basin will be closed to further appropriation can encourage speculation and lead to associated behaviors that may affect the security of water rights.

In western states the path to a new water right involves filing for a permit to use water and then providing proof of beneficial use to perfect the right. A water right certificate is then issued for the proved up portion of the permit, which is some amount of water but not more than the permitted amount. The priority date is the date of application, not the date of proof of beneficial use. Lax enforcement of deadlines to prove up on permits can lead to what is effectively speculation. For example in Nevada, the application for a permit is itself transferable. In effect, the application holds a place in line with respect to the water source and the original owner or successive owners of the permit can move the place of use around without ever actually developing the right. The ability to continually ask for and receive extensions of the time required to prove beneficial use enables the permit holder to effectively speculate in water at a very low cost.

For example, in one western basin a group of investors – apprised of an upcoming water rights acquisition program for the environment – acquired a large property and began developing groundwater and alfalfa fields. While the operation was at best a break-even financial proposition the investors were hopeful that the rights were proved up they would be seen as an acquisition target. This as their groundwater pumping would deplete water supply to an adjacent natural feature and recreation area managed by the state for wildlife purposes. Unfortunately, the investors misunderstood the purpose of the acquisition program and no acquisition materialized. As a consequence, money was spent to create evapotranspiration and dewater a state natural area for no real economic return. This type of speculation is clearly unhealthy, even if barely legal. The potential solution would be to apply a hard stop to the development of applied-for but unproven rights.

Similar situations may occur with certificated rights. If there is no forfeiture system, or the forfeiture system is not enforced, the onset of a market can lead to the resuscitation of *sleeper* rights (i.e., dormant rights not used over a long period). In other words, the presence of a market may motivate entitlement holders who had otherwise technically forfeited the entitlement through non-use to attempt to resurrect

their entitlement and participate in the market. It is also common upon the sale of property to which dormant rights are attached, for the new landowner to attempt to resurrect technically forfeited entitlements as well.

Generally, permit queuing, the development of rights merely in order to market them and sleeper rights may all lead to an increase in overall water use and the amount of rights in the market. This may adversely affect the security and value of rights in good standing. Anticipating and addressing this issue in advance of beginning a program of market activity is advisable. That said speculation is a subjective matter and may not be amenable to objective regulatory action. It is hard to objectively differentiate between an irrigator who is making marginal use of their water in the hopes of one day selling out, and a water user who is just making marginal use of their water. The more important caveat here is that, in the absence of fixed-duration (less than permanent) entitlements, a system of forfeiture is needed in order to make simply hanging on to a right a costly proposition for the potential speculator. Enforcement of such rules is also important.

5.4 Flexibility of Rights

Flexibility is used here to suggest that in order to be *healthy* water markets need to be *adaptable* to changing circumstances. If there is no flexibility to water rights then changes in policy may have little impact on water use. Flexibility is about ensuring there is a balance between the private benefits of market reallocation and the goal of ensuring that a public resource contributes to the public good. An example of flexibility in water rights is the ability to vary the allocation made to a water right depending on hydrological conditions.

Flexibility here refers to the ability of public policy to balance the security of the rights for the right holder with the interests of the public in the resource and associated social and ecological systems.

Many of the features of water rights in the western US, including their nature as well-defined rights, issued in perpetuity and protected from takings, suggest that they are well defined and secure, but not really flexible. Flexibility here refers to the ability of public policy to balance the security of the rights for the right holder with the interests of the public in the resource and associated social and ecological systems. For example, as climate change threatens to change the timing of water availability, as well as the overall amount of water available, how can public policy alter and adapt the water right system so that the economic benefits of the resource are maximized and the public interest served? In effect it seems that the more secure the private right, the less the public has flexibility to re-manage rights. When the security of appropriative rights is combined with the political economy of western water this flexibility seems even more limited. Efforts to regulate water rights and water use in order to involuntarily move water from one use or user to another are feasible but are fraught with controversy and often end up involving compensation for any losses incurred by those that lose access to water. If public policy cannot alter rights or redistribute them then they are fixed and immutable; from the perspective of politics and collective action the rights are locked in. This suggests that the necessary flexibility to adjust to changing circumstance and meet new and different needs will need to come a range of fiscal instruments, including government intervention in the water market, or from policy reform to add flexibility to the water rights system (rather than the rights themselves). This topic is taken up in Section 8.

5.5 Summary

This review suggests that western water rights are generally well defined and secure, suggesting positive enabling conditions for market activity. The elements of appropriative rights are well enumerated, granted in perpetuity, administered effectively and protected from takings by the US Constitution. A number of situation-specific caveats and exceptions however were identified including:

1. Consumptive and non-consumptive portions of rights are not defined as part of the water right and, thus, must be discovered through transfer processes.
2. Depending on the context, the Public Trust Doctrine may undermine the security of water rights, permitting their regulation or expropriation without compensation.
3. The absence of adjudication is an important factor that can limit the security of water rights, particularly with respect to permanent transfers.
4. Effective administration of water rights within an irrigation community does not necessarily mean that they will be equally well administered once changed to other uses, particularly environmental uses.
5. Specific threats to water right security come from exempt uses, open access groundwater use, poorly regulated queuing for new permits and sleeper rights.

And finally, the high degree of security of appropriative rights means that from a policy perspective they are fixed and not flexible. This pushes public policy towards incentive-based fiscal policy and legal reform as tools for shaping water use and reallocating water rights.

6. Tradability and Transferability of Entitlements and Allocations

Water rights in the western US reflect the permission granted by the state (or relevant authority) to the right holder to use the water resource according to the terms and conditions of the right. As the state retains ownership of the water on behalf of the public it remains responsible for administering the use of rights under the water code. The trading of a water right therefore typically must accomplish not just a change in ownership but also an administrative change to the right to use water. Trading in western water rights is a two-step process. The transaction costs and impacts on water right values (for the buyer and the seller) associated with these two steps are critical to the availability of gains from trade in a market and thus have an important impact on the level of trade. Each topic is investigated below to assess these processes and their implications for market activity.

6.1 Tradability

Tradability effectively pertains to the conditions surrounding the ability to change the ownership of the water right in return for compensation. Transferability refers to administrative changes to the other elements of a water right. Tradability can be disaggregated into the reassignment of a right, the authority to sell or purchase rights, and the ability to lease a right temporarily and sell in annual allocations.

Authority to Reassign Rights. A fundamental authority is the ability of the water user to reassign the right to another. The passing of the right to the next generation or the sale of the associated land are occasions that necessitate reassignment. The ability to reassign a water right is important to water marketing. If the death of the holder or the sale of the land (or the business) were to truncate the right this would be analogous to having a very short duration on the right. This would not just diminish the incentive to invest in developing rights in the first instance, but would circumscribe the market value of a right and limit the utility of buying a right in the market. In the western US the reassignment of water rights is permitted. In the case of land transactions, water rights are said to *run with the land*. When land is sold the water entitlements are considered sold along with land unless otherwise specified. The entitlements need only be reassigned and the evidence provided for the reassignment is the deed of sale for the land.

Trading in western water rights is a two-step process.

One issue that crops up in the western US is that often these occasional reassignments are not filed when land, and sometimes water rights, change hands. This means that water right registries held by states are often out of date and may carry names that have long since left the area. This is an inconvenience and obviously does not assist efforts to develop functioning markets. If the name and address on a water right are incorrect it can be time consuming to find the holder of the water right, administer a water rights auction, etc.

Authority to Purchase and Sell Rights. A second level authority is the authority to sell the right to another in return for compensation. In the western US, where water is private property, this authority is well established. Although water runs with the land this is not the same as saying that land and water are inseparable. Water rights may easily be separated from land if the seller explicitly severs the two rights or, in the case of a land sale, reserves the rights and provides notice of such in the land register. This explicit authority to buy and sell rights is useful but not critical. In Mexico, for example, water rights are more circumscribed and it is not permitted to alienate public property, such as water. As a result, water transactions in Mexico consist of two transactions at arms lengths: a payment by the buyer to the seller

and a reassignment filing in the buyer's name signed by the seller, executed simultaneously. This is obviously less than efficient and makes the development of more advanced water marketplaces difficult.

Authority to Lease Water and to Sell Allocated Water. A third form of trading is a temporary trade between users for a limited period of time, typically for a year or more. In the case of a water right lease, the lessor, in return for compensation, allows the lessee to use whatever water ends up being available under the water right during the lease period. Such a lease of a water right should be distinguished from the sale of allocated water. The sale of an allocation typically refers to the sale of stored water or groundwater that is already allocated to the holder of the water right by the regulator or water manager. So, for example the sale of water already stored and allocated in a reservoir. While these market transactions are generally authorized in western states, the real difficulty, as with permanent purchases, is the administrative process. Leases and sales of allocated water do not change the water rights, but may still be subject to review and approval by the regulator (for leases) or possibly just the water manager (for example for stored water under a right held in common within an irrigation district or under federal contract).

It is important to flag the difference between leasing and trading in an allocation. In the western US, allocations are amounts of stored water or groundwater that are determined to be available for use by the holder of the right at the beginning of the hydrologic year or the irrigation season. As these allocations are made from pools of stored water the amount is typically physically present or at least expected with a high degree of reliability (for example where it is already present in snowpack above a reservoir). The amount of available water is known with enough confidence that the relevant water manager makes an allocation to users. When such allocations are made the water user is then often allowed to sell that allocation. This is different than for natural flow rights where the availability of water under the right varies over the season, and may even vary within the day. Owners of such rights are much more likely to lease, or rent, all or a portion of the entitlement for the season. The lessee then acquires the right to withdraw whatever water is allocated to that entitlement, even as it varies from day to day or month to month.

So trading in stored water allocations provides a much higher predictability in terms of the amount of water that will be received in return for payment. These allocations are thus much more amenable to trading. Further, as seen below, natural flow rights are often subject to further scrutiny by regulators before approval for leases are granted, making such trades even harder to consummate quickly and efficiently. An exception to this statement is found in the Umatilla Basin case study (Pagel 2016). In this case groundwater is regulated and yearly allocations are made to a limited number of senior rights. Unfortunately, state rules effectively prohibit those receiving an allocation from transferring their allocation to other users. The problem is that while the allocation could be sold, the transfer of that water to another, presumably junior, user would mean skipping intervening junior users from an administrative standpoint. Failing agreement by these users to forbear such transfers would not be approved by the state. This is not a problem without solution, but would effectively require cooperation and a standing agreement by all the users on the same water source to enable such trades. This is just one example how critical the ability to transfer traded rights is to the operation of a water market.

The authorities discussed above seem straightforward when the owner of the right is a single individual, corporate or government entity. In cases where the property interest is shared in some manner, however, coming to an agreement to sell or lease a right is not only more difficult but the transaction costs of doing so are likely to be higher (Podolak and Doyle 2014). With Reclamation projects this issue is magnified as federal involvement creates further complexity an additional disincentive to trade (GAO 1994) When farm succession leads to joint ownership of water rights by family members the same difficulty is encountered though at a very local scale. In some cases a water right may be jointly used by landowners but held by an irrigation entity. In these cases the authority to trade exists, however the practicalities of

shared property interest create complexity and create additional hurdles to the completion of water trades.

6.2 Transferability

The ability trade in water rights is only the first half of reallocation in a healthy market in the Western US. In most cases the new owner of the water right will want to change one or more of the elements of the water right, such as changing the purpose and/or place of use. Such an administrative change (or transfer) has implications not only for the new owner of the right, but also for other water users that rely on the same source of water. In the western US the transfer process involves application to the relevant state administrative or judicial authority to change the right. Typically this involves notice to the public and the possibility of comment or even public participation. The proposed change, including the amounts proposed for transfer, may be subsequently modified, approved, or denied. For transfers and leases this process can be time consuming and costly. These represent one form of transaction costs that must be shared in some fashion by the buyer and seller, thereby reducing the gains from trade and the likelihood of a trade occurring.

6.2.1 Transfer Review: Injury, Harm and the Public Interest

A water rights transfer is usually taken to mean the ceding of all or a portion of the water right to another user. In the case of irrigation there are two main potential variants. First is the transfer of all or a portion of the water used to irrigate different lands. Second, in some states (as discussed earlier in 8.2.4) it is possible to save some portion of the water that was originally included in the entitlement and re-market that saved water to another user. Regardless of the specific type of change, changes to entitlements can impact other users of the same water source. For this reason, state water codes call for analysis of proposed transfers to determine the presence and extent of potential impacts against one or more thresholds. This is referred to as *injury review*.

Rationale for Injury Review. The basic principle that underlies injury review is that any change in use of a water right should not adversely affect other existing rights. The rationale for injury review relates back to the physical nature of water uses being non-rival uses (Aylward et al. 2016). Injury as a legal construct ultimately relies on an understanding of hydrology. Any change in how water is withdrawn, moved across the landscape, and ultimately used has the potential to impact other water users and to impact environmental quality more broadly. Because most water uses do not fully consume the water that is withdrawn they will return some water to the aquifer or the river. This water can be the basis of some or all of the water available for other entitlements downstream.

If injury is not assessed and avoided, then the predictability and reliability of other entitlements are lessened and each change to entitlements will have impacts on other existing water users with knock-on economic, social or environmental impacts. Ideally, injury of rights held by the environment is included here, though not all states include or allow for environmental rights or protected instream flows. As with the earlier examples of loopholes in the permitting process, if a right is to be secure then it cannot lose its place in the priority line or be made worse off by the changing of another right. Otherwise, water rights are not secure and are subject to *death by a thousand cuts*. The state, as regulator, therefore evaluates these changes to identify if *injury* may occur, and then reshapes the transfer to avoid injury, or allows the applicant to mitigate for this injury.

BOX 9: INJURY: INSTANCES AND APPLICATIONS

A first and obvious example of injury would be the transfer of the place of use from one watershed to another. In this case, the seepage and return flow from the place of use would not accrue back to the source watershed. Junior rights in the source watershed would lose access to this water.

A second example would be the change of water use (in the same location) from irrigation to industrial use. If the old agricultural use was 60% consumptive (with the balance of 40% returning to the source through the groundwater system) and the new industrial use is 100% consumptive, then transferring the full amount to the new use would mean less water returns to the system and to down-gradient users. Approving such a transfer would injure other users and therefore need to be modified or denied. In this case the new industrial permit might be issued at 60% of the former right in order to protect down gradient users.

A third example would be the transfer of an irrigation right to a new point of diversion upstream or downstream. Consideration would then be given to whether the change in location of use and the change in routing of return flow would injure other water users that previously relied on this return flow to fill their right.

Injury versus Harm. In its strict legal sense, the concept of injury relates to specific types of impacts to other permitted water users. There may be many other impacts occasioned by a water transfer. If a user moves off a conveyance system there may be operational and financial implications for other users who share the conveyance. The cessation of irrigation on lands may also occasion changes to vegetation, changes in tax obligations and a host of other social, economic and environmental impacts. As these are not hydrological impacts to existing rights these are non-injury third-party impacts. These impacts may harm others but do not injure them in the strict legal sense and are therefore not a matter of administrative interest to the regulator. Still, harm can represent an important hurdle for water trade. Unmitigated costs, whether operational, financial or cultural, can cause social and institutional opposition to water markets. In formulating a formal plan or policy to encourage water markets or carry out a program of transactions these issues often need to be addressed explicitly, otherwise the plan or program is unlikely to succeed.

The Public Interest. Finally, it is also important to consider whether and how transfers might impact the public's interest in water sources. Harm to the public interest can be legal injury if the public interest is assigned a legal right, as in the case of an instream water right. In rivers with formal instream water rights, if a transfer will reduce the amount of water in the protected reach below the flow required by the instream right (as might occur with a downstream point of diversion change or an increase in consumptive use), this is legal injury. On the other hand, many areas of the west lack formal instream flow water rights. In these cases, a more general sense of injury may be applicable. Many states specify that transfers must be in the public interest in addition to requiring that they not cause legal injury. As a result, if a proposed transfer might cause serious harm to a recognized public interest, even if that harm is not legal injury, the transfer may sometimes be conditioned on not harming the public interest or be denied outright. This should not be over-stated as such cases are rare. They generally require that someone (like an environmental advocacy group) speak up on behalf of the public interest and that the regulating agency agree with that group's accusation.

6.2.2 Quantification of Transfers

How rights are quantified for purposes of transfer is critical to the value proposition for markets. For example, take a water right at the top of a system that has the right to divert 100 AF annually, but typically has a consumptive use of half that or 50 AF. If the water user wishes to sell the water to a user far

downstream the ruling is likely to be that a new diversion right for 50AF is permitted. The first point is that the water right quantity that comes out on the other end of a transfer is often smaller than that on the original water right. This is sometimes referred to as the consumptive use *haircut*.

If the buyer is an irrigator and has the same efficiency as the original owner the new permit for 50 AF would mean 25 AF of consumptive use. This would mean one-half of the previously irrigated acres. Alternatively, the new user might invest heavily in irrigation efficiency in order to establish close to the original number of irrigated acres. Either way the cost of the water to the new user per AF is considerably more than the price per AF viewed from the perspective of the seller. It also stands to reason that the new user probably needs to be earning twice as much per acre in order for this transfer to be financially worthwhile. Quantification of transfers is therefore an important factor in driving the level of market activity. The more modest the haircut the higher the gains from trade will be and the more encouraging this will be for trade. At the same time the more modest a haircut, the greater the possibility of injury and the undermining of the security of other rights.

In the western US there are two general approaches to quantifying the amounts that can be transferred. The first approach is to begin the transfer process under the simple premise that the full amount should be transferable, subject to injury. An alternative approach is to start by limiting a transfer to the historic consumptive use under the water right. This consumptive use is typically taken to be the amount of water that the applicant can demonstrate to have been diverted (or pumped) and consumed by crops over some portion of the most recent five-year period. The latter approach probably provides the lowest possible amount that would emerge from a given transfer.

There are two drawbacks to the historic consumptive use approach. First, consumptive use is typically defined as the net irrigation water requirement of the crop that is grown. There are a range of circumstance under which this under-estimates the amount that can be transferred without injury and over-estimates the amount of water that would be available to other water right holders on the system. For example, seepage from irrigation may percolate into deep groundwater and not return to the stream to fill other water rights. In this case the true measure of consumptive use is the water that is consumed and does not return to the system and not the net irrigation water requirement. In other words for quantification to yield an appropriate amount it should represent the amount *consumed* and not just the portion of applied irrigation water that is evapotranspired. Unfortunately, it is often easier to calculate the latter and so it can become a de facto standard for quantification.

Second, there is state-by-state variation in terms of what evidence of historic use is required before approving a transfer. Many states require evidence of the historic quantity of water actually used, whereas others require some lesser form of evidence of historic beneficial use. In the latter case, the approach to transfer is to recognize that the user has the legal entitlement to make maximum use of the right, even if perhaps this did not occur in the last five years. The latter system is obviously more lenient and is referred to as a *paper water rights* system, as the basis for quantification begins with the amount on the certificate, i.e., on the piece of paper. An advantage of a paper right system is that while the user must still use their water right and avoid forfeiture in order to sell and transfer the right, there is no need to maximally divert and use water every year in order to maintain the maximum market value of the right.

A state that uses evidence of the amount of water historically used to quantify the amount available for transfer is simply applying partial forfeiture, i.e., the portion of the right (rate or duty) not used during the look back period is forfeit and not available for transfer. Of course the likelihood of such partial forfeiture being applied outside of the transfer context is slim. The smart user would simply increase their water use prior to marketing their water in order to ensure that they can demonstrate the full historic use. A difficulty with partial forfeiture therefore is that it incentivizes the diversion and waste of water.

The historic consumptive use approach will result in lower transfer amounts. It therefore acts as a brake on market activity in favor of (often over) protecting existing users. On the other hand it is perhaps simpler to calculate and administer and thus may be more predictable and therefore promote water trade. The approach then may have countervailing impacts by reducing the gains from trade but lowering transaction costs. These two options are illustrated in Figure 9.

Box 10: Transfers in Colorado

Despite the common Prior Appropriation underpinnings, the variability in the way water is administered and the manner in which transfers are regulated is considerable. Colorado is a prime example in this regard. Perhaps the most unique aspect of the Colorado experience is that transfers are processed by the judicial and not the administrative branch of government. Any member of the public (including other state or federal agencies) may protest a transfer in water court but members of the public without a basis for asserting legal injury are held to a stricter burden of proof than water right holders whose rights may be injured. While the cases are decided on the merits, this provision of course provides a way for those that simply do not like a proposed transfer to raise the transaction costs of a water deal for the buyer and seller.

The historic consumptive use standard is most often associated with transfers in Colorado. The strict emphasis on protecting existing uses extends to requiring transferors to ensure that the timing of return flow water received by existing users is not altered by a transfer. So for example if a downstream user receives late season water because of the delay in seepage water returning to the stream from an upstream use, this pattern needs to be adhered to even when the upstream user transfers the water to a user further downstream or to an instream use. This leads to a range of additional costs that such a transaction must bear, including buying other water to mitigate the potential injury or continuing to divert a portion of the water into recharge ponds to simulate the original return flows. In other jurisdictions this would seem an unreasonable burden for a transfer. An alternative approach to injury would maintain that water rights are a right to divert and use water, but not an obligation to do so. The need to deliver return flows downstream effectively compels a water right holder to divert their water right and to do so with the same efficiency.

The transfer system in Colorado can be slow and very costly. It maximizes participation and provides painstaking protection to existing uses. This example illustrates that many of the rules surrounding the administration of water rights under Prior Appropriation were developed with traditional uses in mind and not the enabling of a water market or flexibility with respect to the use and trading of water rights. It is not surprising then that the Colorado water market (outside of trading in correlative storage rights in the Colorado Big-Thompson) consists largely of hard fought efforts to transfer water and the types of more flexible water banking efforts seen in other states have been slow to develop.

6.3 Trade and Transfers for Environmental Flows

Meeting environmental flow and environmental function objectives for rivers, lakes and aquatic ecosystems are long standing challenges in the western US. The long arc of water rights issuance and water resource development has not been kind to these systems. There are many different types of investments being made by the public to restore these systems, including reengineering natural channels, removing entrainments and restoring riparian habitat. Regulatory efforts have also been made in some states to protect residual or junior environmental flows. Given the water rights system for water allocation a proactive and complementary strategy in the flow arena is for conservation and environmental interests, including government and non-profit entities, to buy and transfer rights to environmental uses. The enabling conditions for this include establishing environmental uses as beneficial uses and establishing the authority to transfer rights to environmental purposes without any loss of priority or standing within the

system of water rights administration (Aylward 2013b; Szeptycki et al. 2015). This allows government or civil society to participate in the water market on behalf of environmental and other public uses of water such as recreation.

Over the last two decades the use of environmental water transactions in the western US as a means to restore streamflow and freshwater ecosystem services has increased markedly. For the ten-years from 2003 to 2012 it is reported that the total value of environmental trade was $560 million, some 7% of total market value (WestWater Research 2014). A significant portion of this trade originates from large federally funded transactions aimed at endangered species obligations, whether in the Central Valley, the Truckee River or the Columbia River. California represents a large portion of the state and federal transactions aimed at endangered species. Over the 30-year period from 1982 to 2011, environmental acquisitions in California totaled $547 million with the bulk of this activity coming from 1994 and on (Hanak and Stryjewski 2012). The Truckee-Carson water market case study details how political settlement of longstanding litigation necessarily included a raft of federal funds for environmental purchases to meet endangered species needs for Pyramid Lake and habitat water needs at the Stillwater National Wildlife Refuge (Sanchez, Aylward, and Springmeyer 2016).

The provision of government funds for environmental purchases is needed as the incentive for civil society to invest sufficient funds is limited given the public goods problem. As emphasized in Part I of this report, ecosystem services and other environmental uses of water tend to be public goods without any kind of market return with which to finance water purchases. Without special consideration such uses may be left out or left behind in a water market.

Finding adequate funding to acquire sufficient water to meet environmental needs is just one part of the uphill battle faced in implementing environmental water transactions. A second is navigating the market, which is rife with obstacles and imperfections, as described in the next section. A third issue is consummating the transaction by completing the transfer. Transferring irrigation and other rights to consumptive and non-consumptive environmental uses is a challenging occupation requiring considerable investment of time and money. Figure 9 and Figure 10 attempt to illustrate the basic mechanics of transferring a portion of an irrigation right to an instream, non-consumptive use, as well as how saved water can also be transferred to instream use as conserved water (as discussed earlier).

The ability to carry out these types of transfers vary widely from state to state (Szeptycki et al. 2015). In some states these are relatively straightforward and in some the basic enabling conditions are not met and they are either generally not possible, possibly in theory only, or are possible only in certain contexts. While injury analysis is necessary to the transfer process, the way it is implemented will impact the quantity of water transferred. This applies equally to environmental transfers. In some cases these reflect the same issues of historic versus paper water right transfers already laid out above (see Box 11 for an illustration from Oregon). In other cases, these transfers raise additional issues, not associated with out-of-stream consumptive use to out-of-stream consumptive use transfers. For example, the graphics illustrate that if injury is to be avoided, the non-consumptive portion of a transfer or of conserved water should be legally protectable to the point where prior return flows enter the system. If this is not the case then carrying out these transactions may result in less environmental benefit, which again lowers the gains to be had from trades, and just pushes up the costs to the public of flow restoration.

FIGURE 9: ENVIRONMENTAL TRANSFER TO INSTREAM USE

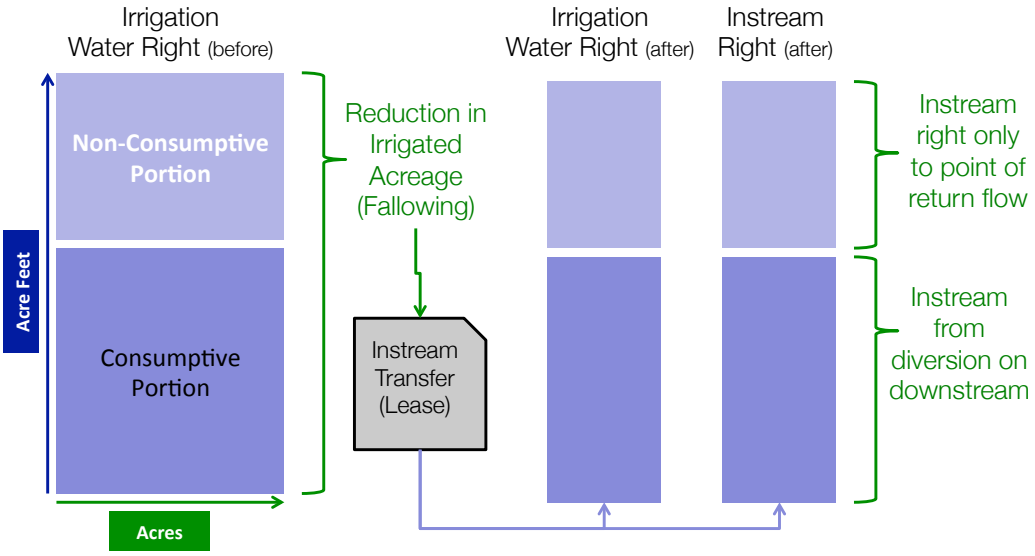
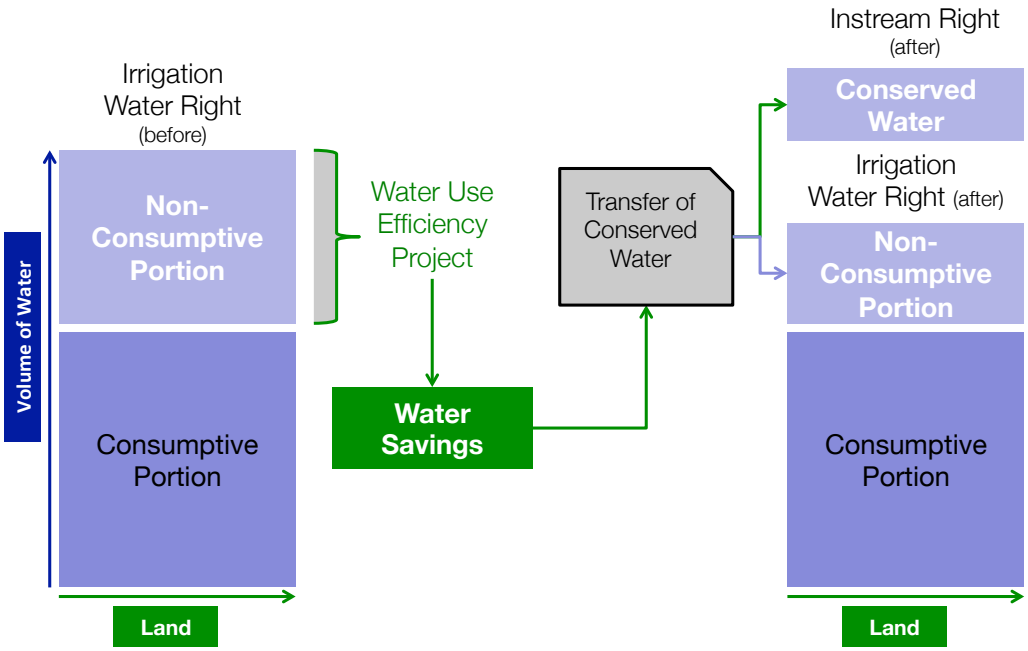


FIGURE 10: ENVIRONMENTAL TRANSFER OF CONSERVED WATER



Box 11: Historic versus Paper Rights and Injury in Environmental Transfers

Oregon and Washington have active environmental flow restoration programs in which existing irrigation entitlements can be permanently retired and dedicated to environmental flows. Such flows provide habitat for important fish species that are protected under the federal Endangered Species Act. The two states have different approaches to injury review each with its own advantages and disadvantages.

In 1998, the Oregon Water Trust, applied to permanently transfer a small irrigation right to permanent environmental flows in a mountain stream called Little Creek. The right was a senior priority first developed in 1863. Prior to the environmental flow transfer, the water was used intermittently for irrigation during the summer months. The Water Trust's application to transfer the right to environmental flows was protested by a group of other water users who irrigated crops with water from the same stream. The arguments made by the protestants were twofold. First, they alleged that the proposed transfer would result in more water being protected for environmental flows than was historically used to irrigate crops on the subject property. Second, they alleged that the proposed environmental flows would alter the historical pattern of use of the original right, resulting in reduced seasonal availability of water to downstream water users. Both arguments are common legal injury complaints in Prior Appropriation contexts and can be distilled into one overarching grievance: if the proposed changes were approved, conditions on the stream would change for all of the other water users who had become accustomed to a specific pattern of water use from the originating right.

The question before the administrative law judge in the Little Creek case then, was whether the changes amounted to legal injury or whether, despite how they might change accustomed patterns of water use, the changes were nonetheless allowable under Oregon law. Oregon is a "paper" right state. Injury analysis in Oregon begins with the assumption that the full "paper" right (i.e. the original rate, volume, and season of use granted at the time of entitlement permitting) can be transferred to a new use such as environmental flows. In other words, despite the historic, actual use of a right (even where such use is less than the "paper" amount), the initial assumption in a change to the right is that the full "paper" amount can be transferred. An important limitation on this assumption is that the right in question must have been used in the last five years (i.e. not forfeited) and that the user be ready, willing and able to divert the full amount under the right.

Based on this tenet of Oregon law, the administrative law judge found in the Water Trust's favor and allowed the transfer to environmental flows to proceed based on the full paper right less return flows to which downstream water users are legally entitled. This result, and Oregon's overall approach, contrasts significantly with its neighbor to the north Washington (and most other western US states, for that matter). Had the same environmental flow transfer been proposed in Washington, which is referred to as a "historic use" state, the initial assumption would be that the average of the two years of greatest use in the most recent five-year period of continuous use is available for transfer (RCW 90.03.380). The resulting finding in Washington would likely have been a smaller allowable environmental flow transfer than Oregon allowed.

Washington's approach tilts the injury analysis in favor of junior water users by placing the burden of maximizing the use of rights on senior water users. Conversely, Oregon favors senior rights by creating the presumption that the entire entitlement can be maintained.

Source: OWRD (2015),Washington Department of Ecology (2015), Protest Against Transfer Application T-8058; (R. D. Pilz 2006)

6.4 Summary

Not surprisingly given the nature of water rights in the western US as private property, the ability to trade water rights is well established. A significant constraint on market activity arises when the buyer goes to consummate a water right transaction by changing the elements of the water right so as to put the water to the new use. Carrying out this step with the relevant administrative or judicial authority can be costly and time consuming. This raises the transaction costs borne by the buyer and seller. The outcome of the process can also result in the transfer of an amount of water less than that on the original water right, reducing the gains from trade. Both outcomes will limit activity in the water market.

A number of specific findings from the review and analysis include:

1. Flexibility in administering temporary trades of appropriative groundwater rights is beneficial, i.e., allowing senior users to make out-of-priority trades of allocations to junior users.
2. While seemingly restrictive and often onerous in terms of process, requirements of appurtenancy for irrigation rights and a proper injury review seem inescapable given the way appropriative rights are defined (as discussed in the prior section).
3. Though injury protections are essential to protect existing uses, including environmental rights or residual waters, and thus important to healthy water markets, the administration of transfers often errs in favor of avoiding any risk of injury to junior users.
4. Historic consumptive use approaches to transfer end up favoring minimal transfer quantities and may undervalue environmental transfers and efforts to implement conserved water transactions.
5. This tendency towards risk avoidance ultimately increases the transaction costs and lowers the gains from water trade and therefore favors existing junior users over prospective new users wishing to participate in the water market.
6. The ability of environmental buyers to participate in markets and consummate their trades with transfers to environmental use is still circumscribed in many jurisdictions and basins.

7. Market Imperfections

An imperfect market is one where the economic conditions for a perfectly competitive market are not present. Based on the standard neoclassical economic model of competitive markets, Part I of the report identifies a number of market imperfections to which water markets in the western US are susceptible. These include the following conditions, which are discussed further in this section:

- market concentration and collusion;
- heterogeneous products;
- incomplete information;
- asymmetric information; and
- barriers to market entry.

7.1 Market Concentration

Market concentration refers to the numbers of buyers and sellers. If there are few buyers or sellers they may be in a position to influence the market in their favor. This problem is typically framed as that of *monopoly* or the power that a sole producer has to constrain market production and sell at higher than efficient prices, thereby generating excess profits (or *monopoly rents*). This can be considered as a case of *hyper-exclusion* in the context of market failure (Randall 1983). But market concentration most often appears as collusion between a small number of sellers that dominate a market (in this case an *oligopoly*). On the buy side of a market, if the number of buyers is limited they may also exercise their power over the market by colluding to set lower than efficient prices. Known as *oligopsony* (or *monopsony* if a single buyer) this power is derived from concentrating buying power in the market, making sellers price takers.

The potential for market concentration and the resulting exercise of market power is probably the major problem experienced in laissez-faire *market systems.*

The potential for market concentration and the resulting exercise of market power is probably the major problem experienced in *laissez-faire* market systems. Capitalist nations rely heavily on market regulators to identify and address anti-competitive practices and particularly that related to market concentration. In the US, the Federal Trade Commission is responsible for ensuring the implementation of federal anti-trust legislation, dating back as far as 1890. Trade regulators are not often involved in regulating water markets. But they can be. A recent example comes from Australia, where the Australian Competition and Consumer Commission's set rules for termination fees for those removing water rights from irrigation districts, as discussed in Box 8.

On the supply (or sell) side of water markets, market concentration can be a major impediment to market activity. Where irrigation delivery entities, i.e., public irrigation districts and private irrigation and ditch companies, control vast infrastructure and retain a property interest in the water rights of their many patrons, these entities may play the role of a monopolist, choosing the quantity and terms on which water entitlements or allocations move through markets to other uses and users. In the western US, irrigation water delivery entities are important providers of water to farmers. For example, by one count federal Reclamation projects account for some 32-50% of acreage irrigated with surface water in these states (Podolak and Doyle 2014). Where these entities have a property interest in the water right alongside landowners they can play an influential role in water marketing. In locations where there are a number of

such irrigation delivery entities they often band together (in Oregon and Washington they may form *boards of control*) to foster joint policies and share legal costs against outside interests. Such groups effectively represent an oligopoly and can lead to collusion to restrict market activity and water trade.

As alluded to earlier this power may be used not to extract monopoly rents for irrigation right holders but simply to opt out of market participation. It is not unusual for irrigation districts or other water management entities to have a formal policy that forbids the purchase and transfer of a water right outside of the entity. Such policies act as a restraint on trade and protect and secure the water rights within the entity. The Treasure Valley Idaho case study recounts the difficulties encountered in attempting to instigate market activity with irrigation districts on the Boise River (Fereday 2016). The economics of such policies are fairly predictable in the context of the global agricultural economy and the changing demographics and rapid growth of western towns and cities. The latter forces drive increasing demand for new uses of water outside the irrigation entity. Within the entity, urbanization, in-migration, amenity farming and falling agricultural prices shrink the internal market over time, lowering internal demand and prices. As the price of water diverges in the two markets, the pressure from patrons of the entity to allow transfers increases. Meanwhile the political and economic pressure from municipal and industrial interests to provide water to the growth areas of the economy intensifies. Ultimately, the outcomes are economic stagnation, or conflict and litigation, if marketing is not allowed, or shrinkage of the agricultural base if marketing is allowed.

The Truckee-Carson Basin water market case study is an example of how, in the absence of concentrated power in the irrigation sector, markets and political settlements facilitated an orderly and long-term transition in water rights from irrigation uses to municipal and industrial uses (Sanchez, Aylward, and Springmeyer 2016). A noteworthy enabling condition in the case of the Truckee Meadows market was the absence of any singularly large or powerful irrigation entity that could close the market or negotiate favorable terms with the Truckee Meadows Water Authority that serves the Reno-Sparks metropolitan area. Likewise, in the Truckee and Carson Divisions of the Truckee Carson Irrigation the purchase of water for environmental and municipal purpose was similarly unimpeded. The irrigation districts status solely as a water delivery entity, with no property interest in the water rights, meant that the district did not have standing to set policies regarding transfers of water rights.

An alternative to outright opposition to markets is for irrigation entities that have market power to strike middle ground and negotiate a water sharing agreement, which sets the terms on which water will be temporarily moved from the entity to faster-growing areas of the economy. As an example, consider the 2004 agreement between the Palo Verde Irrigation District and the Metropolitan Water District in Southern California (Box 12). This arrangement does not permanently transfer rights from irrigators to municipal users but provides a flexible agreement that enables rotational fallowing to provide an assured supply of water to municipal service providers in Los Angeles and San Diego area. Assessing if the district extracted monopoly rents in this agreement is beyond the scope of this paper. It would, however, not be surprising that rents were present given the need for those seeking approval of the agreement to overcome the fears and concerns that many irrigators would have over moving water on a long term basis out of agriculture and to a distant city.

An alternative formulation of the market concentration issue exists on the buy side of the market. Oftentimes the buyers in water markets are public or non-profit buyers seeking water for municipal water supply or public environmental use. These entities may also concentrate the buy side of the market by conducting purchasing operations jointly. In the presence of large numbers of sellers, a monopsony keeps prices low to the benefit of the buyers. However, if there is an active agricultural buyer this effort may not be that effective. An alternative is to band the public irrigation entities together with the environmental buyers and the municipal buyers. Under such a collaborative framework, sometimes called *water banking*, agricultural, municipal and environmental needs can be programmed, and a coordinated purchase price

approach used to bring the necessary quantity to the market. Such an approach was developed by the Deschutes Water Alliance in the Deschutes Basin of Oregon and deployed for a number of years with a modicum of success at moving rights within two local irrigation districts, as well as transferring right out of the districts for municipal use (through groundwater mitigation) and environmental flow restoration (Aylward 2006).

Box 12: Irrigation to Municipal Water Sharing Agreement in Southern California

The Metropolitan Water District (MWD) is a large regional water provider in southern California that supplies water to more than 300 cities including approximately 19 million people in and around the Los Angeles and San Diego metropolitan areas. Most of MWD's service area lacks ready access to water and the area has had a long and contentious history in its pursuit of securing adequate water supplies. As the region's population has continued to grow and drought conditions have impacted many of its water sources, providing reliable and plentiful water has only become more difficult. One way MWD has increased its water supply security is through a series of agreements with large, rural, agricultural water users. One such agreement, signed in 2004 with the Palo Verde Irrigation District (PVID), represents a large-scale example of a water sharing agreement from agriculture to a growing municipal water provider.

In August of 2004, MWD and PVID entered into a 35-year agreement for a land fallowing, crop rotation and water supply program. Commenced in 2005, the program will run through 2040. The heart of the program is a voluntary fallowing mechanism whereby PVID farmers agree to fallow between 7% and 28% of their irrigated acres at MWD's discretion in exchange for a series of payments. Farmers receive a one-time sign up payment of $733/acre, and then are compensated based on acres fallowed in any year that MWD calls for water. Annual pricing for fallowed land was $4,400 per acre in 2013. Prices are adjusted upwards for inflation annually. In addition to direct payments to PVID landowners, MWD also contributes to PVID administrative costs for running the program and has contributed $6 million for local community improvement programs.

PVID has approximately 91,400 acres in irrigation at full capacity. Therefore the maximum amount of fallowing in any given year can be approximately 26,000 acres. Fallow land is maintained in accordance with a set of soil and water conservation practices prescribed by the MWD/PVID agreement. Additionally, all lands will be called on by MWD to be fallowed a maximum of one out of every five years to ensure long-term soil health. The fallowing program can provide between 25,000 and 118,000 water to MWD per year.

The MWD/PVID fallowing program is a good example of long term market-based reallocation of water from a water-rich but sometimes financially stressed user (rural agriculture) to a water-poor but financially powerful water user (municipal water providers). Achieving such large-scale reallocation through other means would inevitably involve conflict, pitting farmers against city dwellers in a lose-lose proposition. By entering into this innovative agreement, MWD secures much needed and flexible water supplies while leaving the farms that control the water financially whole. At the same time, by rotating through the acres that are fallowed in any given year and promoting soil and water conservation on farms, the program also does not permanently transfer PVID lands out of agriculture.

Source: MWD (2013)

7.2 Heterogeneous Products

Few goods in any market are truly homogenous. But, water rights in the western US are perhaps unique in their degree of heterogeneity. The heterogeneity of water rights in priority, type of right, quality, quantity, source, type of water user, end use of water, etc. creates an incentive to trade (McCann and Garrick 2014). The gap in marginal prices between urban and agricultural water rights in the West suggests that market-based reallocation of water rights could benefit buyers and sellers (Libecap 2005; McCann and Garrick 2014). At the same time, heterogeneity increases transaction costs (Ostrom 2003). Under Prior Appropriation, where water rights in an area are defined relative to one another, heterogeneity makes the value and reliability of water rights difficult to compare (McCann and Garrick 2014). For water markets to function effectively, they must account for the countless differences in water rights and their respective hydrological interactions (Pagel 2016; M. D. Young and McColl 2009).

Few goods in any market are truly homogenous. But, water rights in the western US are perhaps unique in their degree of heterogeneity.

In terms of the heterogeneity of the product, in this case water rights, the primary problem area comes from the many classes of priority dates for water rights. It is not unusual to have over twenty or more distinct priority dates, even on small creeks. Each priority date may signify a different reliability with which water is delivered, and therefore represents a different product. The difficulty of course is that this makes evaluation of the worth of a given water right difficult in terms of both expected reliability and value. When trades are infrequent, this makes estimating value a difficult and uncertain exercise. An alternative is the Australian system in which entitlements are grouped into just a few categories: e.g., into high, medium and low *security* entitlements. While Prior Appropriation seems the extreme in terms of heterogeneity there are various adaptations that ameliorate these affects. Three of these instances are discussed below.

In some locations, irrigation districts or companies may manage rights of varying priorities but treat patrons within the district without regard to the priority of the water right that is technically speaking appurtenant to the water user's land. This greatly simplifies the administration of water within the district, but may complicate efforts to market water rights. As long as they remain within the district the rights effectively remain of equal reliability and value. However, when a right is sold or leased to users outside the district the right will be subject to calls in order of priority. This introduces a divergence in reliability and value between what the water right holder sees inside the district from what the prospective buyer will find outside the district. So, the effort to simplify priorities and usage within the district just makes water marketing that much more problematic when it comes to consummating a transaction between buyer and seller. Box 13 provides an example of the issues that arise in such a case with water leasing for instream uses from the Tumalo Irrigation District in Oregon. As the district does not permit permanent transfers out of the district, this problem is inconvenient for those involved. Should the district allow transfers the issue would likely become a major headache for those involved.

Box 13: Marketing Rights Managed in a Correlative Fashion within a District

In Oregon's Deschutes Basin water users within the Tumalo Irrigation District hold an array of natural flow rights on Tumalo Creek and the Deschutes River, as well as rights to storage on Crescent Creek, tributary to the Deschutes. There are eleven different significant priorities on the creek split between TID, Bend and instream uses. The district is the only significant irrigation user on the creek and the district holds seven priorities on Tumalo Creek: 1900 (2), 1905, 1907 (2), 1913 and 1961. The district serves all acres equally, greatly simplifying day to day administration, particularly as the creek is over-appropriated in the late summer months and over time portions of each of the district's priority were exchanged or sold to the City of Bend, making water rights distribution a constant issue through the late irrigation season.

Since 2003 the irrigation district has partnered with the Deschutes River Conservancy on an instream leasing program and conserved water projects. The effort to lease instream rights is awkward. Due to the district policy of treating all users equally the district requires that the Conservancy offer the same price per unit volume for leasing for all priority dates. And yet when the leases are submitted to the state they come from specific lands, which have specific priorities. In late summer, when flows in the Creek are very low below the district diversion the leased water may or may not be in priority depending on which water is leased that year. From year to year the Conservancy may pay the same amount to lease an agreed upon quantity of acres, but the instream value of the rights leased can vary tremendously. The 1913 and 1961 priorities will receive little to no water in the late summer, whereas the 1900 priorities are senior. In a further wrinkle some of the senior rights are volume limited and only available for a portion of the irrigation season. The complexity of organizing and administering water leases (or transfers) in this context is therefore considerable.

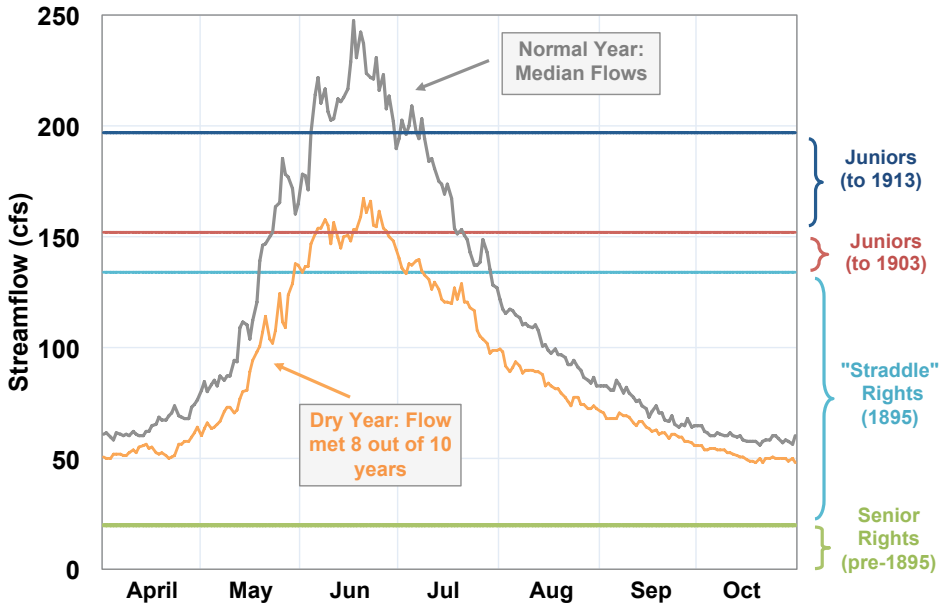
Though there may be many priority dates and classes of rights, this does not mean that every right is of different priority and hence value. Dates of priority reflect dates of application. Typically, what is seen in western basins of the US is a number of smaller individual entitlements dating from anywhere from the 1850s onwards. Due to the Carey Act of 1894 that enabled private irrigation companies and the Reclamation Act of 1902 that provided federal funding for large irrigation projects, there are often large batches of water rights present from the mid-1890s and on into the 1900s. While the dates vary from place to place the reliability of these large batches of rights is often well known, at least in part because of the need of irrigation companies and districts to communicate regularly with their patrons as to which water right is served.

For example, on Whychus Creek in the Deschutes Basin there are water rights that have more than twenty priority dates between 1869 and 1913. However, when set against water availability it becomes clear that in terms of reliability they can be parsed into four groupings of varying reliability (see Figure 11)

1. High Security – senior rights with pre-1895 priority dates have access to water all season long.
2. Medium Security – the large batch of *straddle* rights of 1895 priority date see cutbacks in water from July and August onwards in most years.
3. Low Security – rights with priority between 1895 and 1903 inclusive receive water only during the middle of the irrigation season and for as little as one month during dry years.
4. Very Low Security – rights with priority of 1904 or junior receive no water in dry years and only one to two months during normal years.

In other words although these appropriative surface water rights are extremely heterogeneous at face value, they divide rapidly into just a few classes in terms of reliability. So they may look complex from the outside looking in, but for those living with these rights they may not be quite so difficult to value and trade.

FIGURE 11: WHYCHUS SURFACE WATER RIGHTS



And finally, where naturally flowing surface water rights are unreliable for many irrigators it is often the case that supplemental sources are layered on top of the primary natural flow rights. It is not uncommon to find surface water storage rights paired with underlying junior natural flow rights. To protect against low storage years, or in the absence of storage, supplemental groundwater rights may also be appropriated to reinforce junior natural flow rights. And finally, as insurance against periods of dry years, excess or flood rights are apportioned in some systems in order to recharge the groundwater during wet periods (i.e., when all other uses are met water is simply turned out to recharge the aquifer). Obviously, this layering of water rights is extremely beneficial as a means of ensuring a reliable supply of water for agriculture. Just as obviously, developing such rights across all potential sources maximizes the ability to access each part of the hydrograph for irrigation. This may mean complete dewatering of streams and downstream freshwater dependent ecosystems. For example, in the Walker Basin in Nevada a mix of all four of these rights are appurtenant to farms and ranches. Evaluating the reliability and value of these different primary and supplemental rights for the purposes of restoring Walker Lake is a significant task (Warren 2016; Borgen et al. 2014). To some extent the elegance and efficiency of these water right systems makes them inordinately effective for the purposes of completely tapping the water resource for irrigation, but makes their unraveling for the purpose of marketing or trading a complex endeavor. That said the end result is that, again, bundles of these rights often lead to the same reliability for the underlying irrigation right, even if the primary rights vary in priority.

In water markets where the unit of trade (typically, but not always, water rights) is more homogenous, the trading process is more straightforward. The Twin Platte case study from Nebraska illustrates how relative homogeneity simplifies market transactions (R. Young 2016). The vast water of groundwater withdrawals in the Twin Platte Natural Resource District (TPNRD) irrigate corn and soy, and the unit of trade in the market is the right to irrigate (CIAs). Subtle differences in farm characteristics, such as slope or soil quality, provide enough variation to incentivize trade amongst farmers in the District. However, by using CIAs as the unit of trade rather than volumetric water rights, the TPNRD market avoids some of the complications associated with the water markets described above. First, by monitoring CIAs through annual aerial flyovers, TPNRD avoided some of the unpopularity associated with metering water use on private farmers. Second, using area-based trades as opposed to volume-based trades avoided the problem

of adjudicating groundwater pumping as property to land were already clear and secure. Area-based trades also provided irrigators with a degree of flexibility as the volume of groundwater that they were allowed to pump on their CIAs did not limit them. If they had a right to irrigate one CIA, then they could pump what they needed (or what was cost-effective given the costs of groundwater pumping), and this amount could vary by year.

7.3 Incomplete Information

Access to a range of potentially useful market data is difficult in most water markets. In the western US, water right databases maintained by state agencies are of variable quality and utility. Further, water right information is often not updated regularly and so may be out of date or reflect dormant rights. Hydrologic information is frequently available for major streams and rivers, particularly those developed for human uses. The US Geological Survey (USGS) maintains gages in many of these drainages, augmented in some cases by gages maintained by state agencies. The USGS and state agencies have also surveyed, analyzed and modeled many western aquifers. Surface water reliability is largely the product of hydrology and water rights. As mentioned above, understanding water reliability can be difficult the more heterogeneous the entitlements. Prior appropriation relies on a complaint driven system of user calls on water and the regulating off of junior users. Therefore, in most locations there is a watermaster or water commissioner responsible for administering water rights. Records of this administration provide a useful source of information for understanding water right reliability, but may be of uneven quality. Finally, transactions are often consummated between private parties and the details of price are not necessarily recorded (or recorded accurately) along with the transaction. Information brokers and appraisal firms collect this data but it is privately held and not readily available to the public. In the western US the data needed to inform market participation is far from complete and access to that which is available comes at a cost.

Lack of information can be parlayed into a basis for avoiding any questioning of the new status quo

The Treasure Valley case study provides a particularly instructive illustration of how a lack of data and reporting on water use by irrigation entities can pose a stumbling block to even understanding how changing needs and uses of water have affected irrigation operations (Fereday 2016). This lack of information can be parlayed into a basis for avoiding any questioning of the new status quo, in this case where irrigation rights are used to water large residential areas. The Treasure Valley case study makes it clear how fundamental the possession of basic water use and management data is to formulating plans and policies to enable water trading.

7.4 Asymmetric Information

Asymmetric information simply means that one party to the transaction has more or less information than the other party. Under such conditions, pricing of water transactions is unlikely to be fair or equitable. This may cause market activity to diverge from efficient levels. This is a concern but not as much of a concern as if asymmetries in information lead to complete lack of participation in the market, for example due to mistrust of information that is available. Asymmetric information in western US water markets is difficult to avoid given the issues of incomplete information raised above. Effectively, being a well-informed market participant will be costly. As a result, large public or private entities that have repeat business in the market (as buyers or sellers) are likely to have a considerable advantage over the individual who has one entitlement to sell or just needs to buy a small amount of water. Indeed, one of the advantages of smart markets – automated, anonymous bidding systems – is that buyers and sellers post offers and the market is cleared according to an algorithmic trading program that eliminates the inequities of asymmetric information (R. Young 2016).

7.5 Barriers to Market Entry

In the western US there are no formal barriers to market entry for sellers or buyers. That said it is rare that buyers or sellers venture into the market place without professional advice (as is the case in the real estate market). However, no professional qualifications or licenses are required to act as a water rights broker. Nevertheless, given the complexities and peculiarities of individual markets, as well as the degree of incomplete information, professionals that seek to service customers in the market, for example as brokers or attorneys, will require specialized preparation to provide useful services. In particular, local peculiarities of particular systems of hydrology, water rights and water infrastructure mean that offering such services across different basins is difficult. Doing so across states, in the case of attorneys and appraisers, requires further investment in obtaining and maintaining the relevant license or professional qualification in each state. This is not so much the case for hydrologists and engineers whose skills in the physical sciences carry better across state lines and between basins.

A commonly cited barrier to trade is that buyers and sellers have difficulty seeking one another out (Culp, Glennon, and Libecap 2014; Gray et al. 2015; R. Young 2016). In the Nebraska case study, those wishing to buy or sell CIAs often resort to posting on Craigslist or in newspapers, or inquiring with neighbors (R. Young 2016). In addition to the time and effort associated with seeking out trading partners, not all trades (i.e. compatible buyers and sellers) are guaranteed regulatory approval. Moreover, one-to-one trades do not necessarily satisfy the needs of buyers and sellers as the quantity of water (or CIAs in the case of TPNRD) offered by the seller may not match the amount desired by the buyer. The time and effort required to achieve these one-off trades underscore the need for an efficient trading platform. The Mammoth Trading smart market offers a centralized platform for trade in TPNRD. By internalizing transaction costs associated with gaining regulatory approval, and by acting as a marketplace for interested buyers and sellers, Mammoth Trading reduces the burden of market entry for participating irrigators.

A final element related to market entry is the endowment effect and the consequent exaggerated threshold of sellers' willingness to accept. If sellers fail to put forward an accurate estimate of their willingness to accept, and instead place a premium on the price they are willing to accept from the buyer, this simply squeezes the potential gains from trade and increases the probability that either there are no gains from trade or that transaction costs will stand in the way of a consummated transaction.

In this regard, research has shown that people holding an asset that is not frequently traded and, therefore, for which there is no market and/or the market value is uncertain will focus on the loss from giving up the good and not the potential gains from the sale when asked to sell the asset (Thaler 1980). This *endowment effect* implies that it will be difficult to persuade such asset holders to part with property of this nature. Water rights clearly fit this definition of a long held asset that is rarely traded in a market. A practical implication of the endowment effect is that potential sellers will demand a premium to sell or trade. This problem is frequently observed in water markets. Implicitly then there is a need by the buyer (or the market) to find a way of overcoming this fear of loss – and to persuade the water right holder to focus on the potential gains of the transaction. Two obvious solutions are simply education and the passage of time, so that water right holders grow accustomed to water trade and water pricing. Accelerating such learning may best be achieved by expanded efforts to make information about water rights, water markets and water trade available and transparent to water right holders. This may address market imperfections of incomplete and asymmetric information, as well as market entry. Ultimately, the opportunity for gaming markets and strategically manipulating market participation depend on a lack of market information and transparency. Rent seeking behavior is always easiest when market participants are not well informed and do not have avenues of communication.

7.6 Summary

This section examined a number of market imperfections affecting western water markets. A number of imperfections appear to limit market activity by closing markets or by reducing the potential gains from trade:

1. Market concentration in one irrigation entity, or amongst a few irrigation entities, often exists at the basin scale. This enables these entities to individually or collectively (through collusion) concentrate political power and exercise market power to control and limit access to their patrons and water marketing. This may lead to the extraction of higher than efficient prices when rights are sold, thereby satisfying fewer demands, but just as often it leads to a market closed to outside interests.
2. Asymmetric information favors market insiders and large entities that are frequent participants in the market skewing pricing in favor of the former leading to low participation rates or remorse and distrust of the market by the casual participant.
3. The endowment effect leads potential sellers to focus on the loss the will experience from giving up the right and not on the gains from trade in the market, implying that a significant price premium is needed to tempt these water users into the market.

There are also a number of market conditions that adversely affect trade by limiting the efficiency of the market:

1. The heterogeneity of water right priorities make due diligence on the expected reliability of a water right and appraisal of value more difficult and costly for the prospective buyer. This complexity is magnified when a buyer wants to purchase and remove a water right from an irrigation entity where there are multiple classes of rights but by customary practice available water is shared without regard to priority. Where different sources of water are layered on for a given irrigation use disentangling these sources is another complicating factor.
2. Incomplete information, e.g., a lack of, or poor, data on water rights, their extent, validity and transferability creates uncertainty for buyers and sellers reducing market participation.
3. Barriers/high costs to entry (and exit), e.g., fees, qualifications and the need for specialized advice in order to participate in the market impede the efficient entry/exit of buyers/sellers to the market.

In the discussion, a few potentially constructive ways of addressing these imperfections or using their existence to advance market activity were identified:

1. Market concentration may also be useful in increasing leverage on the buy side of markets. Where public or public interest organizations represent the unmet needs for water for municipal, industrial or environmental purposes they may also band together to exercise political and market power. This may assist in opening up markets and can keep costs down for new water users where there are willing sellers.
2. Just because rights are heterogeneous with respect to priority date does not necessarily imply that each class of priority is a distinct product. When set against the available water supply and when the full range of sources used in irrigation are considered the system may reduce to a lesser number of products with their own reliability, which may reduce the transaction cost burden of heterogeneity.
3. Smart markets provide an intriguing opportunity to limit the inequities that emerge due to asymmetric information and thus may encourage higher participation in transactions programs.

8. Policy Responses

So far the paper has walked through the enabling conditions for markets and the conditions for competitive markets in the western US. The emerging picture is of an appropriative system of water rights that was designed to foster the development of water resources but that was not constructed with the reallocation of water rights in mind, and often not with groundwater sustainability or the water needs of ecosystems in mind. The basic conditions for market activity are present due to the underlying presence of scarcity, well-defined and secure rights, and the ability to trade and transfer rights. However, there exist a raft of issues and loopholes with respect to these conditions that limit or impede market activity. Diving more deeply into market conditions a number of market imperfections are present which lead to further restraint of trade and inefficiencies that impede trade.

Policy responses to water management and markets are going to be largely incentive-based.

Perhaps the most significant finding is that the high degree of security afforded to water rights in the western US is accompanied by a corresponding low degree of flexibility in the rights. While security empowers markets, the lack of flexibility constrains collective action. There is only a limited ability of public policy to intervene and directly reallocate water, set limits or adjust allocations, i.e., to deploy a command and control approach to water allocations. Policy responses to water management and markets are then going to be largely incentive-based. These responses fall into one of two arenas:

1. Fiscal policy: changing incentives and allocations while working within the rules of the game.
2. Policy reform: changing the rules of the game, but doing so in a way that adds to the rules of the game rather than taking away rights from those already in the game (existing users).

Incentive-based fiscal policy consists of three main instruments: water charges, subsidies and buy-backs. These are summarized briefly as they relate to water markets in the first sub-section below. In light of the many rigidities and inefficiencies of existing western water codes the ability of policy reform to loosen the rules and expand authorities to create new opportunities for flexible water use and water rights administration is expanded upon at some length. The intent is to provide an idea of the range of options that are being explored across the west and that may represent some of the best ways forward to work within Prior Appropriation to achieve healthy water markets.

8.1 Fiscal Policy

Working within the rules of the game means resorting to a traditional set of policy instruments for managing natural resources and the environment. As discussed in Section 3.4 of Part I of this report, if the goal of public policy is the efficient and sustainable use of water resources then policy needs to ensure that water right holders face the opportunity cost of their use of water. This can be achieved through a system of competitive market prices or a system of taxes and subsidies. Each of these is discussed in turn.

Public policy can attempt to incentivize water use efficiency and re-regulate water use by instituting charges on water rights, effectively taxing water use. Tiered or conservation-based rates are a well-known and frequently deployed instrument for encouraging residential and industrial water users to conserve water. The question though is how does this approach work for irrigation uses? Imposing charges on irrigation users for water usage, in addition to those already charged to recoup the costs of water delivery, are largely unheard of in the western US. Given the checks and balances in the legislative process and the

political economy of rural America the imposition of such charges in the western US seems unlikely. If anything is as much an anathema to rural water right holders in the western US as condemning water rights, it would be water use charges.

Further, imposing charges on irrigation water uses seems a difficult and potentially blunt instrument for encouraging irrigation water use efficiency. Such an approach relies on the capacity of the administrative agency to design and select the rates. It also makes certain assumptions, an important one being that it is possible on large irrigation conveyances to order water and measure water use. While this is typically feasible for conveyances serving larger farms and ranches it may not be as feasible for the many systems that serve a range of farm sizes, including urbanized lots. Going the route of water use charges suffers from two additional limitations. First it makes the incentive system an administrative not market-based system. State agencies would have responsibility for determining the rates to charge. This means that market price signals, as driven by changes in supply and demand, are disconnected from rate decisions (Willey 1992). Second, the western states already have signed up to a system of marketable water rights. Even if this system does not work as well as it should, layering a system of water charges on top of this market system in order to achieve efficient and healthy outcomes could be a complex undertaking. Certainly if the public policy objective is to cause irrigation users to reduce their water use a simple system of charges could be layered on top of the existing market system. But this just returns to the initial political economy problem of arriving at the necessary political agreement to institute such a system. This seems an instrument of last resort.

An alternative to taxing resource use is to subsidize desired behavior. Public policy can incentivize water use efficiency through water conservation funding programs. The saved water is, at least in theory, then available to other users. Many such federal and state programs exist in the western states. Again, this can be a blunt instrument for water allocation if the saved water is not controlled or directed but rather left to open access. Often such funding programs subsidize irrigation efficiency improvements with little clarity as to whether the saved water goes to benefit the public or whether other private interests simply scoop this water up for private benefit. These subsidy programs are an important tool and a significant topic in their own right but are not explored further as they are tangential to the topic addressed in this paper.

The remaining alternative fiscal policy is for government to directly intervene in the market. Government can buy back water rights. The rights can then be retired to reduce over appropriation, or used to create new rights to meet human or ecosystem demands. Typically, in the western US this means that the public, i.e. federal, state or local government as well as other public entities, either purchase or lease water rights or provide funds to intermediaries to do the same. The Truckee River case study provides an excellent example of this as federal funding went to purchase water to support environmental flows for Pyramid Lake and habitat at the Stillwater National Wildlife Refuge as part of a broader political settlement of water conflicts in northern Nevada (Sanchez, Aylward, and Springmeyer 2016). Directly engaging in the market does not necessarily improve market function or efficiency, and it is costly in terms of public funds, but it is a direct means to achieve water allocation as a matter of public policy.

The remainder of this section examines a suite of policy responses that reform the water rights system or water markets in an effort to engender active, efficient and healthy markets. These reforms are in addition to a number of such reforms already mentioned in the paper.

8.2 Flexibility of the Water Rights System: Incentives for Water Use Efficiency

The strong security and low flexibility of water rights imply that improving markets, and creating healthy markets, will be central to meeting changing needs in the western US in a positive and proactive manner. In this regard it is vital to ensure that the ability to incentivize efficiency and carry out trade in water rights is as flexible as possible, without undermining the protections afforded to existing users, civil society

or the environment. While a tall order it is argued that this is not a zero sum game and that there are win-win reforms. Essentially the argument is that water codes in the west are not perfect and can be improved.

8.2.1 Prior Appropriation and the Use it or Lose it Problem

Under Prior Appropriation the development benefits of defining the priority of rights by date of application is clear, but not without countervailing concerns. A priority system for allocating available water creates distinct winners and losers by explicitly favoring certain rights over others during shortage. This is different than in a correlative system in which all users have equal priority and share the available water. Under Prior Appropriation, curtailment during shortage occurs without regard to the use being made of the right; that the right is senior is all that matters. Further, in many, but not all states, permitted rights are subject to forfeiture. Non-use of the right for a period of time, typically five years, may make the right forfeit or the use subject to claims that the right has been abandoned. Even further the use of only a portion of the amount of water specified on the water right certificate may make the right subject to partial forfeiture. *Use it or lose it* is a provision of Prior Appropriation as a beneficial use system.

A common refrain is that this feature of Prior Appropriation leads water users to take all the water that is available to them each year, with little incentive to take only what is needed or to invest in water use efficiency. The security of the right leads users to feel confident in their ability to access their entire right every year, just as they (and those who came before them) did in past years. However, what worked one hundred years ago in terms of diverting and using water, can seem out of place today given starkly different contexts in terms of overall water demand and availability. Thus, rather than creating the conditions for flexibility and coaxing addition marginal economic benefit from available supplies, priority in time may have the unfortunate effect of promoting the status quo of water use among a few inefficient users.

The use it or lose it problem relies on a few unstated assumptions, all of which need to be true for the statement to hold. These assumptions relate to the ability to spread water saved by more efficient use and the inability to market saved water. These points are examined in detail in order to be clear about when and where the incentive to use more water than is necessary applies, and under what conditions it does not apply. The goal is to identify potential policy reform that creates new flexibilities for addressing this problem. The analysis begins with the incentive to save water and then moves on to the marketing of water.

8.2.2 Spreading Saved Water to New Irrigated Lands

The first assumption is that an investment in irrigation water use efficiency would not allow the user to bring more land into production and garner additional profits from a set amount of water under the right. So-called *spreading* of water across a larger area (than was originally permitted) is indeed generally not allowed. Spreading can be an enlargement of the water right. It can create additional consumptive use on the newly irrigated acres. By investing in water use efficiency and spreading the resulting savings a portion of the diverted amount that formerly went to seepage is converted to consumptive use and lost to the river system. The premise that the system is over appropriated and that the seepage contributed to other existing rights provides the implicit rationale for not allowing spreading of saved water to a new consumptive use. This situation originates in the definition of the water right as a diversion quantity destined for irrigation of a specific set of acres. This is very different than the case in Australia where rights are defined as consumptive volumes at the point of take and not as area-based rights (Dyson 2016). In that case, there is every incentive for the irrigator to be maximally efficient so that they may either irrigate additional lands, or market the water.

In the US west then there is a logical rationale for not allowing the spreading of water. In a fully appropriated system this would threaten the security of the rights of others. Of course in systems that are not fully appropriated, investments in water use efficiency that enable spreading would be economically advantageous. The problem is that if water rights are still available for permitting then the farmer who would like to expand their acreage can simply apply for these rights. There is no need to spend scarce cash on improving efficiency. If there is no water available then saving water would in theory make new water available, but in well over-appropriated systems this is not that likely. A further case is where water is so short that historically full irrigation of lands was not achievable. In this case the irrigator may choose to invest in efficiency and gain the ability to fully irrigate lands under the right. The obvious issue here is that this represent a case of resuscitating dormant or *sleeper* rights, which poses other issues. In theory those rights would be forfeit and the investment and the spreading would not occur. In reality, forfeiture is rarely applied outside water transfers. In sum, spreading water to new acres is generally not an option under Prior Appropriation and thus it is not useful in combatting the use it or lose it problem.

8.2.3 Use it or lose it and Junior Users

A further permutation of the water spreading assumption relates to water users that are short irrigation water during some period of the year. This statement applies to all but the most senior rights on a system, i.e., those whose rights are filled by baseflow in the system. Given patterns of precipitation in the western US and the profile of crop water demand, such seasonal shortages are widespread, particularly in late summer months. With climate change these seasonal shortages are likely to increase. Arguably such water users have an incentive to invest in water use efficiency. In this case by investing they are able to move towards a full allocation of water and reap the higher productivity and returns associated with this investment. It is important therefore to emphasize that the argument about the lack of incentive to invest in water use efficiency under Prior Appropriation essentially applies to senior, not junior, users. Typically western states have passed statutes that make it clear that a historic shortage of water, or continued use of water less than the maximum amount under the water right, does not lead to partial forfeiture of the underlying right (Koehl 1998). Such a rule incentivizes investment in efficiency, even if it means that such users effectively may claim an additional portion of consumptive water the benefit of which junior users previously enjoyed.

8.2.4 Marketing the Saved Water

But these arguments about investment in efficiency are all about the incentive for investment by the water right holder in water use efficiency for the purpose of increasing their own water use. How do the existence of water markets play in the hypothesis that senior rights under Prior Appropriation will use and waste water without concern for its economic value? A second assumption implicit to the hypothesis posited above is that the water right holder cannot invest in efficiency or reduced water consumption and then market that saved water. This issue can be sub-divided into two authorities. The first is the authority to market the saved water directly. This includes the authority to save and transfer water that was consumptively used or the non-consumptive water previously lost to seepage. The second authority is the ability to retain and sell the saved water when marketing the full water right.

Marketing Consumptive Use. For storage rights there is little constraint on the ability to market a reduction in the consumptive portion of a water right. Once water is stored in reservoirs there are often few restrictions on parsing or bundling water allocations for marketing to other users. This as stored water is water removed from natural flow and there is not the same level of concern over how that water is then parsed between consumptive and non-consumptive uses. As the water was stored in priority and is available in a later period, a change in its use should not injure another irrigator relying on natural flow. Beyond the case of stored water the potential to market a savings in consumptive use is more difficult. In general the splitting of the rate or duty for a natural flow water right in order to establish another

consumptive right poses potential enlargement issues. In particular, water managers and regulators typically oppose such proposals as such transfers are problematic in terms of how to manage, monitor and administer a reduced rate or duty right. Splitting a consumptive right into two seasons and marketing a portion is feasible. But attempting this with a portion of the rate or duty across the full season of use is a more complex undertaking. This may be an area for further investigation given that the potential utility of being able to trade in consumptive use units, as outlined above in the Australian case. Potential avenues for enabling these transactions may be technological in nature. For example, remote sensing of evapotranspiration of irrigated areas may provide a method for managers and regulators to insure that this type of transaction does not result in an enlargement of consumptive use under the original water right. This could even extend to the spreading water as discussed earlier.

Marketing Non-Consumptive Use. Historically, there was no incentive to invest in saving water that simply is lost back to the stream, or to the groundwater system and from there back to the stream. This meant that it was a normal practice to simply divert the full amount of one's water right all the time. There was no value to leaving any water instream. However, the inclusion of environmental flow and instream rights into water rights system is creating the demand for this water. Where diversions by senior users are hugely inefficient and dry up waterways, environmental buyers are now willing to pay for these improvements. The hitch is the ability to protect the water saved by efficiency improvements for an instream use, often called *conserved (or salvaged) water*. In an area with a single diverter, contractual arrangements can be struck to create these voluntary arrangements and fund efficiency improvements. On systems with multiple users and diversions it is vital to be able to protect the saved water from diversion by others. This requires the ability to permit or otherwise create an enforceable call on this instream water. While by no means universal, state water codes are evolving in various ways to enable these water right transfers, i.e., creating conserved water and instream rights from the original rights. Box 14 provides an overview of Oregon's Instream Water Rights Act and Allocation of Conserved Water Program. These are non-consumptive use to non-consumptive use transfers and thus do not pose the same problems with enlargement of the original right. That said conserved water is typically protectable instream only as far is feasible without injuring existing rights that rely on the diversion of this water. The utility of the tool is therefore situation dependent (Aylward 2013a).

Eliminating Partial Forfeiture. Another way that the use it or lose it problem can be avoided is to eliminate partial forfeiture. Generally, administrative application of the forfeiture rule for entire irrigation rights is only rarely undertaken (Neuman 1998). One instance when this may occur is when an effort is made to transfer a right that does not have the required evidence of historic beneficial use. Partial forfeiture is more difficult to prove and thus even more rare. However, it is a frequent concern and often cited by water users as an obstacle to water marketing. There is a general reluctance to expose rights to scrutiny by the state. And yet this must happen to engage in water marketing. Eliminating partial forfeiture may compromises traditional principles of beneficial use and forfeiture but it is one way of achieving greater flexibility in water rights administration (Koehl 1998).

Oregon provides an example in this regard. After a number of years of effectively not enforcing partial forfeiture the state agency put the question to the legislature. In 1997, Senate Bill 869 codified this practice by adding an exemption to partial forfeiture in the case where a water right holder has a facility capable of handing the entire rate and duty of the right and the user is otherwise ready, willing and able to make full use of the right. The bill was motivated by the legislature's desire to avoid irrigators' feeling as if they needed to use all the water under their water right once they had become more efficient (Koehl 1998). Or put another way, when contemplating an investment in water use efficiency the user would not feel that to do so would put their water right at risk, or negatively affect their ability to transfer water later. Similarly, the intent was to avoid penalizing users that moved to lower water use crops, such as wheat, and then later wanted to return to a higher water use crop, such as alfalfa. It is important to recognize that the state administers this exception only with respect to the rate, duty and season of the water right. An

irrigator that has evidence of irrigating only half their acreage will still forfeit half their water right upon transfer review. This as they have not shown that they are willing to irrigate their full water right.

Box 14: Oregon's Instream Water Rights Act and the Allocation of Conserved Water Program

As with much of the western US, settlement of the state of Oregon and the associated appropriation and development of water resources led to the over-allocation of Oregon streams and rivers. Over time, this led to a decline of salmon populations, as well as resident fisheries. The environmental, social, spiritual and economic values associated with healthy riparian ecosystems and aquatic biodiversity were eventually recognized in policy and legal reform aimed at restoring water to streams and rivers. In 1987 the Oregon legislature passed Oregon's Instream Water Act (the Act), which recognized that state water policy should be aimed at meeting both human uses and those of freshwater ecosystems.

The Act converted all existing minimum stream flows (which were established by administrative rule) into instream entitlements, equivalent to traditional out-of-stream appropriations. These new instream entitlements dated from 1955 at the earliest, which made them junior to, or less secure than, most existing water rights. The Act, however, put instream entitlements on a level playing field with out-of-stream uses meaning that entitlements could be acquired and transferred to instream uses without loss of priority. The Act also includes an explicit program to incentivize water conservation as a means to assist the state in its efforts to provide for current and future water uses, but in particular to assist collaborative efforts to restore streamflow. The Allocation of Conserved Water Program allows water right holders who invest in more efficient water delivery systems to save water and to then either leave the conserved water instream indefinitely, or apply it to another consumptive use. The amount of water that results from conservation measures is calculated as the difference between:

- the smaller of the full amount of the paper water right or the maximum amount of water that can be diverted using the existing facilities (this as facilities can degrade over time such that the full amount of the water right can no longer be diverted); and
- the amount of water needed after the implementation of conservation measures.

In addition to avoiding injury to other entitlements, the program requires that a minimum of 25% of the savings that are declared as conserved water be dedicated to an instream entitlement.

Application of the program did not really gain much traction until the early 2000s. By 2014 some eighty-five applications had been filed. Initially, the predominant use of the program was to generate instream entitlements. In other words, conservation groups have funded irrigation water use efficiency projects to save non-consumptive water that was previously diverted. The savings are then transferred to instream entitlements that restore streamflow between the prior point of diversion and the point at which this non-consumptive water would have returned to the stream. As of 2008 Oregon's Department of Water Resources had issued final orders on 37 applications with a total flow rate of almost 100 cfs.

The Allocation of Conserved Water Program remains somewhat unique in its treatment of conserved water in the western US due to the ability to create permanent instream entitlements from water conservation projects. Some states, such as Washington, allow time-bound transfers or leases of water savings. Other states have no legal provision for incentivizing water conservation in this manner allowing only the transfer of the consumptive use portion. Further, no other state has a formal program that provides incentives for, and rules regarding, the legalized 'spreading' of irrigation water. While this element has taken longer to be adopted by water users the program provides a specific example of how this might be undertaken while still providing a net benefit to environmental flows.

Sources: Amos (2008) and Aylward (2008)

8.3 Policy Reform for Flexibility: Adding to the Rules of the Game

In this section a number of policy responses that add to the rules of the game are briefly explained. The intent is to show that in many jurisdictions regulators, water users and stakeholders are experimenting with ways to improve the incentives for healthy water markets, and often doing so by increasing the flexibility of the water rights administration system. The list of items covered is not intended to be comprehensive but rather illustrative of the types of opportunities that are underway. For a more comprehensive review the National Research Council's report of 1992 remains the standard, particularly as many of the recommendations in that report have yet to be fully implemented (National Research Council 1992) The examples provided here rest largely on new legislation. Nevertheless, there may also be important opportunities in rule-making under existing law (Gould 1988).

8.3.1 *Dual Purpose Irrigation and Instream Rights*

A unique element of Texas' law on water right amendments is that it allows water right holders to add a use to their right such as environmental use without requiring the user to switch to that use entirely and/or for perpetuity (Texas H.B 3, 2007)). Put differently, once a user has added a new use to their water right, they are free to split their use between the alternate uses in terms of volume and season of use as long as the additional use does not enlarge on the original water right. So an irrigation water right with an environmental use amendment could do one of several different things: split the volume of their water right between irrigation and environmental use at the same time, split the season of use such that they use the water for irrigation for some of the season and for environmental use for other parts of the season, or switch between irrigation and environmental uses from one year to the next. California also offers a similar type of flexibility, referred to as *stacking*. Water users in California can add uses to their water rights and allocate water to the different approved uses under their right at any given time (Szeptycki et al. 2015). Both the Texas and California approaches to adding uses to existing rights go through a transfer process to guard against enlargement of the original water rights. This type of flexibility is relatively novel and untested, but provides an excellent example of the type of innovation needed to increase the flexibility of water use.

8.3.2 *Expedited Leasing Programs*

Water leasing can be a low cost and flexible water transaction tool. Annual water leasing for environmental purposes has proven a useful tool in the Pacific Northwest. Nowhere more so than in Oregon where over 1,550 instream leases have been filed since the first one was submitted in 1995. One reason for the success of the program is that the lease approval is expedited. While there is a public notice issued and a watermaster review of beneficial use is conducted the leases are approved without an injury review. Should issues arise following approval the lease is quickly unwound by the state. This sort of aggressive risk-taking by state agencies is rare but should be encouraged. Oregon's program can be compared to California's temporary environmental transfer statute, which also appears to offer a streamlined, expedited administrative process for simple temporary transfers. However, in practice, the tool has not been widely or successfully used. A recent study found that the average approval time of environmental transfers under section 1725 is over four months, despite the fact that these transfers are changes for one year or less (Szeptycki et al. 2015). As of April 2014, a total of only 15 temporary transfers had been approved since instream dedications became legal in 1991. Only two of these transfers were filed by small, private entities or NGOs and the remaining were filed by the Bureau of Reclamation or an irrigation district (Szeptycki et al. 2015).

8.3.3 *Surface to Groundwater Mitigation Programs*

As mentioned previously in this report, un- or under-regulated groundwater pumping can undermine otherwise secure surface water rights when the pumping is from an aquifer with a direct connection to a surface water source. It can also remove residual water from a river that would otherwise provide environmental or other benefits. Regulatory groundwater mitigation programs address this problem by capping groundwater withdrawals and only approving new wells that are mitigated. This type of mitigation is increasingly required in western states. Some states, like Montana and Idaho, have had to first litigate whether or not the surface water and groundwater resources are hydraulically connected (Ziemer, Kendy, and Wilson 2006).

Washington State is the most proactive state in the West at rule-making on groundwater mitigation, developing such rules and associated mitigation programs basin-by-basin across the state (Cronin and Fowler 2012). Though the approach in Washington is not universal, a number of programs are targeted at maintaining instream flows for ESA-listed fish species. The process begins when the state develops *Instream Flow Rules* (Geller 2003). These rules prescribe instream flows with the same force and effect as consumptive use water rights. They are given a priority date as of the adoption of the rule. Their practical effect is to essentially set aside any residual water not already appropriated or, stated differently, to cap the issuance of new out-of-stream water rights that consume water from the target river. These rules either explicitly include new groundwater wells that have a hydraulic connection to the target river, including otherwise exempt wells, or such wells are included more generally as a principle of state law. Once new groundwater withdrawals are capped, the only way to develop a new groundwater right is by developing or purchasing mitigation. Mitigation comes in the form of retiring an active, consumptive surface water use. The applicant can provide mitigation for a new well or it can be purchased from a local *water bank* or *water exchange*. These institutions act as intermediaries, acquiring consumptive use water rights to develop mitigation supply and marketing the resulting mitigation to those seeking a new groundwater right. While Washington has instream flow rules in 29 basins across the state there are still only a handful of active mitigation programs – in Yakima, Kittitas, Walla Walla and Clallam counties – as mitigation was added to these rules only after 2001 (McCormick and Christensen 2016).

Groundwater mitigation commonly serve a dual purpose of facilitating additional groundwater use and helping to restore instream flows for target aquatic species. Mitigation programs essentially take one existing water use, for example for irrigation, and leverage it into two new uses, one for instream use and one for a new consumptive use (generally domestic use, though sometimes also new irrigation uses). At the point of impact for the new groundwater use the flow added to the river offsets the pumping. However, typically the additional instream flow is added from a prior point of diversion that is well upstream. For example, in the Deschutes Groundwater Mitigation Program in Oregon, instream transfers that mitigate for new wells in fast-growing Central Oregon provide additional instream flow from the City of Bend on down to Lake Billy Chinook, a distance of some 30 miles. These surface to groundwater mitigation programs thus increase water productivity.

8.3.4 *Local Performance-Based Water Plans*

Another innovation is to delegate certain authorities from the state to the local level, provided that local stakeholders set and achieve performance goals that respond to policy objectives. The idea is to provide local communities that know the resource and the system with the ability to flexibly manage water to meet not only the goals of water users but the broader community (Doherty and Smith 2012; Pagel 2016). These could occur at different scales depending on need. Innovative legislation in Washington enables such plans to be formed at very local scales, effectively two or more water right holders may form a Local Water Plan (see Box 15). In the Umatilla Basin case study from Oregon, a similar concept is proposed but at a large-scale basin level. The idea is to promote effective water management and marketing by enabling

water users to work together to use water differently, with appropriate requirements to avoid injury to non-participating water users, and to provide instream flow or other measureable environmental benefits (Pagel 2016).

BOX 15: LOCAL WATER PLANS IN WALLA WALLA WASHINGTON

Local water plans are an innovation that was authorized by the state of Washington as part of a larger 10-year trial period for a "Flow from Flexibility" program in the Walla Walla basin. The Walla Walla Watershed Management Partnership was legislatively authorized in 2009 as a pilot water management program for the State of Washington. The program is intended to incentivize and test innovative, voluntary water management tools to allow for more effective use of existing water rights while simultaneously improving instream flows. An important element of the program is legislative authorization for Local Water Plans ("LWPs") that empower local governance of water resources, subject to clear standards to protect instream flow, aquifers, water quality and the interests of water users.

In a 2015 report to the Washington Legislative Assembly, the Partnership called LWPs "the most powerful tool the Partnership has to offer to water users…." The LWP program allows landowners to propose a comprehensive, integrated plan for managing water uses with substantially more flexibility than would be allowed under traditional water right management options available through the Washington Department of Ecology, the state's water resource management agency. As a trade-off for the additional flexibility and local control, each LWP must provide a "public benefit" and a portion of any existing water rights included in the plan must be dedicated to instream flow enhancement. LWPs are reviewed and approved at the local level, by the Partnership, subject to the standard of ensuring public benefit and accountability. The program includes a "banking" mechanism to hold un-used water rights or portions of rights with protection from forfeiture due to non-use during the time period the water rights are banked (RCW 90.92.070).

Source: Pagel (2016) and (Walla Watershed Management Partnership 2015, 13)

8.3.5 *State-run Administrative Water Banks*

Another useful water marketing mechanism is state-run administrative water banking facilities that serve as ways to change water uses. The water user places their water right into the state bank and then, depending on the rules in place, another user may take the right out of the bank, sometimes even for another purpose of use. One example comes from Idaho, where the State Water Board has been running a flexible and temporary reallocation scheme called the Idaho Water Supply Bank since the 1930s (IDWR 2015). Largely used for short term leasing of water between irrigators, the bank sets default prices paid to lessors and prices that lessees must pay. Alternatively, deposits in the bank may be tagged as already contracted and a leasing contract executed directly between buyer and seller. Washington has a similar program called the Trust Water Rights Program. Water rights may be placed in the trust for a limited or longer duration. The Trust largely provides an administrative function, and in particular functions as an instream lease program. Rights donated to the trust do not undergo Washington's *extent and validity* review (injury and quantification) and thus are not protectable instream and cannot be withdrawn for other uses. However, once in the trust the forfeiture clock stops ticking. Rights that are deposited in trust for protection as instream flow or for withdrawal for another use are evaluated for extent and validity. Groundwater mitigation efforts in Washington pass through the trust as a surface or groundwater right is deposited and then an offsetting groundwater use is authorized. Unlike the Idaho bank, the Washington program does not facilitate pricing or payment for water.

Providing such state banks that hold rights and authorize withdrawals can provide a degree of programmatic consistency, particularly in terms of bundling or unbundling deposits and withdrawals.

Much depends however on how simple or complex the bank's own process is for validating the water right prior to putting it back into use. In the Washington case, for example, the instream lease function of the Trust Program would benefit from adding the expedited approvals of the Oregon Instream Leasing Program.

8.4 Summary

This section briefly covers a suite of specific policy responses – above and beyond those mentioned under the conceptual framework – that can be used to improve water management and water markets. Fiscal policy always remains an option for government, even if water markets are not performing well. Charges on water use and subsidies for water use efficiency are two administrative approaches to incentivizing efficiency and changes in water use. The alternative to achieving a change in water allocation is for government to buy-back water rights and retire them or dedicate them to new (and public) uses. While markets are theoretically a more pleasing approach to the economist, all three fiscal instruments are potential policy tools. In the western US, however, the political economy of water charges are a difficult prospect and have yet to be deployed. Subsidy programs are very much in vogue in the western states, but do not always lead to healthy outcomes. By design or by a lack of proper design these funds can end up subsidizing additional private consumptive use of water and leaving less residual water for the environment. Buy-backs for the environment and other purposes are also a frequent tool of public policy, particularly to address endangered species issues.

This section goes on to suggest that the old adage about *use it or lose it* is now a bit dated. There are many circumstances in which there are incentives for irrigators and irrigation delivery entities to improve their water use efficiency. These include policy reforms that encourage efficiency through the trading of saved water or, at least, eliminating the chilling effect of partial forfeiture. It can be argued that the inflexible nature of water rights has led to induced innovation. Creating new flexibilities in the administration of water rights systems is an avenue to address the lack of flexibility inherent in the water rights themselves. Additional examples reviewed include reforms to authorize:

- Conserved (salvaged) water programs that enable savings from water use efficiency projects to be permitted as new rights creating new incentives for conservation.
- Restrictions/elimination of partial forfeiture to allay irrigator fears that they must always use the full rate and duty under their right or lose a portion of their right.
- Dual-purpose irrigation and instream rights that create new flexibility in moving from one use to another and back again.
- Expedited leasing programs that proceed in a timely fashion yet provide the state the ability to rescind leases should problems arise.
- Surface to groundwater mitigation programs that enable new groundwater demands to be met by offsetting pumping impacts with instream transfers and other water projects.
- Local water plans that enable water users to jointly manage water to a set of planned performance targets, while flexibility managing water between users within the plan.
- State-run administrative water banks that provide a flexible means of unbundling and bundling short-term water leases, as well as convenient withdrawal for new uses of banked rights.

Continued innovation in technology and policy should continue to address these problems in a proactive manner. State-by-state experimentation with creating this flexibility is ongoing and there is constant activity across the states to find new pathways to enable water marketing. Unfortunately, these efforts by their very nature originate and are applied in a single state, often with little investment in evaluation and learning from these experiences within the state. Some efforts have been made to foster interstate communication and cross-fertilization but arguably not to the extent desirable, and this exchange is also limited by the underinvestment in learning. The result is that when a new state takes up policy reforms

they often reinvent the wheel. Even within states that share common policy approaches such as temporary instream leasing or conserved water programs, no two programs are the same. Rather than replicate what is working in another state, each successive reform often starts from scratch. Greater cross-state communication, exchange and coordination would therefore be useful.

9. Conclusions

This paper applies a conceptual framework for understanding how water markets function to the western US. The effort is ambitious given the wide-ranging geographic settings across the west, as well as the variety of federal and state (and county, irrigation district, etc.) rules governing water. In the face of such a diverse range of contexts and in the face of the legal, economic and socio-political complexity of water rights and water markets, the process of developing a deep understanding of a given context, assessing current market conditions against desired outcomes and identifying paths towards healthy water markets will never be reducible to a formula (or a formal diagnostic). Understanding the multi-disciplinary issues involved is as much art as science, and like any craft requires long hours of time spent in the shop. And, for better or worse, each basin and each set of stakeholders seem to need to follow their own inquiry to come out on the other side with ideas, proposals and solutions that meet with the general acceptance necessary to move forward.

But this cautionary note is as much about the stream-by-stream, watershed-by-watershed and basin-by-basin process of searching for better and improved ways of managing water as it is about water market design. Indeed, a healthy market must sit in the context of collective action around managing water sustainably. Markets are means not ends. Water transactions are a powerful tool and water transactions programs therefore need to be carefully designed and evaluated. With that said the big question is how can western water be managed more sustainably and what is the role of markets? Markets surely can play an important role in mediating between the changing needs for water, whether in the form of long-term reallocation of water or in meeting drought year needs. Deploying the power of markets within the scope of political agreement over water transactions programs remains a challenging but desirable objective. Using policy reform to add to the rules and create flexibility in water marketing, particularly for temporary transactions, is likely to be integral to such an effort.

However, there are two shortcomings in the management of water quantity in the West that markets will not solve on their own: unsustainable extraction of groundwater and meeting environmental flow needs. Meeting these policy objectives without resorting to clawing back rights through condemnation, means relying on one or more of the following three incentive-based fiscal policies.

First, government and civil society can allocate funds to use markets to buy-back water rights for retirement or dedication to environmental flows. The success or failure of this approach rests on the extent to which the market is active, efficient and healthy.

A second option is to allocate funding and subsidize water use efficiency. This is an attractive and valuable option. But such programs need to be much more carefully designed, projects vetted more carefully and program evaluations carried out in an independent, participatory and transparent fashion. Importantly, such programs need to avoid adverse affects to what environmental flows still remain in western waterways. The idea that public funds should subsidize private benefits and create costs to the public should be untenable in the 21st Century. While promising if well carried out, it is critical to recall that efficiency improvements simply move water around the system differently, they do not create new units of water. So, ultimately the utility of such investments is limited. It is also worth recalling that adopting policy reforms to encourage conserved or salvage water brings these funds into the market for water, as efficiency gains become permitted uses that can be traded. There is ample room for demand management strategies and markets can work together if so designed.

A third and final fiscal option is charging for water. This alternative appears difficult politically and perhaps even unnecessary (at least if markets are working).

It is useful then to consider two futures for the western states. In the first, healthy markets flower across the west. Active markets reallocate water amongst private and public interests in an efficient and healthy manner. In this case the limiting factor on sustainability is the amount of funds necessary to incentivize water use efficiency and buy-back water to address over appropriation and environmental flows. As the scale of the problem in the western US is unknown, it is not even possible to hazard a guess at the price tag. Given the prospect of limited funding such efforts will need to be prioritized. But all in all, under this scenario the prospect for an all out crisis is abated as economic needs are met and longer-term problems are chipped away at over time.

A second less rosy *business as usual* scenario is of course possible. The crux of the matter is that water rights are very secure in the western US and offer little flexibility for public policy to support water allocation that meets the changing needs for water, to say nothing of the demands of a changing climate. If policy does not evolve towards more competitive and healthy markets the utility of the market tool is called into question. For example, if reforms do not level the playing field between seller and buyer then irrigation entities may continue to deploy their market power to close markets, restrict trading and broker excess profits for their constituents. As a consequence the cost of buy-back programs simply go up.

At the end of the day, if markets don't function or are never allowed to function in an active, efficient and healthy manner, water ends up locked in traditional uses and is not available to meet changing needs. Buy-backs are nigh impossible and hugely expensive. Subsidy programs for water use efficiency would no doubt be deployed but won't close the gap for new consumptive demands or address climate change. Should such a stalemate persist, policy makers really only have two options in the business as usual scenario. First, is simply to assess large charges on water use and let the economics determine which users have high enough value water uses to actually call on their water right. At that point perhaps interest in selling rights to new high value users would be piqued leading to a renewed effort in creating functional water markets. Second, policymakers still have the option of condemnation of existing water rights in order to make water available for new consumptive demands, sustain groundwater resources over the long run and provide for environmental needs.

The point of painting this dark scenario is not to suggest that any of the business as usual scenario is desirable but to make the point that developing healthy water markets is not really an optional exercise if the goal is sustainable water management. Functional markets are vital to avoiding chaos and dysfunction. The good news is that efforts and experimentation with improving markets is underway. The bad news is that the level and quality of the effort and the seriousness with which the effort is taken in some quarters does not engender optimism as to the ultimate outcome. Further, the time that is available to improve the situation is not clear, but seems to be shrinking with the unrelenting pace of climate change.

There is a saying in Silicon Valley that people often mistake innovation for effectiveness. Innovation for innovation's sake does not always produce desired outcomes. Water markets are innovative and can be effective at meeting specific water management outcomes. However it often seems like there is more pressure to try new things in the water market realm in the western US than to simply work hard to replicate what has already proved effective. Based on the case studies and analysis in this report, many things are obviously not working to facilitate healthy water markets. But a number of things are, or could be effective, with a concerted effort at cross-pollination, education, and sharing of implementation experiences. To be sure, the political economy of the changes necessary to adopt effective policies in the many contexts that currently lack them does not mitigate in favor of easy success. But as noted here, the alternatives (most notably the status quo) leave the West's water trapped where it is today – in places that do not uniformly maximize value for the economy, the environment and broadly, the people of the western US.

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