Paying Back the River: A First Analysis of Western Groundwater Offset Rules and Lessons for Other Natural Resources

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* This article is based on research for a dissertation in pursuit of the degree of Doctor of the Science of Law at Stanford University. I thank Professors Barton (Buzz) Thompson, Jr., Michael Wara, and David Freyberg (Stanford University), for their comments and insights on my dissertation, Sandford Clark (University of Melbourne), for sharing his wisdom on water law over many years, and the United States Studies Centre at the University of Sydney, for its support for the Comparative Groundwater Law and Policy Program, which funded this work. I also thank the many local water agency staff who took the time to speak with me informally about their agencies and respond graciously to my requests for documents.

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Natural resources offsets are a legal tool often used by regulators charged with protecting those resources to permit an activity that impacts them adversely in exchange for a compensatory measure that reduces or negates that adverse impact. Offset rules span resources as diverse as wetlands, streams, water quality, air quality, endangered species, and native vegetation. The literature on offsets in these environmental contexts is voluminous. Water offsets, the focus of this Article, are analogous to environmental offsets in contexts such as wetlands mitigation and greenhouse gas emissions. Groundwater offsets enable a groundwater pumper to reduce their net impact on hydrologically connected surface waters by neutralizing some or all of the adverse impact associated with their pumping on surface water rights. This form of offset is one way of addressing the oft-recognized problem of many water laws in failing to recognize the impacts of pumping groundwater on surface water rights. Though some evaluation of groundwater offset rules has been undertaken for single jurisdictions,[1] they are generally poorly explored in the literature, particularly in a comparative and empirical sense, focusing on implementation on the ground. The Article provides the first systematic, comparative, empirical analysis of groundwater offset rules as they stand across the West. It comes at a time when the significance of groundwater pumping and its potential impacts on surface water rights is increasingly recognized. Notably, Assembly Bill 1739 passed the California Legislature in August 2014.[2] This state's first, politically charged attempt at statewide groundwater regulation explicitly recognizes the impacts of groundwater pumping impairing surface waters on the overall sustainability of California's water systems. In a larger sense, the Article adds to the broad natural resources and environmental policy design literature by deriving lessons for natural resources policy drawn from understanding how offsets in the water sphere take shape, are implemented in practice, and contrast with more well-known environmental offset rules. The starting point for this analysis is an evaluation method developed by Salzman and Ruhl for environmental offsets,[3] which this Article extends to accommodate a broader range of natural resources, including water quantity. Connecting offset concepts across the environmental and water contexts has not previously been done, making the Article of key interest not only to water lawyers and water agencies across the West, who seek legal solutions for managing an increasingly scarce resource, but also to environmental and natural resources lawyers who deal with mitigation and offsets in environmental contexts more generally.

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1. For exceptional examples, see Eva Lieberherr, *Acceptability of the Deschutes Groundwater Mitigation Program*, 38 ECOLOGY L. CURRENTS 25, 27 (2011) and Clive J. Strong, Conjunctive Administration of Surface and Ground Water: The Crossroads Between Law and Economics, Law Seminars International: Idaho Water Law, Boise, Idaho, Sept. 23, 2011 (2011). There is some academic discussion of the concept more generally. *See, e.g.*, Barton H. Thompson, Jr., *Beyond Connections: Pursuing Multidimensional Conjunctive Management*, 47 IDAHO L. REV. 273 (2011).

2. A.B. 1739, 2013-14 Leg., Reg. Sess. (Cal. 2014) (codified at CAL. WATER CODE §§ 348, 1120, 1529.5, 1552, 1831, 5200-09, 10721, 10726.4, 10726.7, 10726.9, 10729-733.8, 10735-736.6 (West 2015)).

3. James Salzman & J.B. Ruhl, *Currencies and Commodification of Environmental Law*, 53 STAN. L. REV. 607 (2000).

This Article focuses on the groundwater offset rules of the eight western states in the United States that have adopted them based on original review and analysis of the large body of relevant legal rules and policy documents in these states and interviews conducted by the author with each of the eight state administering agencies, which were directed at understanding the challenges of implementing the rules. The Article asks five key questions: What are the key elements of groundwater offset rules around the western United States? How can we evaluate the effectiveness of the rules to preserve the integrity of water rights, using techniques of evaluation developed in the context of offsets for other natural resources, like greenhouse gas emissions and wetlands? How do groundwater offset rules perform when evaluated? How do they work in practice? And, finally: What do the lessons of groundwater offset rules teach us about the design of offset rules for other natural resources?

I. INTRODUCTION

Offsets for natural resources enable regulators charged with protecting those resources to permit an activity that impacts them adversely in exchange for a compensatory measure that reduces or negates that adverse impact. Both internationally and domestically, many well-known offset programs operate in the context of adverse impacts to elements of the environment, including wetlands, streams, water quality, air quality, endangered species, and native vegetation.[4] They are so conceptually and practically attractive that they have also been used in social contexts, such as in the supply of low-income housing,[5] and have been proposed to deal with other environmental contexts, like the bycatch of seabirds in fisheries,[6] and larger social harms, like poverty.[7] In addition to being

4. *See, e.g.*, Robert Hahn & Kenneth Richards, *Understanding the Effectiveness of Environmental Offset Policies*, 44 J. REG. ECON. 103 (2013); Bruce A. McKenney & Joseph M. Kiesecker, *Policy Development for Biodiversity Offsets: A Review of Offset Frameworks*, 45 ENVTL. MGMT. 165 (2010).

5. *See generally* Harold A. McDougall, *Regional Contribution Agreements: Compensation for Exclusionary Zoning*, 60 TEMP. L.Q. 655 (1987) (discussing the use of regional contribution agreements in New Jersey, under which a municipality was able to pay another municipality to fulfill part of the first's obligation to provide low-income housing).

6. *See, e.g.*, Sean Pascoe et al., *Biodiversity Offsets: A Cost-Effective Interim Solution to Seabird Bycatch in Fisheries?*, 6 PUB. LIBR. SCI. ONE e25762 (2011).

7. *See, e.g.*, Ezra Rosser, *Offsetting and the Consumption of Social Responsibility*, 89 WASH. U. L. REV. 27 (2011).

widespread and important in and of themselves, offsets warrant attention as a close cousin of environmental trading markets and water markets, an important form of government policy intervention that responds to key drawbacks of traditional regulation, and the focus of much modern environmental and water law scholarship.[8]

Formally, an offset rule can be defined as a rule that allows regulated entities to undertake activities that produce adverse impacts—which would otherwise be disallowed under a regulatory scheme that limits the production of those impacts—by undertaking compensatory benefit-producing activities.[9] As conceived here, offset rules are a tool used to prevent "net" harm from manifesting and can be distinguished from tools used in the remedial context to compensate for harm that has already occurred.[10] A set of offset rules establishes the requirements that apply to the creation and use of offsets through formal laws, regulation, and policies.[11]

An increasingly popular and under-evaluated form of offsets, and formal rules about offsets, occurs in many western states in the United States to control the impacts of pumping groundwater on

8. *See, e.g.*, Barton H. Thompson, Jr., *Uncertainty and Markets in Water Resources*, 36 MCGEORGE L. REV. 117 (2005); LEE GODDEN & JACQUELINE PEEL, ENVIRONMENTAL LAW: SCIENTIFIC, POLICY, AND REGULATORY DIMENSIONS 188-91 (2010). Environmental trading markets are typically conceived of as pollution markets (which involve the trading of a right to emit, measured in volume or weight) and ecosystem service markets (which involve the trading of commodities measured by ecosystem function, given by metrics like acres or length). Philip Womble & Martin Doyle, *The Geography of Trading Ecosystem Services: A Case Study of Wetland and Stream Compensatory Mitigation Markets*, 36 HARV. ENVTL. L. REV. 229, 230-31 (2012). Though not synonymous with them, offsets (including groundwater offsets) frequently occur alongside and benefit from such trading mechanisms. *See infra* Part II. In contemporary usage, the term "offset" generally refers to benefits derived from activities that are undertaken by third parties not subject to a cap on impacts. This can be distinguished from, for example, a producer of impacts who reduces those impacts to a level below that required for compliance with an individual limit and may trade this "allowance."

9. *See* Hahn & Richards, *supra* note 4, at 105. This definition is inspired by that proposed by Hahn and Richards but modified to be applicable outside the purely environmental context.

10. *See infra* notes 94–100 and accompanying text for a brief discussion of groundwater rules that respond to impairment in this remedial sense.

11. Sometimes offsets can take effect outside the realm of formal rules, for example through contractual mechanisms between the producer and victim of adverse effects. *See infra* note 89. This paper focuses on formal rules for reasons of data availability, as a first step to create a framework for evaluating these rules, which could later be expanded to encompass more informal mechanisms.

surface water rights ("groundwater offset rules").[12] Such rules address arguably one of the most critical issues for water law: how to control the impairment of one water right by the exercise of another. Indeed, the problem of legally linking the impairment caused by groundwater pumping to connected surface waters is one that requires policy development in many places around the world.[13] Groundwater offset rules have played a central part in important changes in water use across the West, impacting areas as diverse as the development of corn ethanol plants in Nebraska[14] and expanding high-end tourist resorts in Oregon.[15] They will likely continue to provide an important way to facilitate access to the reliability and quality benefits of groundwater as a supply source in connected groundwater-surface water systems. In the California context, the impairment of surface water rights by the exercise of groundwater rights has traditionally been ignored by water law. However, the issue has recently received new recognition under California's first attempt at state groundwater regulation, AB1739, passed in August 2014. Among other things, this statute includes effects on surface waters in its definition of sustainable groundwater pumping management for the purposes

12. Note that this paper considers rules that form part of state water laws, but not some minor rules that form part of other bodies of law, e.g. New Mexico's replacement water requirements associated with mine dewatering, regulated under N.M. STAT. ANN. § 72-12A (West 2014). The paper does consider groundwater offset schemes that form part of state water law but are implemented using another law, e.g. requirements in Washington to obtain a groundwater offset before a building permit will be issued. Laura Ziemer et al., *Mitigating for Growth: A Blueprint for a Ground Water Exchange Pilot Program in Montana*, 148 J. CONTEMP. WATER RESOURCES & EDUC. 33, 39-40 (2012).

13. *See generally* Tom Gleeson et al., *Towards Sustainable Groundwater Use: Setting Long-Term Goals, Backcasting, and Managing Adaptively*, 50 GROUND WATER (2012); Noah D. Hall, *Interstate Water Compacts and Climate Change Adaptation*, 5 ENVTL. & ENERGY L. & POL'Y J. 239 (2010); Christina Hoffman & Sandra Zellmer, *Assessing Institutional Ability to Support Adaptive, Integrated Water Resources Management*, 91 NEB. L. REV. 805 (2013); Rebecca L. Nelson, *Groundwater, Rivers and Ecosystems: Comparative Insights into Law and Policy for Making the Links*, 23 AUSTL. ENV'T REV. 558 (2013); Andrew Ross, *Easy To Say, Hard To Do: Integrated Surface Water and Groundwater Management in the Murray-Darling Basin*, 14 WATER POL'Y 709 (2012); Barton H. Thompson, Jr., *Beyond Connections: Pursuing Multidimensional Conjunctive Management*, 47 IDAHO L. REV. 273 (2011); R. Timothy Weston, *Harmonizing Management of Ground and Surface Water Use Under Eastern Water Law Regimes*, 11 U. DENV. WATER L. REV. 239 (2008).

14. Interview with Brian P. Dunnigan, Director, Neb. Dep't of Natural Res., in Lincoln, Neb. (Nov. 10, 2011) (describing ethanol plants as large new water users that would buy irrigated land and cease applying water to it as a form of offset for their groundwater-intensive production processes).

15. Interview with Barry F. Norris, State Eng'r, Or. Water Res. Dep't, in Salem, Or. (Oct. 25, 2011).

of sustainability plans to be prepared by local agencies, which the statute grants new powers to control groundwater pumping.[16] Evaluating and understanding the strengths and weaknesses of groundwater offsets can contribute not only to their introduction and development in particular jurisdictions. It can also assist with the development of natural resources offset rules more generally and can help inspire solutions designed to deal with the toughest of problems in natural resources regulation, like fragmented administration of connected resources.

This Article has four main parts. Part Two provides background on environmental and groundwater offsets and describes risks to the equivalence of impacts and offsets, which offset rules are designed to minimize. It then extends and translates an evaluation framework derived from the environmental offset literature into the groundwater context to outline a method for evaluating how offset rules address risks to equivalence. Part Three uses this translated framework to evaluate groundwater offset rules across the western United States, based on a comprehensive review of laws and policies that establish these rules. Part Four uses data from interviews with water agency staff to describe the challenges that agencies face in implementing offset rules. This discussion expands the issues under consideration beyond equivalence to the challenges of cost, equity, communication, and monitoring. Finally, Part Five reflects on the implications of the Article's findings for the design and use of groundwater offsets, including in California, and natural resources offsets more generally.

II. ENVIRONMENTAL OFFSETS, GROUNDWATER OFFSETS, AND LINKING THE TWO

A. *What Do Environmental Offset Programs Aim to Do, and What Key Challenges Do They Strike?*

Broadly understood, environmental emissions trading programs have been used for over four decades, first having been introduced to help reduce airborne pollutants in the United States.[17] Rather than attempt a comprehensive description of these environmental programs—a job done by several excellent recent

16. CAL. WATER CODE §§ 10721, 10726.4 (West 2015).

17. Michael Gillenwater & Stephen Seres, *The Clean Development Mechanism: A Review of the First International Offset Programme*, 1 GREENHOUSE GAS MEASUREMENT & MGMT. 179, 181 (2011).

review and evaluation articles[18]—this Part describes the main features of two notable and very different environmental programs that have, at their heart, offsets produced by third parties. It emphasizes features that have especially challenged their performance, and demonstrates how these challenges vary with the characteristics of the underlying resource. It then contrasts these two programs with the nature and goals of groundwater offset rules and suggests that despite important differences to environmental offset rules, an evaluation framework developed for the latter promises to yield useful lessons for the former.

The basic goal of an environmental offset program is to enable a regulated project to go ahead, where that project would have an otherwise prohibited adverse environmental impact, on the condition that that impact is mitigated or neutralized by the project proponent taking some compensatory action.[19] This compensation can be undertaken either directly by the project proponent, or indirectly through a third party, usually using a credit banking mechanism.

Importantly, an action that gives rise to the need to offset (an "impairing action") can adversely impact many ecosystem functions (which can be defined as "biophysical processes and ecosystem features")[20], of which law or policy will seek to protect only a subset. It is only possible to evaluate the degree to which the rules of an offset program protect the integrity of the underlying resource with a firm grasp of the valued functions that the rules seek to protect—effectively, the denominator in evaluating how well the system protects those functions—and those functions that the system does not seek to protect. This is a key insight offered by analyzing groundwater offset rules, discussed further in Part Five.

This Article uses two large and well-established offset systems to

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18. *See, e.g.*, *id.*; BRUCE MCKENNEY, ENVIRONMENTAL OFFSET POLICIES, PRINCIPLES, AND METHODS: A REVIEW OF SELECTED LEGISLATIVE FRAMEWORKS (Biodiversity Neutral Initiative, 2005); Colleen E. Bronner et al., *An Assessment of U.S. Stream Compensatory Mitigation Policy: Necessary Changes to Protect Ecosystem Functions and Services*, 49 J. AM. WATER RESOURCES ASS'N 449 (2013); McKenney & Kiesecker, *supra* note 4.

19. Environmental offsets also exist in non-regulatory contexts, enabling a user of environmental resources voluntarily to neutralize the effects of their use. JONATHAN L. RAMSEUR, CONG. RESEARCH SERV., RL 34241, VOLUNTARY CARBON OFFSETS: OVERVIEW AND ASSESSMENT (2009), *available at* http://tinyurl.com/kfc5u22.

20. Margaret A. Palmer and Solange Filoso, *Restoration of Ecosystem Services for Environmental Markets*, 325 SCI. 575, 575 (2009). This article also provides a brief introduction to the concept of ecosystem functions, explained in the context of ecosystem services and environmental markets. *Id.*

introduce the basic features of, and issues and concerns associated with, offsets at either ends of the spectrum of distinctiveness, and therefore fungibility, of natural resources. The first, wetland mitigation under the United States federal Clean Water Act ("CWA"),[21] seeks to protect the ecological value of wetlands. It represents one end of the spectrum of fungibility of natural resources that have been regulated using offset arrangements. Wetlands are complex resources of many ecological types, the valued ecological characteristics of which are highly place-specific and take time to develop. The second, the Clean Development Mechanism ("CDM") seeks to help developed country parties to the Kyoto Protocol to the United Nations Framework Convention on Climate Change[22] cost-effectively meet their greenhouse gas emissions reduction targets by allowing them to fund projects that reduce emissions in developing countries, where the cost of such projects is comparatively low. The CDM deals with the opposite end of the spectrum of fungibility of natural resources: greenhouse gases are freely circulating, common pollutants, the global warming effects of which are independent of where they are emitted, and the impacts of which do not "mature" as do the benefits of wetlands.

B. *Lessons from Environmental Offset Rules at the Poles of Resource Fungibility: Wetland Mitigation and International Carbon Offsets*

A central provision of the CWA prohibits discharging a pollutant into waters of the United States.[23] A person proposing to discharge dredge or fill material into a wetland may, however, do so if they first obtain a section 404 permit[24] (though notably, the CWA does not prohibit groundwater pumping that damages wetlands equally).[25] Since federal policy aims to achieve "no net loss" of wetland acreage and functions, even a small loss of wetlands above a specified numerical threshold requires a

21. Federal Water Pollution Prevention and Control Act, 33 U.S.C. §§ 1251-1388 (2012).

22. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Conference of the Parties, Rep. on its 3rd Sess., Dec. 1-11, 1997, U.N. Doc. FCCC/CP/1997/L.7/Add.1 (Mar. 25, 1998) [hereinafter Kyoto Protocol].

23. 33 U.S.C. § 1311 (2012).

24. 33 U.S.C. § 1344 (2012).

25. Kevin O'Hagan, Comment, *Pumping with the Intent to Kill: Evading Wetlands Jurisdiction under Section 404 of the Clean Water Act through Draining*, 40 DEPAUL L. REV. 1059, 1059-60 (1990-91).

permit.[26] A frequent condition of such a permit is to undertake compensatory mitigation for that damage. This program was introduced after it became apparent early in the life of the CWA that the agencies administering the permitting program were not willing to deny permits to dredge or fill wetlands.[27] In theory, mitigation becomes available only after measures have been taken to avoid and minimize harm, known as "mitigation sequencing," though in practice, it seems that these sequencing requirements receive little attention in the permitting process.[28]

Legally binding statutes, regulations, and formal policies guide the application of offset requirements.[29] They provide that mitigation may be undertaken by "restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts . . . ."[30] "In-kind" compensation (that is, the same wetland type) is preferable to out-of-kind compensation, though under a recent "watershed approach" to mitigation, the latter is possible where it is environmentally preferable to restore higher priority wetlands.[31] Current policy favors that the permittees not directly undertake the mitigation activity, but rather use mitigation banks (of which there were almost 800 in 2009, both for-profit and not-for-profit, though only 431 were active)[32] that sell already-created wetland credits to compensate for adverse effects. An alternative is in-lieu fee programs, under which the permittee pays a fee for future mitigation activity to be undertaken by a third party.[33] Key trading

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26. Bronner et al., *supra* note 18, at 451, 453 (explaining that in the section 404 context, the threshold is above 1/10 acre or 404.7 m^2).

27. Bronner et al., *supra* note 18, at 450; Womble & Doyle, *supra* note 8, at 246.

28. Bronner et al., *supra* note 18, at 450, 459; Womble & Doyle, *supra* note 8, at 247.

29. *See, e.g.*, Compensatory Mitigation for Losses of Aquatic Resources, 33 C.F.R. § 332 (2014); Compensatory Mitigation for Losses of Aquatic Resources, 40 C.F.R. §§ 230.91-230.98 (2014); Womble & Doyle, *supra* note 8, at App. 1.

30. 33 C.F.R. § 332.2; 40 C.F.R. § 230.92.

31. The current "watershed approach" to geographic restrictions holds that restoring historical distributions of wetlands may not be optimal for restoring watershed function, but rather that off-site or out-of-kind compensatory mitigation may be environmentally preferable where higher priority wetlands can be restored, filling more important watershed needs. This approach explicitly allows for the swapping of non-equivalent credits and debits. 33 C.F.R. § 332.3(c); 40 C.F.R. § 230.93(c); Womble & Doyle, *supra* note 8, at 253-55, 259.

32. Womble & Doyle, *supra* note 8, at 249-51.

33. *Id.* at 251; Royal C. Gardner et al., *Compensating for Wetland Losses Under the Clean Water Act (Redux): Evaluating the Federal Compensatory Mitigation Regulation*, 38 STETSON L.

limits are expressed in geographic terms, as spatial restrictions on the service areas of wetland mitigation banks, and restrictions on where a section 404 permittee that provides its own mitigation may do so.[34]

Wetlands mitigation practices have been subject to several key criticisms over their integrity, that is, that they do not adequately ensure that permitted damage to a wetland will be truly compensated. Scholars argue that the scope of protected wetland functions is too narrow, concentrating only on environmental values, and ignoring the social and economic (e.g., recreational) values of wetlands, thereby inadvertently damaging the latter in offset transactions.[35] Even the core protected environmental values are argued to be compromised by using overly simple requirements for substitutability, which allow for externalities relating to geography and wetland type or quality.[36] These simple requirements also disregard the connection between a wetland's ecosystem services and its setting in the environment.[37] In addition, temporal non-fungibility between impairing actions and offsetting actions has occurred where compensatory projects occur after the impacts. In the longer term, the success of wetland mitigation is uncertain if the administering organization goes bankrupt or is not responsible for poor performance,[38] and long-term stewardship requirements (e.g., activities like removing invasive species), tend not to apply.[39] Another concern relates to the ability of a wetland restoration project to generate multiple kinds of credits, for example relating to water quality and habitat, destined for different environmental markets, without undertaking additional activities[40]—a practice known as "credit stacking."[41]

REV. 213, 243 (2009).

34. *See generally* Womble & Doyle, *supra* note 8 (describing and analyzing geographic restrictions that apply to U.S. wetland and stream mitigation markets).

35. Bronner et al., *supra* note 18, at 453-54.

36. *Id.* at 456-57. For example, they have allowed for relatively large distances between impact and compensation sites, compromising ecological integrity; and they unrealistically assume a compensation ratio of 1:1, whereas the restoration of 1 unit may not be equivalent to 1 unit of impact. *Id.* at 454, 456-57, 459. More fundamentally, in-lieu fee programs sometimes set fees that have not been sufficient to cover the full costs of the impacts. Womble & Doyle, *supra* note 8, at 251.

37. Gardner et al., *supra* note 33, at 221-34.

38. ROYAL C. GARDNER, LAWYERS, SWAMPS, AND MONEY: U.S. WETLAND LAW, POLICY, AND POLITICS 135-37 (2011).

39. Gardner et al., *supra* note 33, at 240-42, 245-47.

40. *See, e.g.*, Womble & Doyle, *supra* note 8, at 290.

A further category of concern relates to governance and accountability. These concerns relate to more indirect risks to the equivalence of offset credits and debits. Scholars argue that policy insufficiently guides the methodology used in establishing projects, for example, the site design.[42] They also suggest that insufficient record-keeping is required for compensation projects, for example, setting out performance criteria, tracking monitoring results and specifying and using evaluation methods;[43] and that there are insufficient compliance activities, for example, ensuring that the mitigation action is actually undertaken, or is undertaken in a way that meets required performance standards.[44] In addition, public entities may both operate mitigation banks or in-lieu fee programs and also oversee mitigation banks, raising concerns about conflicts of interest.[45]

Turning to the opposite end of the spectrum of natural resources fungibility, the largest global offset market is established under the Kyoto Protocol's CDM.[46] CDM projects produce Certified Emissions Reductions (CERs), which developed country parties to the Kyoto Protocol may use to meet their greenhouse gas emissions reductions requirements. The purchase of CERs is intended to be "supplemental to domestic actions"[47]—analogous to mitigation sequencing in CWA wetlands mitigation.[48] Key types of projects used to produce CERs include those that capture industrial gases or methane, renewable energy facilities, facilities that use waste heat, and gas-fired power projects.[49]

An Executive Board regulates the CDM, undertaking functions that include assessing projects, issuing credits, adopting rules, and accrediting and supervising auditing firms. The Executive Board has approved 140 detailed standard methodologies for monitoring

41. Alice Kenny, *When is Credit-Stacking a Double Dip?*, ECOSYSTEM MARKETPLACE, Nov. 16, 2009, http://tinyurl.com/mknpcnp.

42. Bronner et al., *supra* note 18, at 455; Gardner et al., *supra* note 33, at 234-35.

43. Bronner et al., *supra* note 18, at 458-59; *see also* Gardner et al., *supra* note 33, at 235-40.

44. Bronner et al., *supra* note 18, at 451; Gardner et al., *supra* note 33, at 216-17.

45. Womble & Doyle, *supra* note 8, at 287.

46. Michael W. Wara & David G. Victor, *A Realistic Policy on International Carbon Offsets* 5 (Stanford Univ. Program on Energy and Sustainable Dev., Working Paper No. 74, 2008).

47. Kyoto Protocol, *supra* note 22, at art. 6(1)(d).

48. *See* Womble & Doyle, *supra* note 8, at 247.

49. Wara & Victor, *supra* note 46, at 10.

and quantifying emissions reductions.[50] A project proposal is submitted, using a standard "Project Design Document" based on an approved methodology, to the host country for approval, then audited by an accredited independent auditor who provides a validation report, subjected to a 30-day public comment period, separately appraised by Board staff, then finally considered for approval.[51] After the project has been operating, its reductions must be monitored and separately verified on a regular ongoing basis by a different independent auditor before the Board issues credits.[52]

Putting criticisms related to its specific international context aside,[53] several key concerns with the CDM are indicative of challenges experienced with offsets even at this end of the spectrum of natural resources fungibility. As in wetlands mitigation, a preliminary criticism relates to the scope of functions addressed under offset rules. Only functions relating to global warming are included; other characteristics of the greenhouse gases related to human health and felt more locally, such as indirect increases in ozone-related respiratory illnesses as a result of the exacerbating effect of global warming on ozone in areas that are already polluted with ozone (itself a greenhouse gas),[54] are not included. This exclusion potentially allows such impacts to be undesirably spatially concentrated if facilities emitting ozone, for example, can buy CERs more cheaply than reducing their own emissions.

A key criticism of the CDM relates to the perverse incentives it may create; for example, a historically popular project to rein in a powerful greenhouse gas created as a by-product of a refrigerant gas created perverse incentives for industries to increase their production of the refrigerant merely to gain valuable CERs.[55] As with wetland mitigation activities, other projects are thought unlikely to represent "additional" reductions of greenhouse gases

50. Gillenwater & Seres, *supra* note 17, at 182.

51. *Id.* at 181-82.

52. *Id.* at 182.

53. Such criticisms relate, for example, to the program's influence on developing countries in encouraging them to avoid commitments to reduce greenhouse gas emissions. Wara & Victor, *supra* note 46, at 18-19.

54. Mark Z. Jacobson, *On the Causal Link Between Carbon Dioxide and Air Pollution Mortality*, 35 GEOPHYSICAL RESEARCH LETTERS L03809, 4-5 (2008).

55. Wara & Victor, *supra* note 46, at 11-12.

compared to what would have occurred in their absence.[56] Even worse, where it occurs, "leakage" means that emissions elsewhere increase as a result of CDM projects.[57] Highly volatile prices for CERs threaten the economic viability of projects, particularly those that would produce higher quality, more expensive offsets.[58]

Procedural and governance concerns relate to potential conflicts of interest that may arise in verifying project benefits, the allegedly political nature of some decision-making by the Executive Board, and delays in issuing credits because of burdensome reporting and approval requirements that precede issuance.[59]

The broad outlines of wetlands mitigation under the CWA and CERs under the CDM demonstrate variation in the kinds of natural resources that may be subject to offsetting arrangements, and therefore the broad kinds of non-equivalence that can threaten the integrity of offset programs. Broadly, rules that deal with a more fungible resource or form of waste will be less problematic from an environmental integrity perspective than those that are less fungible along the same dimensions. The environmental values of wetlands are spatially dependent, take time to develop, and differ depending on the type of wetland.[60] The impacts of greenhouse gas emissions, on the other hand, do not depend on the location at which the gases are emitted, do not take significant time to mix in the atmosphere, and one ton of carbon dioxide is precisely equivalent to another in its global warming potential. The offset rules for these disparate natural resources show other important kinds of variation, particularly in governance and accountability mechanisms, and dissatisfaction with particular elements of these mechanisms. Both sets of arrangements demonstrate the value of banking mechanisms, which allow the accumulation of a large quantity of certified benefits that can then be transferred to a number of impact producers as offsets.

We turn now to examine, in overview, the goals and

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56. *Id.* at 13-15.

57. Gillenwater & Seres, *supra* note 17, at 196.

58. Craig H. Hart, *The Clean Development Mechanism: Considerations for Investors and Policymakers*, 7 SUSTAINABLE DEV. L. & POL'Y 41, 43-44 (2007).

59. Wara & Victor, *supra* note 46, at 14-17.

60. *See generally* Richard P. Novitzki et al., *Restoration, Creation and Recovery of Wetlands: Wetland Functions, Values, and Assessment* (U.S. Geological Survey Water Supply Paper 2425), *available at* http://tinyurl.com/c7jgh78 (defining wetland functions and values, how they vary, and how they may be assessed).

functioning of offset rules for groundwater–a natural resource that arguably falls somewhere between wetlands and greenhouse gases in fungibility. Following that overview, we use the examples of these three offset programs to examine in more detail how offset rules approach the implications of fungibility for equivalence between impacts and offsets, and how the rules treat broader concerns such as efficiency and equity.

C. *What Do Groundwater Offset Programs Aim to Do?*

Groundwater offsets are fundamentally about paying off the conceptual "debt" of the adverse impacts of pumping groundwater before these impacts manifest. Pumping groundwater has the potential to impact a great variety of physical things, including water quantity and quality in the source aquifer and connected water bodies; dependent ecosystems; the land surface; aspects of the hydrologic cycle; and energy use.[61] In addition, groundwater indirectly supports recreational, spiritual, and cultural services that benefit the public as a whole,[62] so groundwater pumping may also impact these public services. Although offsets could in theory be used to address any of these impacts, it is the direct physical impacts that are more readily quantifiable and substitutable in-kind, which this study has found are generally the subjects of existing groundwater offset rules. Nonetheless, the range of these impacts demonstrates how groundwater is interconnected with many other elements of the environment and suggests a highly distinctive resource.

In practice, interviews with state water agency staff conducted for this study revealed that groundwater offset rules in the western United States tend to only address the impacts of pumping groundwater on surface water.[63] Generally, offset rules only

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61. Rebecca Nelson & Meg Casey, *Taking Policy from Paper to the Pump: Lessons on Effective and Flexible Groundwater Policy and Management from the Western U.S. and Australia* 46 (2013) (Stanford Univ. Comparative Groundwater Law and Policy Program, Working Paper), *available at* http://tinyurl.com/mjygooc.

62. DIXON H. LANDERS & AMANDA M. NAHLIK, U.S. ENVTL. PROTECTION AGENCY, FINAL ECOSYSTEM GOODS AND SERVICES CLASSIFICATION SYSTEM (FEGS-CS), EPA/600/R-13/ORD-004914 69-70 (2013).

63. There are exceptions to this general statement. In Nebraska, for example, offset rules derive from multiple concerns: meeting interstate compact obligations, complying with requirements of the Endangered Species Act, and addressing actual and potential conflicts between groundwater and surface water users. NEB. DEP'T OF NATURAL RES. ET AL., BASIN-WIDE PLAN FOR JOINT INTEGRATED WATER RESOURCES MANAGEMENT OF OVERAPPROPRIATED PORTIONS OF THE PLATTE RIVER BASIN, NEBRASKA 1, 2 (2009);

address these impacts in certain cases—where those physical impacts translate into impacts on a property right to surface water that has a higher legal priority than the groundwater right in terms of quantity (including location and timing) and usually quality.[64] In the western United States, where the prior appropriation system generally applies, these higher priority surface water rights are consumptive or instream water rights (that is, water rights for environmental purposes) that developed earlier in time. In addition to offsets dealing with competition between individual water rights, offsets also operate to resolve interstate competition between groundwater pumping in an upstream state and a legally enforceable right of a downstream state to receive certain surface water flows from the upstream state.[65] This is not to say that the other types of impacts referred to above are ignored by other elements of groundwater permitting processes (though many are)-just that this study has not uncovered formal rules for offsets that are generally available to deal with them.[66] The significance and implication of this limited scope of the rules for offsets are discussed further in Part Five.

Even with this narrower view of the functions protected by groundwater offset rules, impacts on surface water rights can be relatively case-specific. Impacts tend to be more distinctive than the impacts of emitting a greenhouse gas on global warming, but probably less distinctive than the ecological function of a wetland. Pumping a well will deplete a stream in a particular stream reach, which can only be determined through technical study. Since groundwater quality may differ from the quality of the receiving stream, the depletion may also change the quality of stream water. Finally, the effects of pumping take time to fully propagate at a particular point of impact at the stream, and that time lag, in turn,

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Interview with Jesse Bradley, Head, Integrated Water Mgmt. Div., Neb. Dep't of Natural Res., in Lincoln, Neb. (Nov. 9, 2011) (referring to endangered species concerns in the Platte River Basin).

64. *See, e.g.*, COLO. REV. STAT. ANN. § 37-92-308(3)(b)(IV) (West 2014) (relating to substitute water supply plans).

65. *See, e.g.*, the case of Nebraska, discussed *supra* note 63. Since the latter can be conceived of as a simple version of the former, this paper will in general discuss individual "senior water rights," but also note that these findings apply to the interstate context.

66. For an exception, see Washington State's recent formal mitigation policy, which allows for offsetting adverse impacts on the "public interest." WASH. DEP'T OF ECOLOGY, WATER RESOURCES PROGRAM POLICY (POL-2035): EVALUATING MITIGATION PLANS 7 (2013), *available at* http://tinyurl.com/k9gwfrv.

depends on local hydrogeological characteristics.[67]

Evidence gathered from interviews with state water agency staff who administer groundwater offset rules indicates that with regard to surface water impacts, the rules aim to encourage economic growth that depends on increasing groundwater extraction in two legally distinct contexts in which that would otherwise be impossible. The first is where connected surface water systems are fully allocated to intrastate rights holders; the second is where interstate compacts require an upstream state to maintain certain deliveries of surface water flows to a downstream state.[68] In both cases, the alternative to an offset system is not permitting further pumping of stream-connected groundwater.[69]

In addition to facilitating groundwater-dependent economic growth, groundwater offsets promote an oft-cited goal of modern water resources management—joint management of surface water and groundwater, with regard to their different characteristics.[70] Logically, offsets increase the productivity of water by allowing higher-value uses of water (in this case, of groundwater) to proceed when the user buys and retires lower-value replacement surface water (or otherwise the transaction would not be beneficial to the buyer and would not take place). This takes advantage of

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67. *See generally* John Bredehoeft & Eloise Kendy, *Strategies for Offsetting Seasonal Impacts of Pumping on a Nearby Stream*, 46 GROUNDWATER 23 (2008) (describing how groundwater pumping and recharge, aquifer properties, and well locations affect the timing of streamflow depletion).

68. Interview with Barry Norris, *supra* note 15; Interview with Brian W. Patton, Bureau Chief, Planning Bureau, Idaho Dep't of Water Res., in Boise, Idaho (Oct. 31, 2011); Interview with Kevin Rein, Deputy State Eng'r, Colo. Div. of Water Res., in Denver, Colo. (Nov. 7, 2011) (fallowing groundwater-irrigated land to satisfy obligations to deliver Republican River water to downstream states).

69. The Yakima Basin in Washington State demonstrates an extreme version of this option: state law prohibits appropriating *any* additional groundwater in upper Kittitas County, unless that appropriation is in accordance with the "Upper Kittitas Ground Water Rule." That Rule forbids new appropriation of groundwater for usually permit-exempt purposes, with an exception for building permits, but even then only when that appropriation is made "water budget neutral" through offsetting. WASH. ADMIN. CODE § 173-539A-040 (2014).

70. *See, e.g.*, Barton H. Thompson, Jr., *Beyond Connections: Pursuing Multidimensional Conjunctive Management*, 47 IDAHO L. REV. 273, 279 (2011); John Hedges, Legislative Update, *Currents in California Water Law: The Push to Integrate Groundwater and Surface Water Management Through the Courts*, 14 U. DENV. WATER L. REV. 375, 382-85 (2011); R. Timothy Weston, *Harmonizing Management of Ground and Surface Water Use Under Eastern Water Law Regimes*, 11 U. DENV. WATER L. REV. 239, 242 (2008) (describing the undesirable gap between hydrologic and legal conceptions of groundwater-surface water connections in eastern states); William Blomquist et al., *Building the Agenda for Institutional Research in Water Resource Management*, 40 J. AM. WATER RESOURCES ASS'N 925, 925 (2004).

the connectedness of groundwater and surface water, and uses aquifers as a conveyance facility to enable users to access the cheapest or most appropriate water source.

The benefits of this kind of joint management are not only economic, but also potentially environmental and equitable. By enabling a shift from direct surface water use to connected groundwater use, offsets can also achieve environmental benefits by distributing water extraction from streams over the year rather than concentrating it in low-flow periods when withdrawals are most likely to affect dependent human and non-human stream users. In theory, offsets can improve equity of access to water by facilitating access to groundwater for those who, for geographic reasons, may lack access to surface water, and who would also lack access to groundwater if pumping groundwater were banned to protect surface water.

Finally, offsets may help increase the political palatability of (or reduce the political pressures to weaken) limits on consumptive water extraction represented by instream flows, in much the same way as environmental offsets in other contexts are considered to serve as "politically important defensive policies to ensure the viability of [protections that come under fire]."[71]

D. *Key Elements of Groundwater Offset Rules and Their Water Law Context*

A review of state water laws and interviews with state water agency staff reveal that detailed offset rules exist in eight states: Colorado, Idaho, Montana, Nebraska, New Mexico, Oregon, Washington, and Wyoming.[72] These rules generally prohibit

71. James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 STAN. L. REV. 607, 678 (2000).

72. This list does not include states that have groundwater offset regimes that both (1) lack detailed rules and (2) are not well-used (i.e., only a handful of mitigated permits exist, based on interviews with water agency staff). In such states, a groundwater offset might occasionally be required as a condition of a groundwater permit, on an ad-hoc basis, in the absence of a formal policy or well-established practice of offsetting. As an example, mitigation requirements for groundwater use in the Cache Valley of Utah fall into this category. Interview with Kent Jones, State Eng'r, Utah Dep't of Natural Res., Div. of Water Rights, in Salt Lake City, Utah (Nov. 2, 2011) (referring to several occasions in which groundwater users in the Cache Valley have been required to mitigate for stream depletions); Interview with Boyd Clayton, Deputy State Eng'r, Utah Dep't of Natural Res., Div. of Water Rights, in Salt Lake City, Utah (Nov. 2, 2011) (stating that the Cache Valley is the only area that has a management plan that requires depletions to be mitigated, though ad hoc requirements may be imposed in other locations); UTAH DEP'T OF NATURAL RES.,

impairment of senior rights in relation to quantity, location, timing, and quality of water.[73]

Before delving into the key substantive elements of groundwater offset rules, a few brief notes are warranted on the state administrative frameworks, which house these rules. These frameworks vary significantly by state, and display useful approaches to overcoming regulatory fragmentation, a subject to which Part Five returns. Administrative responsibility for offset rules tends to lie with the agency responsible for groundwater permitting. In most jurisdictions, this is the state water rights agency.[74] This agency may be housed in an environment or natural resources department[75] or it may be a stand-alone, autonomous agency of the state.[76] Some states adopt a more local focus, corresponding to their groundwater permitting arrangements. For example, Nebraska's groundwater offset rules are administered by, and apply at the level of the local natural resources district.[77] However, these rules are influenced by a supra-district plan and involve cooperation with Nebraska's Department of Natural Resources,[78] which permits surface water diversions according to a different allocation doctrine (prior appropriation in the case of surface water, correlative rights in the case of groundwater).[79] Several other states adopt a sub-state focus in other ways. Some, like New Mexico and Washington, have a general set of offset rules that applies statewide, with tailored, more detailed rules applying in certain local areas.[80] In others, environmental NGOs have been

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INTERIM CACHE VALLEY GROUND-WATER MANAGEMENT PLAN (1999), *available at* http://tinyurl.com/kdjzy3c.

73. *See infra* Table 1 and Part III.

74. For example, the Colorado Division of Water Resources; the Idaho Department of Water Resources; the Montana Water Resources Division; the Oregon Water Resources Department; the New Mexico Office of the State Engineer; the Washington Water Resources Program; and the Wyoming State Engineer's Office.

75. For example, the Washington Department of Ecology; Utah's Division of Water Rights falls within the Department of Natural Resources; the Colorado Division of Water Resources (also known as the Colorado Office of the State Engineer) within the Department of Natural Resources; and Montana's Water Resources Division in its Department of Natural Resources and Conservation.

76. For example, the Oregon Water Resources Department; the Wyoming State Engineer's Office; and Idaho's Department of Water Resources.

77. Hoffman & Zellmer, *supra* note 13, at 809.

78. *See* NEB. DEP'T OF NATURAL RES. ET AL., *supra* note 63, at 1.

79. Hoffman & Zellmer, *supra* note 13, at 814-16.

80. *See* WASH. DEP'T OF ECOLOGY, *supra note* 66; WASH. ADMIN. CODE § 173-539A (2014). This last rule is Washington State's Upper Kittitas Groundwater Rule. *Id.*; *see also*

heavily involved in a locally specific element of administration, for example, establishing the equivalent of a mitigation bank in Oregon.[81]

Groundwater offset rules, unlike those for wetlands mitigation or Kyoto Protocol greenhouse gas reductions, lack mitigation sequencing requirements. In theory, these could take the form of requiring groundwater pumpers to reduce their stream depletion by undertaking water conservation measures like using high-efficiency irrigation equipment and only permitting offsets for the depletion that results from high-efficiency groundwater use. One potential reason for the lack of mitigation sequencing is that pre-existing elements of a state's water law determine the level of efficiency required of applicants for water rights (though the level of efficiency is often described only in broad terms, like "reasonable use" or not "wasting" water, which act as a low bar for users to meet).[82] Part Five canvasses this issue more fully.

Methods of providing an offset vary depending on the state. The most common method is buying or leasing surface water rights for instream use[83] to compensate for stream depletion caused by pumping groundwater. Other methods include: reducing another right holder's use of connected groundwater[84] for example, through a land fallowing program;[85] conserving surface water and dedicating it to instream use;[86] "pumping and dumping" water from unconnected sources into the river;[87] and

N.M. STAT. ANN. § 72-12-3(E) (West 2014); N.M. OFFICE OF THE STATE ENG'R, ROSWELL BASIN GUIDELINES FOR REVIEW OF WATER RIGHT APPLICATIONS IV(A) (2005).

81. Eva Lieberherr, *Acceptability of the Deschutes Groundwater Mitigation Program*, 38 ECOLOGY L. CURRENTS 25, 27 (2011).

82. *See* Janet C. Neuman, *Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use*, 28 ENVTL. L. 919, 923-48 (1998). In theory, these requirements reduce the pumping impacts of an individual well by setting a threshold of acceptable use efficiency (in broad terms). In practice, the bar is set low. Though one could theoretically argue for setting the "beneficial use" bar higher for rights requiring an offset than those that do not, in return for the increased risk of impacts of the former rights, this does not appear in any offset rules studied here.

83. *See, e.g.*, OR. ADMIN. R. 690-505-0610(3)(b) (2014); NEB. REV. STAT. ANN. § 46-715(3)(e) (West 2014). This includes buying "contract water" from federal government storage projects for release to a stream. Telephone Interview with Tim Davis, Water Res. Div. Adm'r, Mont. Dep't of Natural Res. & Conservation (Aug. 2, 2012).

84. *See, e.g.*, OR. ADMIN. R. 690-505-0610(8) (2014).

85. *See, e.g.*, DICK WOLFE, COLO. DIV. OF WATER RES., SUBDISTRICT NO. 1 ARP APPROVAL: PLAN YEAR 2012: REVIEW, FINDINGS, AND APPROVAL OF SUBDISTRICT NO. 1'S 2012 ANNUAL REPLACEMENT PLAN 3, 9-10 (2012).

86. *See, e.g.*, OR. ADMIN. R. 690-505-0610(3)(a) (2014).

87. *See, e.g.*, WASH. DEP'T OF ECOLOGY, *supra* note 66, at 9.

artificially recharging a connected aquifer, to cause the recharged water to discharge into the river over time.[88]

Though it is often controversial, some states also allow non-water offsets. This can include compensating (financially or otherwise) affected surface water users[89] and undertaking environmental projects, such as restoring riparian areas or removing culverts to increase areas available for fish spawning[90] in the case of affected instream flow rights. These practices do not accord with a strict water rights protection view, under which the only way that a junior groundwater pumper could offset impairment to an affected senior water right would be by substituting the same volume of water of suitable quality at the same location and time. This protects the water right itself, in perpetuity; protecting the *value derived from the water right* in another way would not be considered sufficient by some state agencies. Some state water agencies take this strict view, doubting the legality of non-water offsets.[91] At the extreme, the practice of some water agencies is to fiercely protect an impaired water right even if its owner is willing to accept impairment,[92] or has not protested.[93] This response suggests that states are seeking to

88. *See, e.g., id.*; IDAHO ADMIN. CODE r. 37.03.11.043(03)(d) (2013); William Blomquist et al., *Institutions and Conjunctive Water Management Among Three Western States*, 41 NAT. RESOURCES J. 653, 678-79 (2001) (describing augmentation plans that involve diverting water into canals and recharging ponds in winter, from which water then seeps back into the river in summer, and permits ongoing groundwater pumping).

89. *See, e.g.*, IDAHO ADMIN. CODE r. 37.03.11.010(15) (2013) (stating that a mitigation plan identifies ways to "prevent, or compensate holders of senior-priority water rights for, material injury . . . ."); Interview with Kent Jones, *supra* note 72 (describing an early practice of accepting monetary compensation, which occurs less often now).

90. *See, e.g.*, WASH. DEP'T OF ECOLOGY, FOCUS ON MITIGATION IN THE YAKIMA BASIN 2 (2012); Interview with Kevin Rein, *supra* note 68 (addressing issue of Colorado Water Conservation Board allowing injury to an instream flow right in return for another measure of environmental value, if, for example, replacement water cannot be found).

91. Interview with Tim Davis, *supra* note 83 ("[S]omebody can't contractually go in and say, you know, 'They paid me off.'"); Interview with Shelley Keen, Manager, Water Rights Permits Section, Idaho Dep't of Water Res. (Oct. 31, 2011) (referring to an agency view that it lacks the authority to require or authorize anything other than water for mitigation purposes). The basis for these concerns in not entirely clear; they may be based on the precise wording of particular state statutes, or perhaps feared contravention of the requirement that the power of eminent domain—here, affecting a surface water right—must be exercised for a public use. Alexandra B. Klass, *Takings and Transmission*, 91 N.C. L. REV. 1079, 1089-97 (2013) (reviewing the meaning of "public use").

92. Interview with Tim Davis, *supra* note 83.

93. Telephone Interview with David Heber, Statewide Projects Coordinator, N.M. Office of the State Eng'r (Mar. 15, 2012) (explaining that an offset condition would be imposed if impairment of a senior surface water right were found, even in the absence of a

protect the integrity of the water rights system itself, and perceive a threat to a single right to be a serious threat to the system as a whole. Part Five returns to this point. The implications of this view are interesting for the contrast between environmental and groundwater offsets. The beneficiaries of these programs appear different on face value—the public as a whole, versus a single entity that owns a water right. This difference may suggest that different entities should be accountable for ensuring equivalence. However, the desire to protect the integrity of the water rights system suggests a more complex view of public benefits in the groundwater offset situation.

For completeness and context, it is necessary briefly to discuss the flip-side of a groundwater offset—the delivery call. Unlike in environmental offset systems, the concept of a delivery call is often available in western water law as a "back-up" to offsets, which are defined in this paper as mechanisms that prevent harm before it manifests.[94] In prior appropriation systems, a delivery call enables a senior water right holder to "call" on a junior water right holder to refrain from exercising its right so that the senior may fulfill its higher-priority right after impairment of the right manifests. Some states in the western United States adopt a "wait and see" approach to addressing the impacts of pumping groundwater on surface water by focusing more on responding to impairment after it has taken effect than on preventing it from occurring at the permitting stage using an offset.[95]

Conceptually, the availability of the delivery call might seem to decrease the importance of preventive offsets, since it essentially allows for a "loan" of water that can later be recalled, removing the corresponding impact. However, the practical difficulty and equity concerns associated with delivery calls suggest that preventive offsets are much preferable and of great importance. Commentators have noted that making a successful call against a

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protest about that impairment).

94. *See infra* notes 95–100 and accompanying text.

95. *See, e.g.*, Interview with Kent Jones, *supra* note 72 ("[H]istorically, when the Division of Water Rights has looked at impairment issues in the past, that people's water rights are being affected, they're complaining that water levels are dropping and, or having problems, we've generally been hesitant about approving new applications in those areas. But if people aren't complaining it has not been uncommon in the past for us to approve applications which may in fact exceed the safe yield of the basin. . . . So if we ever get into a problem where groundwater levels start dropping or surface waters are impacted, we'll come back then and start administering, by priority, the first in time, first in right and cut off the junior users . . . .").

junior groundwater appropriator as a senior groundwater appropriator can involve difficult problems of proof and the potential for time lags to make it impossible to achieve timely benefits.[96] In addition, in some states the senior appropriator would bear the burden of the costs involved in proving interference,[97] which can amount to reversing the burden of proof that would apply in the case of an offset.[98] In jurisdictions in which the state bears the cost of undertaking an impairment investigation, such investigations can be so time-consuming as to result in multi-year delays before seniors can benefit from curtailment,[99] assuming the state has the pre-requisite political will to proceed with the investigation. Efforts to mitigate the impacts of groundwater pumping that result from delivery calls can prove complex, long-running, and litigious.[100]

E. *Risks to Equivalence under Offset Rules: Applying the Experience of Environmental Offsets to Groundwater*

As suggested above, natural resources are complex and distinctive in various ways. This section argues that this distinctiveness, and therefore challenges to fungibility, present risks that offsets will not match impacts, that is, that they will be non-equivalent, in two major ways. First, and most fundamentally, the impact or offset may be mis-quantified at a basic level ("mis-

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96. Edella Schlager, *Challenges of Governing Groundwater in U.S. Western States*, 14 HYDROGEOLOGY J. 350, 353, 357-58 (2006).

97. *See, e.g.*, Interview with Kent Jones, *supra* note 72 (speculating that although Utah has not had much experience of senior surface water appropriators making a call against junior groundwater users, the protesting party would bear the burden of demonstrating that they are experiencing impairment caused by the pumping).

98. *See, e.g.*, MONT. CODE ANN. § 85-2-360(3)(b) (2013) ("The department may grant a permit for a new appropriation only if the applicant proves by a preponderance of the evidence that the adverse effect would be offset through an aquifer recharge or mitigation plan . . . .").

99. *See, e.g.*, HINCKLEY CONSULTING & AMEC EARTH & ENVTL. (FOR WYO. STATE ENG'R'S OFFICE), HORSE CREEK GROUNDWATER/SURFACE WATER CONNECTION INVESTIGATION: GOSHEN AND LARAMIE CNTYS., WYO., 1-1 (2011), *available at* http://tinyurl.com/ka2nmsd (noting that the investigation was the result of a long line of complaints, the last in April 2009, whereas the final report of the interference investigation was released in October 2011).

100. *See, e.g.*, Clive J. Strong, Deputy Attorney Gen., Chief, Natural Res. Div., *Conjunctive Administration of Surface and Ground Water: The Crossroads Between Law and Economics*, Law Seminars International: Idaho Water Law, Boise, Idaho, (Sept. 23, 2011) (describing litigation and resolution of a groundwater-surface water delivery call in the Eastern Snake Plain of Idaho).

quantification"). Second, and more subtly, characteristics of the impacts and offsets may be incompatible, that is, "non-fungible" in space, type or time ("non-fungibility")—a concept originally offered by Salzman and Ruhl, which is here modified and extended to fit the groundwater context. Let us explore these two major risks in turn.

1. *Mis-quantification*

Consider an offsetting process as two basic quantification tasks, designed to ensure that the quantity of the offset matches the quantity of the adverse impact. The first task involves determining the damage caused by an "impairing action" (e.g., filling a wetland, pumping groundwater, emitting greenhouse gases from a coal-fired power plant), which necessarily involves constraining the assessment to the valued functions that the offset system protects.[101] The second involves determining whether an "offsetting action" (e.g., restoring a wetland, retiring a surface water right, building a renewable energy facility) is sufficient to offset the damage. Mis-quantification will result in unintended harm to the natural resource if the impact is underestimated, or if the offset is overestimated.

In the case of environmental offsets, the difficulty of determining the damage caused by the impairing action, and the risks of mis-quantification, vary with the specific situation, even within a given resource. To take a simple example, replacing a wetland with a car park destroys the wetland. Calculating debits and credits of offsets in the wetland mitigation context can also be much more complex where the approach focuses on the unit of wetland functions, and has given rise to numerous assessment protocols, which vary by site.[102] These also raise concerns associated with cost-effectiveness and whether the models and indicators used accurately reflect the function of a wetland.[103] Equally, determining the greenhouse gas emissions of a project or nation can be technically difficult. On the offsetting side of the equation, significant uncertainty attaches to the future ecological

101. *See supra* notes 61-65 and accompanying text.

102. For a list of common functional assessment procedures and their attributes, see COMM. ON MITIGATING WETLAND LOSSES, NAT'L RESEARCH COUNCIL, COMPENSATING FOR WETLAND LOSSES UNDER THE CLEAN WATER ACT, 285-91 (2001).

103. Charles Andrew Cole, *HGM and Wetland Functional Assessment: Six Degrees of Separation from the Data?*, 6 ECOLOGICAL INDICATORS 485, 486 (2006).

value of a wetland undergoing restoration, or the volume of carbon dioxide emissions that will truly be displaced by a renewable energy project.[104] These activities do not fall within a pre-existing scheme for permitting or accreditation, other than in the context of offsets. In the CDM context, where offset projects can be very diverse, individual projects historically have used distinct methodologies to calculate baselines and thereby quantify expected emission reductions.[105] With time, a wide range of detailed, standardized approaches for different categories of projects has developed.[106] Quantifying carbon offset benefits is also complicated by the difficulty of proving that the offsetting action makes a new contribution to the goal of the scheme (commonly called "additionality"), rather than rewarding a state of affairs that would exist in the absence of the credit for the offset (the baseline).[107] In the carbon context, a company claiming an offset for carbon emissions reductions that are required by regulation anyway, or reductions that it was intending to make because doing so was the most financially advantageous option, would result in non-additional offsets.[108] CDM projects, in particular, have been subject to significant concerns that non-additional projects have occurred inadvertently because of information asymmetry between project proponents knowledgeable about true incentives for projects, potentially biased project verifiers, and understaffed project approvers.[109]

In the groundwater offset context, quantifying the offsetting action is clear in the common case of retiring surface water rights—since their location and volumes are specified in the replacement water right, and their quality is relatively easily discernible. This background water rights framework does the work of defining and "accrediting" water rights along the dimensions that are important for offsetting purposes. The risk of over-estimating the offsetting action comes about where a gap between this accreditation framework and reality produces a non-additional offset. This may happen where the right to be retired

104. *See generally* Palmer & Filoso, *supra* note 20 (describing shortcomings in the science associated with wetland restoration, producing risks that the desired outcomes will not be achieved).

105. Gillenwater & Seres, *supra* note 17, at 191-92.

106. *Id.*

107. *Id.* at 187-91; McKenney & Kiesecker, *supra* note 4, at 170-71.

108. Wara & Victor, *supra* note 46, at 14.

109. *Id.* at 14-15.

does not reduce river depletion relative to the baseline level of depletion because it had not actually been used, or used fully, in practice ("paper water," not "wet water"), and presumably would remain unused into the future.[110] Pumping groundwater justified by such an offset could well increase stream depletion if using "paper water" in this way gives it legitimacy that it would otherwise lack. Information asymmetry may be present in this situation too, albeit to a lesser degree: the surface water right holder (offset producer) possesses complete information about their history of use, and some regulators may not have complete information in the form of reports of use over time, or metering data to verify the information presented.

Quantifying the impacts of pumping groundwater, however, is far from straightforward. The magnitude, location, and timing of the effects of pumping groundwater on a connected river depend on many factors: the distance between the wells and the stream, the rate of pumping, recharge from the pumping activity, and various properties of the aquifer.[111] These properties include how easily it transmits water (transmissivity and hydraulic conductivity), changes in the elevation of the groundwater surface (hydraulic gradient), and how much water is available for use (specific

110. Note that other quantification concerns, while important elements of the environmental offset literature, such as enforcement, are best considered an aspect of the surrounding water rights system of which offsets are a part; others, such as leakage and verification, would be much less problematic in the groundwater context, at least where the offset is sourced from a replacement surface water right. In particular, protection of surface water rights used for mitigation from more junior appropriators is important to maintain their value; similarly, ensuring that retired rights are no longer used is important to maintain their value. But there is no reason to expect that monitoring and enforcement of these water rights would be different than that for other water rights. Leakage—the change in impact that occurs outside the offset transaction—is a key issue in the carbon offset context, where an emissions reductions project simply causes an increase in emissions elsewhere. This is a potential concern in the groundwater context, where a requirement to offset groundwater pumping may simply encourage aspiring groundwater users to package their pumping in a way that takes advantage of rules that exempt some categories of pumping from offsetting. However, as with enforcement concerns, measures to prevent "leakage" in the groundwater context are really an element of the surrounding water rights system and how it structures permit exemptions for wells, rather than an element of the offset rules themselves. A final substantial area of discussion in the carbon offset context is validation and verification, meaning checking the eligibility of the project before implementation, and checking the performance of the project post-implementation. Post-implementation auditing is less likely to be problematic in the case of groundwater offsets because of the clear effects of retiring a surface water right that is adequately enforced.

111. *See generally* Bredehoeft & Kendy, *supra* note 67, at 23-29 (describing the factors that influence the nature of stream depletion).

yield).[112] Calculating these effects can be very challenging, particularly where aquifer properties are highly spatially heterogeneous and there are little available data about them. The nature of the effects, for example, when the depletion will be felt and whether it fluctuates or is basically constant, can change significantly depending on these factors.[113] These problems are further compounded when the focus shifts to quantifying the impact on a surface water right, as distinct from on surface water generally. The historical beneficial use of a potentially impaired surface water right may differ from what the right says on paper. Since western water law typically does not recognize long-unused water rights as valid under the doctrines of forfeiture and abandonment,[114] determining the historical beneficial use of the potentially impaired water right is a further step necessary to quantify the effect of the impairing action and ensure equivalence with the volume of the offsetting action.

2. *Non-fungibility*

In addition to mis-quantification—essentially the problem of mis-calculation—the second major risk to equivalence between impacts and offsets is "non-fungibility" of space, type, or time, which gets at the problem of mis-characterization of impacts and benefits. Non-fungibility of space occurs where the value of a resource, or the impacts of an impairing action, are location-dependent, such that trading a resource credit in one location for a debit in another location results in diminished resource value or different beneficiaries. Non-fungibility of space can cause a spatial redistribution of impact, leading to impact "hot spots."[115] The classic manifestation of this in relation to groundwater offsets is a dewatered stream reach caused by the point of diversion of the replacement water right being downstream of the location of depletion caused by pumping groundwater.

Non-fungibility of type occurs where the impacts and benefits are not in the same metric, such that trading them diminishes

112. For an accessible introduction to these and other common terms used to characterize aquifers, see STEVE GLASSER ET AL., U.S. DEP'T OF AGRIC., TECHNICAL GUIDE TO MANAGING GROUND WATER RESOURCES Appendix II (2007), *available at* http://tinyurl.com/lpydkhl.

113. *Id.* at 28-29.

114. Neuman, *supra* note 82, at 928.

115. Womble & Doyle, *supra* note 8, at 231-32.

resource value. The potential for non-fungibility of type arises in groundwater offsets because groundwater withdrawal may influence the quality of water in connected streams (including temperature), since the quality of discharged groundwater can differ from that of surface water. This can affect surface water users that are sensitive to water quality, such as industrial users, as well as fish that are often the primary intended beneficiaries of instream flow rights.[116]

Non-fungibility of time occurs where the timing of impacts differs from the timing of benefits, such that the overall resource value is diminished for a period of time. Non-fungibility of time has five elements in relation to groundwater. The first relates to the initiation and incremental increase in river depletion. The effects of withdrawing groundwater take time to propagate through to the stream; stream depletion increases with time until the full level of depletion is felt, at which time the system reaches equilibrium. This can cause a temporal mismatch between depleting the stream and compensating for the depletion. Second, and more substantially, non-fungibility of time can present an ongoing problem, since the impacts of withdrawing groundwater and the benefits of the replacement water may relate to different times of the year on account of different kinds of water rights, e.g. year-round vs. irrigation season rights. This is further complicated by the fact that the impacts on a stream of pumping groundwater from April-October, for example, can be displaced by days, weeks, months, or longer, because of the time lag that occurs between pumping from a well located distant to a stream, and propagation of those effects to the stream. Non-permanent offsets are a further manifestation of non-fungibility of time, and a key concern of the environmental offset literature.[117] The benefits of retiring a water right to offset groundwater pumping would be lost if the water dedicated to instream mitigation purposes were appropriated by another individual for consumptive use.[118] Fourth, where the

116. For example, the principal intended beneficiaries of Oregon's Deschutes Groundwater Mitigation Program are flows for scenic waterways and instream water rights. OR. WATER RESOURCES DEP'T, DESCHUTES GROUND WATER MITIGATION PROGRAM 1 (2007), *available at* http://tinyurl.com/m5f5jz2.

117. *See, e.g.*, Gillenwater & Seres, *supra* note 17, at 196.

118. This will not be treated directly in the evaluation framework proposed here, since enforcement of water rights is conceived as a feature of the background water rights system, rather than as a feature of offset rules specifically. More indirectly, the permanence of the benefits of retiring a surface water right may be reduced or lost

availability of offset water is affected by climatic conditions, a drought year, for example, could reduce the availability of the source and cause a mismatch between offsets and impacts. This would occur, for example, where the source of replacement water is a relatively junior surface water right or a contractual right to have stored water released from a reservoir. This is because under the prior appropriation water rights systems that dominate the western United States, water rights themselves can be highly diverse, for example, with different priority dates and accordingly different reliabilities. Finally, the impacts of pumping from a particular well may change due to changes in the environment, for example, the installation of additional wells that have the effect of changing groundwater flow patterns in a way that brings about new impacts that are not offset in places that were previously unaffected by the first well. Table 1 summarizes the nature of these threats to integrity with reference to the most common method of offsetting in each offset context: restoring a degraded wetland; buying an existing surface water right and dedicating it to instream flow; and building a renewable energy project to replace a facility that produces more greenhouse gases, respectively. Table 1 also indicates the potential for each kind of threat to manifest in each case, in the absence of a rule to constrain transactions, that is, the potential that exists just by virtue of the nature of the resource in question.[119]

through future external changes. For example, climate change might significantly reduces the reliability of the retired surface water right (it would be able to be fulfilled in fewer years than historically was the case), such that dedicating it to instream flow had a lesser impact on actual flows. Similarly, climate change could increase the consumptive component of a groundwater right by increasing evaporation, BRYSON BATES ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, TECHNICAL PAPER ON CLIMATE CHANGE AND WATER VI 15, 27 (2008), and reducing return flows, thereby increasing the amount of offset required over time, and leading to a corresponding shortfall in the offset provided using calculations made pre-climate change. However, the policy question of who should bear these burdens seems more open, and given that this is a significant question for water rights systems as a whole, it is not discussed further here.

119. Note that this assessment of the potential threat may not correspond to the difficulty of designing an offset rule to address it; for example, there is high potential for groundwater offsets to experience non-fungibility of time, but this could be addressed relatively easily by a rule that requires substituting a year-round surface water right in response to year-round groundwater depletion.

Table 1: Threats to the integrity of offset rules, and their potential to manifest—the examples of wetlands, groundwater, and carbon offsets

Threat & potential to manifest	**Wetland mitigation**	**Groundwater offsetting**	**Carbon offsetting**
Non-fungibility of space	Restored wetland provides services to fewer people than original	Depletion occurs upstream of point of diversion of surface water right, causing dewatered stream reach	—
	High potential: error extends in two or three dimensions, as benefits of wetlands vary in all directions from the site	Medium potential: error restricted to one dimension (along line of river)	No potential: Greenhouse gases mix completely in atmosphere and move freely
Non-fungibility of type	Functions of restored wetland have different ecological value to original	High quality groundwater discharge substituted for low-quality surface water	—
	High potential: ecological functions of wetlands are highly distinctive	Medium potential: replacement water from same stream unlikely to be of substantially different quality, relative to other sources	Low potential: Greenhouse gases can be characterized using their global warming potential
Non-fungibility of time	Wetland fully restored some time after damage to original sustained	Year-round depletion caused by pumping groundwater replaced by seasonal surface water right	Offset project fully operational sometime after credit claimed
	High potential: wetland maturation can take a long time	High potential: Surface water rights available as replacement water likely to be for irrigation, therefore seasonal	Low potential: operational status of offset project easily discernible, time to completion relatively short

Table 1 shows that concerns about non-fungibility that apply in the context of environmental offsets also apply to groundwater offsets. In each case, the extent of the potential of groundwater offsets to suffer from a particular threat to fungibility falls within the same continuum of concern as applies to environmental offsets. Both of these facts demonstrate the potential mutual benefits of analyzing the features, functions, and performance of groundwater and environmental offsets to guide the improved design of a more general class of "natural resources offsets"—a point which Part Five explores further.

Two important side notes should accompany the observation of this comparability between groundwater and environmental offsets. The first is that it stands despite the apparent difference in the character of the underlying goods—public in the case of wetlands and climate, and private in the case of water rights. However, western United States water rights also have a strong public character. This is the case most obviously in the case of water rights held by the state[120] or private individuals for public-benefit environmental purposes.[121] More profoundly, though less obviously, rights to use water may generally be considered private property, but the water itself is owned by the public, held in trust by the state,[122] and accordingly, water permitting processes involve explicit public interest considerations.[123] In the cases of both

120. All western U.S. states with formal groundwater offset rules also provide for instream flow rights, which are generally held by a state agency for the benefit of the public. OKLA. WATER RES. BD, OKLAHOMA COMPREHENSIVE WATER PLAN 2011 UPDATE: TECHNICAL MEMORANDUM INSTREAM FLOWS IN OKLAHOMA AND THE WEST 3-2 (2009). For a list of states with detailed offset programs, see *supra* note 72 and accompanying text. Since instream rights are frequently relatively junior, they are more likely to be impacted by new or altered groundwater extraction than older, more senior consumptive surface water rights.

121. "Regular" surface water rights of varying priority dates may also be held by individuals for wildlife or environmental purposes, which carry a clear public benefit despite their private holding. Arlene J. Kwasniak, *Water Scarcity and Aquatic Sustainability: Moving Beyond Policy Limitations*, 13 U. DENV. WATER L. REV. 321, 343-45 (2009-10).

122. *See, e.g.*, CAL. WATER CODE § 102 (West 2014) ("All water within the State is the property of the people of the State"). Under this provision, which was "perhaps . . . intended as a preemptive strike against any private effort to claim 'ownership' in a proprietary sense," the state "owns" groundwater in the abstract sense that the *people* of the state own it. State v. Super. Ct. of Riverside Cnty., 78 Cal. App. 4th 1019, 1026, 1030 (2000).

123. The "public interest" is a frequent consideration that applies to permitting new water diversions and changes to existing diversions across the western U.S. *See generally* Amber Weeks, *Defining the Public Interest: Administrative Narrowing and Broadening of the Public Interest in Response to the Statutory Silence of Water Codes*, 50 NAT. RESOURCES J. 255

environmental resources and water rights, "there are interests beyond those of the traders that must be taken into account."[124] In addition, in both cases, the compliance obligation being offset is a private liability.

The second side note is that an important difference between groundwater and environmental offsets exists in the way that impacts and offsets propagate. In the case of environmental offsets, impacts and offsets may propagate outward from the relevant site in all directions. In the case of offsets designed to compensate for the effects of pumping groundwater on surface water rights, they propagate down a river. In addition, groundwater pumping most strongly affects down-gradient, rather than up-gradient water rights;[125] filling in a wetland can affect birds that travel to the wetland from many different, and potentially unpredictable, places. This difference arguably means that there is a lesser risk of spatial non-fungibility than is the case where assessing impacts requires a spatially broader, less geographically predictable scope of assessment. Even when impacts to right holders are considered beyond the point of diversion, for example municipal rights for cities that are far from the point of diversion, these impacts are likely to be along known corridors. These differences should be borne in mind when considering the relative degrees to which groundwater offset rules provide mechanisms to address non-equivalence.

F. *A Framework for Assessing Approaches to Deal with Threats to the Integrity of Groundwater Offsets*

The foregoing section demonstrates the potential threats to the integrity of offset rules: mis-quantification and non-fungibility.

(2010) (examining the response of state water agencies to statutory provisions requiring the public interest to be considered in permitting decisions, where the public interest is not defined). As explained further below, groundwater offset transactions usually involve permitting a new groundwater diversion, or changing the purpose of a surface water right (which is used as replacement water to compensate for depletion caused by pumping groundwater), or both, thereby enlivening these public interest considerations. In addition, offset transactions excite the same potential for third party impacts (for example, "downstream" economic detriment) as are considered by some to require public involvement in water marketing generally. JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES: CASES AND MATERIALS 289-298 (Thomson/West 4th ed. 2006).

124. Salzman & Ruhl, *supra* note 71, at 668.

125. PAUL M. BARLOW & STANLEY A. LEAKE, U.S. GEOLOGICAL SURVEY, STREAMFLOW DEPLETION BY WELLS: UNDERSTANDING AND MANAGING THE EFFECTS OF GROUNDWATER PUMPING ON STREAMFLOW 21 (2012).

This section builds a framework for evaluating approaches or measures that are adopted in groundwater offset rules to address the most important of those threats. It first provides an overview of the broad types of approaches that offset rules across the western United States use in practice to deal with these threats, and then presents these as an ordered range of approaches,[126] giving an example of each.

Risks of mis-quantification are addressed in a preliminary way by ensuring that the relevant water rights are real or "wet." This involves proving that the water right to be used as a source of replacement water is beneficially used in practice. This ensures that the offset offers real benefit.

Beyond basic proof of use, adequate quantification requires accurately calculating the volume of water that will be drawn from the river by the proposed well, which means first knowing how much water will be consumptively used. Consumptive use for irrigation purposes can be calculated using assumptions about evaporation and other factors that are site-specific to a greater or lesser degree.[127] Calculating stream depletion then involves determining a method that is likely to yield a reasonably accurate result given local conditions and data.[128] However, even the most complex modeled approaches are unlikely to ensure complete accuracy, because the characteristics of subsurface environments are rarely completely known. Accordingly, in some rare instances,

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126. This evaluation system is presented as a practical way to judge the degree to which certain elements of offset rules prevent externalities, but the ordinal scale used is not intended to be viewed as conclusive in a normative sense, for two reasons. First, as Part Four explains further, the integrity of offset rules is not the only consideration in designing such rules, though it is a major concern. Second, different combinations of measures could, in theory, achieve high integrity offset rules, though some may be more likely than others to work in practice.

127. For examples of approaches to calculating consumptive use, *see* OR. WATER RES. DEP'T, DESCHUTES BASIN MITIGATION PROGRAM: FIVE-YEAR PROGRAM EVALUATION REPORT 6 (2008) (offset requirement calculated based on average consumptive uses for different use types); Modified North Platte Decree, Nebraska v. Wyoming, 325 U.S. 589, 665 (1945), modified and supplemented in Nebraska v. Wyoming, 345 U.S. 981 (1953), further modified in Nebraska v. Wyoming, 534 U.S. 40 (2001), Appendix G, Exhibit 6A (Procedures for Calculating Consumptive Use of Irrigation Water Above Guernsey Reservoir, Wyoming) 208.

128. Depletion in some situations can be well-estimated using established techniques. Bredehoeft & Kendy, *supra* note 67, at 26. Approaches to estimating volumetric impacts include—in decreasing order of the likelihood of accurately quantifying these impacts—a numerical model, an analytical stream depletion equation, or a simple hydrological calculation. For a technical explanation and examples of approaches, *see id.* at 54-72.

groundwater offset rules explicitly include measures to counter the possibility of errors in quantification, such as a cap on offsets,[129] or a ratio that requires more than one unit of replacement water for each predicted unit of stream depletion.[130]

Risks of non-fungibility can be addressed using three types of approaches described in general terms by Salzman and Ruhl.[131] I continue to use their terminology, but translate it into a form suitable for evaluating groundwater offsets. The first approach is to specify a detailed "currency" or unit of exchange between impacts and offsets, which ideally captures all the important variables that reflect the valued characteristics that will be exchanged and leaves out none.[132] The key currency variables related to groundwater offsets are, in addition to volume (which I have characterized as a quantification issue), timing, location, and water quality. As demonstrated by Table 1 and Part Three, some groundwater offset rules adopt a currency that involves all four of these variables. Salzman and Ruhl hypothesize that such a currency approach could seriously conflict with the goal of efficiency—in the sense of achieving protections at less cost than alternative mechanisms—by substantially increasing transaction costs and thinning offset markets to the point of threatening their very viability.[133]

The second approach to addressing non-fungibility is to use market rules to constrain substitutions that would result in a mismatch between characteristics that are not defined in the

129. More specifically, a volumetric limit on the new groundwater rights that can be permitted conditional on obtaining an offset. Caps are frequently proposed to deal with concerns about integrity in the context of carbon offsets, Wara & Victor, *supra* note 46, at 5, but in reality only limit the damage caused by non-equivalence, rather than reduce the risk of the damage occurring. Caps on offsets also exist, but are uncommon, in the groundwater context: e.g., Groundwater offset arrangements in Oregon's Deschutes Basin, where a 200 cfs cap on offsets applies. PHILLIP C. WARD, MEMORANDUM TO WATER RESOURCES COMMISSION (OREGON): DESCHUTES BASIN GROUND WATER MITIGATION PROGRAM FIVE-YEAR REVIEW 3 (2008) (noting that environmental groups have generally supported the cap, but others suggest that the cap has encouraged the submission of speculative groundwater applications).

130. DESCHUTES RIVER CONSERVANCY, TEMPORARY MITIGATION VS. PERMANENT MITIGATION (undated), *available at* http://tinyurl.com/jw8kbry (using a ratio of 1:2 credits in the case of leased, rather than permanently retired water).

131. Salzman & Ruhl, *supra* note 71, at 627-30.

132. *Id.* at 614. Salzman and Ruhl describe currency as simple (for example, volume), universal (which involves conversion, for example, to dollars) or comprehensive (a metric that involves multiple variables simultaneously); these represent an increasing degree of capturing important variables in the currency unit, thereby preventing non-fungibility. *Id.* at 631-37.

133. *Id.* at 636.

currency.[134] Market restrictions can limit "who can trade, where they can trade, when they can trade, and what the exchange rate of the currency should be." [135] The most common use of market rules for groundwater offsets addresses non-fungibility of space. Rules restrict the geographic area[136] from which offsets can be sourced relative to the location of the proposed well. This restriction minimizes the spatial difference between the impact and the offset and avoids causing a dry stream reach between the depleted stream reach and the source of the replacement water. Salzman and Ruhl hypothesize that comprehensive currencies correspond to reduced use of market rules, and that simple currencies result in highly restrictive market rules.[137] Part Three tests this hypothesis in the case of western United States groundwater offset rules.

A third and final approach to preventing non-fungibility entails using public oversight to deal with remaining externalities that may arise due to the incentives of agencies and traders to accept them, contrary to the public interest,[138] which threaten the environment and social welfare.[139] Unlike currency and exchange measures, public review measures act as a backup, rather than a principal mechanism for ensuring equivalence. Typically, review measures give the public the right, in a relatively limited form, to oversee offset transactions.[140] Public participation poses a fundamental design challenge of finding a path between the "largely ineffectual practice of commenting on trades that are

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134. *Id.* at 642-45.

135. *Id.* at 637.

136. *See* Womble & Doyle, *supra* note 8. Another common rule in natural resources offset programs deals with temporal non-fungibility between impacts and offsets by only validating offsets for limited periods of time, or by only issuing offset credits when replacement resources achieve partial or full functionality. *See* Salzman & Ruhl, *supra* note 71, at 642. This factor does not differentiate modern groundwater offset rules, since all now formally require an offset to be arranged before impacts manifest. *See, e.g.*, N.M. OFFICE OF THE STATE ENG'R, *supra* note 80, at IV(E). A final exchange mechanism, exchange rates, appears in the form of offset replacement ratios, where the number of credit units required to offset a debit unit exceeds 1:1. Womble & Doyle, *supra* note 8, at 279. Such mechanisms are used in Oregon, for example. *See supra* note 130 and accompanying text.

137. *See* Salzman & Ruhl, *supra* note 71, at 638.

138. *See id.* at 675-76 (discussing the incentives of parties to an offset transaction that tend to ignore the public interest). That is, project proponents and regulators may have overlapping interests in ensuring simple and low transaction cost approvals (reducing project costs and protecting the "political defense of regulatory power," respectively) to create high externalities. *See id.* at 676-77.

139. *See id.* at 680.

140. *Id.* at 684.

effectively fait accompli and absolute veto power," while avoiding the potential for unhelpful interest group interference.[141] Potential mechanisms to ensure effective public participation include public veto, expert review panels, and courts.[142] Salzman and Ruhl note that environmental offsets rarely involve public review, but rather involve generic rules and government agencies as umpire.[143] Groundwater offset rules tend to use a range of public comment and public hearing mechanisms as the key form of public review.[144] Some rules place the burden on the public protester to demonstrate the potential for impairment; others require the proponent to prove no impairment will occur.[145] As such, these rules offer a unique insight into the challenges of using these public mechanisms in an offset context with implications for other natural resources discussed at Part Five.

The table below crystallizes the discussion above into an ordinal scale of general approaches to addressing the most important risks to the equivalence of groundwater offsets and pumping impacts.[146] These approaches are demonstrated by the types of rules that appear empirically in groundwater offset rules across the western United States, separated into those that would theoretically provide high- to low-equivalence (low- to high-externality) groundwater offsets. Note that this table is based on retiring surface water rights, which is the main method of groundwater offsetting; particular challenges posed by other methods are discussed further in the next section.

141. *See id.* at 687-88.

142. *Id.* at 687-93.

143. *See id.* at 668-69.

144. *See infra* Table 3 "review."

145. *See supra* notes 97-98 and accompanying text.

146. Note that this evaluative framework excludes quantification matters that are often dealt with on a case-by-case basis, rather than articulated in generally applicable rules. Methods of calculating consumptive use, the choice of analytical or numerical model, and the use of uncertainty ratios all fall into this category. *See, e.g.*, IDAHO DEP'T OF WATER RES., MITIGATION PLAN EVALUATION CHECKLIST (2009), *available at* http://tinyurl.com/kx8z82u (regarding the choice of model).

Table 2: Approaches to addressing risks to the equivalence of groundwater pumping and offsetting by retiring a surface water right

	Integrity*		Definition of rating	Example^
Quantification	*Proving offset is real*	High	Rules require proof of historic beneficial use of replacement water right	Colorado (rules for augmentation plans). Must provide "records or summaries of records of actual diversions of each right"[147] to be used as replacement water.
		Low	No proof required	Theoretical possibility (no example found).
Fungibility	*Currency*	Very high	Metric relates to location, volume, timing, and water quality; impact modeled using monthly or seasonal time-step	Colorado (rules for substitute water supply plans). Depletion locations and lags are calculated using specified accepted methods.[148] State engineer makes a water quality finding.[149] Monthly accounting of impacts and offsets is required.[150]
		High	As above, but impact modeled using annual time-step	Idaho (rules apply across the state). Depletion analysis deals with volume, location, and timing.[151] Quality may be considered.[152]
		Med.	Metric relates only to location, volume, and timing, not quality	Oregon (rules for Deschutes Basin). Location element is determined using broad zones of impact.[153] Water quality impacts are not considered.[154] Annual time-scale is used to estimate depletion.[155]

147. COLO. REV. STAT. ANN. § 37-92-302(2)(a) (West 2014).

148. *See* COLO. OFFICE OF THE STATE ENG'R, ATTACHMENT TO POLICY 2003-2: GENERAL GUIDELINES FOR SUBSTITUTE WATER SUPPLY PLANS SUBMITTED TO THE STATE ENGINEER PURSUANT TO SECTION 37-92-308, C.R.S. (2003) 2-3 (2003).

149. *See* COLO. REV. STAT. ANN. § 37-92-308(4)(a)(IV) (West 2014).

150. *See* COLO. OFFICE OF THE STATE ENG'R, POLICY 2003-2: IMPLEMENTATION OF SECTION 37-92-308, C.R.S. (2003) REGARDING SUBSTITUTE WATER SUPPLY PLANS 4 (2003).

151. Memorandum from Jeff Peppersack to Reg'l Offices, Water Allocation Bureau Re: Evaluation of Mitigation Plans for Water Rights Permits (Application Processing Memo #72) 2 (May 3, 2010), *available at* http://tinyurl.com/qfe4qyx.

152. *Id.* at 1, 5.

153. *See* OR. WATER RES. DEP'T, *supra* note 127, at 20.

154. OR. WATER RES. DEP'T, DESCHUTES GROUND WATER MITIGATION PROGRAM: HOUSE BILL 3494 REPORT 38 (2009).

155. *See* OR. WATER RES. DEP'T, *supra* note 127, at 29 (describing the decrease in the percentage of time that flow requirements were met, due to the mismatch between

		Low	Metric relates only to volume	Wyoming (rules for "Above Guernsey Dam" area under 2001 Modified North Platte Decree). Caps on groundwater-irrigated acreage and consumptive use apply in stream-connected areas.[156] Depletion above cap is required to be offset only at NE-WY state line.[157]
		High	Uses small zones to restrict the geographic areas from which replacement water rights may be sourced	Nebraska (Central Platte Natural Resources District rules). Location of offsets is restricted to "the same landowner's property whenever possible"; otherwise any area west, or no more than a mile east of the depletion.[158]
		Med.	As above, but uses larger zones	Oregon (rules for Deschutes Basin). General zone of impact addresses regional impacts; six local zones address localized impacts.[159] Zones are used to ensure mitigation occurs at location where impacts are broadly anticipated.[160]
	Exchange	Low	Zones not used as basis for market restrictions	Colorado (rules apply state-wide). No zones are used to guide the location of suitable replacement water.
	Review	Very high	As for "High," but in addition, the decision-maker formally undertakes to consult non-government parties before making a decision	Washington (rules apply state-wide).[161] The state will not make a decision before consulting external stakeholders, including affected parties, other agencies, and tribes.

seasonal mitigation and groundwater extractions, which occur at a uniform rate over the course of the year).

156. STATE OF WYO., DEPLETIONS PLAN, PLATTE RIVER BASIN, WYOMING (WYOMING'S DEPLETIONS PLAN) 4 (2006).

157. *Id.*

158. *See* CENT. PLATTE NATURAL RES. DIST., RULES AND REGULATIONS FOR GROUNDWATER USE IN FULLY AND OVER APPROPRIATED AREAS rr. 4.3, 8.2.4 (2014).

159. *See* OR. WATER RES. DEP'T, *supra* note 127, at 19-21.

160. *See id.* at 19.

161. WASH. DEP'T OF ECOLOGY, *supra* note 66, at 12.

		High	Water right holders and others may protest[+] proposed approval of a groundwater right that is required to offset	Idaho (rules apply state-wide). The state publishes a notice of proposed appropriation, usually including the offset component, and if there is a protest by "any person," a hearing is held.[162]
		Med.	Only water right holders or a person affected may protest	Montana (rules apply state-wide). "A person has standing to file an objection . . . if the property, water rights, or interests of the objector would be adversely affected by the proposed appropriation."[163]
		Low	Rules do not provide for protests	Wyoming (North Platte). An application for a groundwater permit is generally not subject to any notice requirement, and no protest procedure applies.[164]

* These measures relate to the *effectiveness of rules in promoting integrity* in theory, not the effectiveness of their implementation in practice; nor do they relate to performance in terms of efficiency or equity.

^ Examples have been chosen to represent the maximum variation in approaches.

[+] "Protest" means that the rules require notice of the proposed approval, allowing formal protests to be made to the administering agency.

III. EVALUATING GROUNDWATER OFFSET RULES ACROSS THE WESTERN UNITED STATES

As foreshadowed above, and set out in detail in Table 2, great variation is evident in the approaches taken by groundwater offset rules to ensure water right integrity, particularly in the categories of quantification (namely, proving that an offset is real in the sense of "additionality," that is, that a replacement water right has been historically used such that retiring it has a real effect) and fungibility. The table below summarizes the combination of policy settings used in western United States groundwater offset rules in these categories and their sub-categories. Rankings of very high, high, medium, and low are allocated to each measure based on the

162. *See* IDAHO CODE ANN. § 42-203A (West 2014); IDAHO ADMIN. CODE r. 37.03.11.043.02 (2014).

163. MONT. CODE ANN. § 85-2-308(3) (2014).

164. Interview with John Harju, Assistant Adm'r, Ground Water Div., Wyo. State Eng'r's Office, in Cheyenne, Wyo. (Nov. 8, 2011).

definitions set out in Table 2.

Table 3: Policy settings of groundwater offset rules across the western United States

	Additionality	Currency	Exchange	Review
CO (statewide)	High[165]	V. high[166]	Low	High[167]
ID (statewide)	High[168]	High[169]	Low	High[170]
MT (statewide)	High[171]	V. high[172]	Low	High[173]
NE: Central	High[174]	Low[175]	High[176]	High[177]

165. *See* COLO. REV. STAT. ANN. § 37-92-302(2)(a) (West 2014) (relating to augmentation plans).

166. *See supra* notes 148-150.

167. COLO. REV. STAT. ANN. 37-92-302(1) (West 2014) (permitting "any person" to oppose an application for a plan of augmentation); COLO. REV. STAT. ANN. 37-92-308(4)(a)(II)-(IV) (West 2014) (requiring the State Engineer to notify and consider the comments of any person on a notification list in relation to a substitute water supply plan, before approving the plan).

168. A mitigation plan must include information on historic use of replacement water. *See* Peppersack, *supra* note 151, at 3, 5.

169. *See supra* notes 151-152 (requiring a detailed, case-by-case analysis of how a proposal to pump groundwater affects a surface water right in terms of effects on the water volume, location, timing, and potentially quality).

170. *Supra* note 162 and accompanying text.

171. MONT. CODE ANN. § 85-2-360 (2014) (relating to mitigation supported by an application for a change in appropriation right or rights); MONT. ADMIN. R. 36.12.1902 (2014) (requiring proof of historic beneficial use of a water right subject to a change application, which is required to change the use to an offset purpose in relation to a replacement water right).

172. MONT. CODE ANN. § 85-2-361 (2014) (requiring individualized, location-specific data/modeling exercise to neutralize adverse effect, which is differentiated from net depletion; the hydrogeological assessment required with the application in closed basins must include any predicted water quality changes).

173. *Supra* note 163 and accompanying text.

174. Irrigation history of the land must be proven to be certified as "irrigated acres," which are available as offsets. CENT. PLATTE NATURAL RES. DIST., *supra* note 158, at rr. 5, 6.

175. *Id.* at r. 4.3 (calculating volume of depletion on the basis of irrigated acres and crop type, rather than volume: "number of acres to be taken out of irrigation production . . . are equal or greater in depletion . . . than the acres to be newly irrigated"); CENT. PLATTE NATURAL RES. DIST., REQUEST FOR VARIANCE/TRANSFERS LOCATION OF USE: IRRIGATION 1 (Jan. 2008), *available at* http://tinyurl.com/m2htrxl(requiring that a variation to the use of a water right, as would be required to change the use of a water right used for replacement water to an offset purpose, be supported only by details as to the number of acres irrigated and crop type). There are no specific rules for considering water quality impacts. The time-step for calculating depletion is very long—50 years. CENT. PLATTE NATURAL RES. DIST., *supra* note 158, at r. 4.3.

176. CENT. PLATTE NATURAL RES. DIST., *supra* note 158, r. 4.3, Attachment A (using assumptions about depletion derived from a simple geographical rule and a map showing "percent river depletion by section.").

177. Public hearing.notice and public hearing required before Board of NRD makes decision. CENT. PLATTE NATURAL RES. DIST., *supra* note 158, at r. 4.3.

Platte[S]				
NM: Roswell[S]	High[178]	High[179]	Low	Med.[180]
OR: Deschutes Basin[o]	High[181]	Med.[182]	Med.[183]	High[184]
WA (statewide)	High[185]	High[186]	Low	V. high[187]
WA: Yakima	High[188]	Med.[189]	Med.[190]	Low[191]

178. N.M. OFFICE OF THE STATE ENG'R, *supra* note 80, at IV(B), (E).

179. Individual modeling of depletion is carried out using a default numerical model. It is assumed that the entire diversion is consumptively used. N.M. OFFICE OF THE STATE ENG'R, *supra* note 80, at IV(A). Quality effects are considered on a case-by-case basis using a default method and consultation with the New Mexico Environmental Department. *Id.* at (V) (using the "chloride concentration ratio" method, which can decrease the permitted diversion). However, the timing of depletion is considered on an annual time-step. Interview with David Heber, *supra* note 93.

180. To protest, one must either be a water right holder asserting impairment or a non-water right holder asserting detriment to the public welfare or that the action would be contrary to conservation of water in state and that the objector will be "substantially and specifically affected by the granting of the application;" all political subdivisions and agencies have standing. N.M. STAT. ANN. § 72-12-3(D) (West 2014).

181. Creating mitigation credits requires changing the use of a right to mitigation, which involves proving beneficial use. OR. REV. STAT. ANN. § 540.520(2)(g) (West 2013); DESCHUTES RIVER CONSERVANCY, WHYCHUS WATER BANKS FEASIBILITY STUDY: FINAL REPORT 8 (2010), *available at* http://tinyurl.com/plo33hp.

182. *Supra* notes 153-155.

183. OR. WATER RES. DEP'T, *supra* note 127, at 19-21.

184. *See* OR. REV. STAT. § 390.835(9)(f), 537.620(6)-(7), 537.621, 537.622 (2013) (outlining process of public notice, call for public comments, and contested case hearing).

185. *See, e.g.*, WESTWATER RESEARCH, BENEFICIAL USE ANALYSIS WATER RIGHT CERTIFICATE G2-26862GWRIS: FINAL REPORT 5-19 (2010) (setting out history of use, calculating mitigation water by consumptive quantity of the water right over the last five years of use, and stating that this is Department policy), *available at* http://tinyurl.com/oxyffyu.

186. Mitigation plans are assessed on a case-by-case basis, considering timing (on at least a seasonal basis), location, water quality effects and quantity using "detailed hydrological analysis, which may include an analytical or numerical model." WASH. DEP'T OF ECOLOGY, *supra* note 66, at 5, 8. Note that under some situations, the Department of Ecology will accept offsets that are out-of-kind, out-of-location, or out-of-time. *Id.* at 6-7, 10-11. Also note that in the case of offsetting impairment to instream flows, the Department of Ecology explicitly considers instream biological needs, fish species affected, and quality of fish habitat affected—considerations that are not explicitly mentioned in any other state's offset policy. *Id.* at 12.

187. In the case of potential impairment of instream flows, the Department of Ecology consults with various parties (e.g., tribes, wildlife departments) before making a determination. *Id.* at 12.

188. WASH. REV. CODE ANN. § 90.42.080(4), (8), (10), (11) (West 2013) (generally limiting, with some exceptions, the value of a trust water right, which is a common source of a replacement water right, to the amount of water used in the previous five years); WASH. ADMIN. CODE § 173-539A-050 (2013) (relating to mitigation achieved using the state's trust water rights program, which is used for mitigation in the Yakima River Basin).

189. Applications for new groundwater appropriations allowable under the Upper

basin[S]				
WY: North Platte[o]	High[192]	Low[193]	Med.[194]	Low

[o] Only basin in the state where offsets are used under a formal policy. Ad-hoc application of offsets applies elsewhere.[195]
[S] Offsets are used in several basins in the state, with different rules applying to each. This basin is used as an example because it has a feature of particular interest. E.g. Roswell, NM (water quality included in currency); Central Platte above Chapman, NE (very high degree of groundwater development); Yakima, WA (detailed rules apply to permit-exempt wells).

Kittitas Ground Water Rule (permit-exempt uses) must be accompanied by a determination of "water budget neutrality," which involves assumptions about the proportion of water used for various categories of use being consumptively used. WASH. ADMIN. CODE § 173-539A-050 (2013). The Department of Ecology must determine that the water right proposed to be put into the Trust Water Rights Program as mitigation water (i.e., the offset measure) will not result in impairment of senior water rights if any senior water rights are located downstream of the point of withdrawal of the proposed groundwater right. WASH. ADMIN. CODE § 173-539A-060(4) (2013). It is assumed that one unit of consumptively used groundwater results in stream depletion of one unit. A seasonal time-step is used. *See, e.g.*, Letter from Wash. Dep't of Ecology to Mark & Jane Rattray, Re: Determination of Water Budget Neutrality for Request No. 14-35584 (July 31, 2013), *available at* http://tinyurl.com/mav4hv3. In relation to location, the adequacy of a particular replacement water right is guided by indicative maps of suitability of such rights to offset groundwater pumping in particular locations of the watershed, but the Department retains discretion in approving the offset, or requesting more information to facilitate its determination that the offset will result in the groundwater appropriation being "water budget neutral." *Infra* note 190.

190. The usual way of obtaining replacement water is through buying a "mitigation certificate" from an offset bank (in Washington, called a "water exchange"), of which there are six in Upper Kittitas County. *Yakima River Basin Water Exchanges Information Page*, WASH. DEP'T OF ECOLOGY, http://tinyurl.com/lqdtxk9. Maps produced for each water exchange show the areas of groundwater withdrawal for which a mitigation certificate purchased from the bank would likely be suitable, unsuitable, or for which more information would be required. *See, e.g.*, *Roan Mitigation Map*, WASH. DEP'T OF ECOLOGY, http://tinyurl.com/omu4xt9.

191. Determinations of water budget neutrality, required for mitigation, are not subject to any special public hearing procedures; only the general right to appeal a decision of the Department to the Pollution Control Hearings Board applies. WASH. ADMIN. CODE § 173-539A-090 (2013); Letter from Dave Nazy, Hydrogeologist, Wash. Dep't of Ecology, Feb. 22, 2014.

192. Additionality may be implied but is not explicit. STATE OF WYO., DEPLETIONS PLAN, PLATTE RIVER BASIN, WYOMING (WYOMING'S DEPLETIONS PLAN) II.D.2.a (2006) ("[I]f a project proponent wants to implement a new project, the proponent could retire an existing water use that depletes water in the same quantity as the new project . . . .").

193. *Id.* at II.D. The time-step used to calculate depletion is seasonal (i.e., if impacts occur during the irrigation season, they must be mitigated during the irrigation season; if impacts occur during the off-season, they must be mitigated during the off-season).

194. The same sub-basin or river reach is preferred, but if there are mitigated effects on intervening water rights holders, replacement water can be sourced from a different river reach. *Id.* at II.C.3, II.D.2.a.

195. Interview with Barry Norris, *supra* note 15.

In relation to quantification, the table shows that groundwater offset rules are strongly focused on the "paper water" problem in relation to replacement water rights, ensuring that they have been historically beneficially used. Often this concern is dealt with through procedures for changing a water right to mitigation purposes which almost universally require showing proof of historic use, rather than through a specific component of offset rules.[196]

In relation to fungibility, the table shows that the majority of groundwater offset rules studied use currency measures to control externalities, that is, they focus greatly on the specifics of individual situations rather than more generalized pre-determined market rules.[197] Cost differences present as the main potential reason for the general preference for currencies over market rules—or more precisely, preferences for encumbering different parties with the cost burdens associated with quantification. Producing maps restricting where groundwater pumping-induced depletion can be offset with replacement water, the most common form of market rule, involves a significant up-front cost in terms of technical study to determine areas of similar hydrogeological parameters and therefore baseline conditions. The state would typically bear this cost. By contrast, groundwater applicants pay for case-specific technical studies under a currency approach.

This hypothesis about the relationship between preferences in imposing technical costs on agencies versus applicants, on the one hand, and preferences for currencies versus market rules, on the other hand, seems supported by fact that the rule sets which do adopt strong market rules all either apply to areas smaller than the state, which likely contains the costs that accrue to the state; or, in the case of Nebraska, these rules are adopted by local natural resources districts, which, unusually, obtain their funding directly from user taxes.[198] Further support for this explanation appears when considering the nature of the typical groundwater applicant and their ability to shoulder a significant cost burden. In Oregon's

196. *See supra* Table 3 "additionality" and related notes.

197. This is suggested by comparing the frequency of "very high" and "high" in the currency row of Table 3 with that in the exchange row of Table 3 (noting, however, that the table does not comprehensively list all regional rules in use in all states that have groundwater offset rules).

198. Hoffman & Zellmer, *supra* note 13, at 841.

Deschutes and Washington's Yakima basins, quasi-municipal users and individuals using groundwater for domestic or hobby farm use are the typical users requiring offsets.[199] These users are less likely to be able to shoulder the burden of expensive, case-specific technical studies, making it more politically palatable to emphasize market restriction, rather than currency, mechanisms.

Another possible reason for preferring a currency approach to market rules is that the latter may be considered to pose an unacceptably large potential to impair surface water rights. States that are highly protective of water rights, for example, those in which the agency seeks to avoid impairment even if the impaired right holder would accept it,[200] accordingly reject this approach. By contrast, offset rules that adopt market restrictions occur in regions where the water rights that are sought to be protected are less likely to be vigorously defended, either because they are instream flow rights held by a state agency (the impairment of which does not result in direct economic loss) or because the main intended beneficiaries are downstream states that are likely to consider impairment at a higher aggregate level rather than take an interest in individual water right applications.

An important implication of the preference for currency rules over market restrictions in the groundwater offset context would seem to be that it inhibits the establishment of mitigation banks in the sense in which they have arisen in the carbon offset and wetland mitigation context. Focusing on each case-specific situation of stream depletion thins the market of eligible offsets for that depletion, and makes less likely the development of mitigation banks comprised of standardized offset units that apply to larger geographic areas and individual cases of stream depletion. Rather, groundwater offsetting occurs frequently through individual water market transactions that are facilitated by private water brokers.[201]

In describing environmental offset programs, Salzman and Ruhl hypothesized an inverse relationship between the strength of

199. OR. WATER RES. DEP'T, *supra* note 127, at 8 (quantifying quasi-municipal use in the Deschutes Basin); Lieberherr, *supra* note 81, at 26 (describing hobby-farm uses in the Deschutes Basin); Ziemer et al., *supra* note 12, at 36 (describing how mitigation developed to serve permit-exempt water uses for residential growth in Walla Walla and Kittitas Counties, Washington).

200. *Supra* note 91 and accompanying text.

201. For a discussion of banking in the groundwater offset context and potential ramifications for transaction costs, see *infra* notes 218-221 and accompanying text.

currency measures and the strength of market rules.[202] This relationship is very clearly borne out in the case of groundwater offsets. Not only does this happen at the extremes (high-currency/low-market rules, and low-currency/high-market rules), but also in the case of the mid-point (medium-currency, medium-market rules), where the state publishes guidance information in the nature of market restrictions, but retains ultimate discretion to approve the transaction based on case-specific factors. Although I have found no evidence demonstrating that state agencies consciously choose to focus on currency or market rules in this way, it makes sense: strength in one measure reduces the need for strength in the other to control externalities.

As distinct from the significant variation seen across currency and market approaches, the extent of public review of offset transactions in most states is generally high. This may be explained by the long tradition of public involvement in state water administration. A weak review requirement in Wyoming occurs where the driver for the offset rules is compliance with an interstate compact, rather than intrastate water rights. In this case, the agency may assume the public is less interested or likely to object to externalities to offset transactions.

IV. IMPLEMENTATION CHALLENGES

We have seen that groundwater offset rules in different jurisdictions seek to ensure equivalence between impacts and offsets in different ways and to different degrees, illuminating various options to the designer of offset rules. Making a decision about those options will often involve other goals alongside ensuring equivalence, for example, economic efficiency, equity, and stakeholder satisfaction. We turn now to consider these other goals through interview data that discloses water agencies' perspectives implementing these rules and the relative advantages and disadvantages of different approaches. These implementation issues relate to transaction costs, equity, communication, and monitoring. They generally confirm the potential risks of comprehensive currencies and precise quantification requirements to which theory points.

202. Salzman & Ruhl, *supra* note 71, at 637-38.

A. *The Cost Challenge*

A general goal of offsets is to reduce the public and private cost of achieving regulatory objectives.[203] Groundwater offset rules can help to avoid incurring the opportunity costs of foregoing groundwater development to protect connected surface water. However, as has been argued in relation to environmental offsets, there is a trade-off between achieving certain protections and lowering costs.[204] Groundwater offset schemes avoid some significant costs associated with environmental offsets, like developing certification processes for credits—that is, the cost of defining and establishing property rights[205]—since the surface water rights typically used as offsets already exist in a "certified" form. However, costs are still incurred in the form of private transaction costs, like gaining knowledge of the rules, finding an offset, purchasing the technical expertise required to apply for an offset right, as well as the associated public administrative costs.[206]

Offset rules can affect these costs. As set out above, more certain protections—lower externalities—are achieved by narrowing the definition of an equivalent unit for the purpose of an offset currency or narrowing the geographic area of exchange allowed by market rules. Both approaches risk creating a thin market,[207] where there are few possible candidates for providing offsets, for example few water rights eligible for retirement to provide offsets at a particular location. As has been recognized in relation to both markets generally and environmental offset markets in particular, thin markets result in relatively low competition, low incentive for innovation, and higher potential for strategic behavior among providers, all of which can result in higher and more volatile prices for credits.[208] Where groundwater offset rules do not allow for non-water mitigation, an inability to buy replacement water for a reasonable price may jeopardize the potential to develop groundwater that requires an offset: a

203. Hahn & Richards, *supra* note 4, at 104.

204. *Id.*

205. Anthea Coggan et al., *Influences of Transaction Costs in Environmental Policy*, 69 ECOLOGICAL ECON. 1777, 1778 (2010).

206. *Id.* at 1779.

207. Hahn & Richards, *supra* note 4, at 10 (thin markets in relation to water quality trading programs in small watersheds); Salzman & Ruhl, *supra* note 71, at 631-37, 647, n.100.

208. Womble & Doyle, *supra* note 8, at 273-74.

groundwater right applicant will not proceed where compliance and transaction costs exceed benefits. This occurred dramatically in the South Platte basin in Colorado, under complex circumstances that involved a court finding that the offset actions of well user organizations, which were formed to help small-scale diverters access replacement water cheaply and quickly without a formal court-managed process, were undertaken unlawfully.[209] Thin markets may also make it more difficult to identify what few water rights are eligible to act as offsets—the needle in a haystack problem.[210] Oregon has experienced this effect in certain zones in the Deschutes Basin.[211]

Other common elements of groundwater offset rules are also theoretically likely to lead to high compliance and transaction costs and delays. High transaction costs are associated with technical modeling where offset rules require impacts to be precisely quantified. Government and public reviews of individual transactions can be lengthy, particularly under currency approaches, which can increase transaction costs (monetary costs and delay) and increase uncertainty for pumping proponents.[212] These transaction costs pose a problem not only for groundwater applicants; offset processes that are excessively costly or time-consuming may "create strong political pressure to loosen the rules and grease the wheels of issuance, thus potentially undermining a key component of an offset system's environmental effectiveness."[213] Water agency staff also acknowledge the potential for thin markets and relatively high transaction costs in relation to groundwater offsets,[214] though groundwater proponents in jurisdictions in which offsets have long been established seem more prepared to accept these costs relative to those in which the

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209. Empire Lodge Homeowner's Ass'n v. Moyer, 39 P.3d 1139 (Colo. 2001); Lain Strawn, *The Last Gasp: The Conflict over Management of Replacement Water in the South Platte River Basin*, 75 U. COLO. L. REV. 597, 613-14 (2004).

210. Interview with Peggy Clifford, Manager, Trust Water Program, Wash. Dep't of Ecology, in Olympia, Wash. (Oct. 27, 2011).

211. OR. WATER RES. DEP'T, *supra* note 127, at 24 (describing how, at various times in the Crooked River Zone of Impact, mitigation water has been "difficult to establish," and in the Whychus River Zone of Impact, there are relatively few opportunities to generate mitigation water).

212. Salzman & Ruhl, *supra* note 71, at 673.

213. Wara & Victor, *supra* note 46, at 17.

214. *See, e.g.*, Interview with Brian Walsh, Policy and Planning Section Manager, Water Res. Program, Wash. Dep't of Ecology, in Lacey, Wash. (Oct. 27, 2011).

rules are newer.[215]

However, useful tools have arisen to deal with these transaction and compliance costs. Various institutions are used to increase information availability, so groundwater applicants can access all opportunities within potentially thin markets for replacement water. Some states use state-facilitated water rights clearinghouses, which can be as simple as a web page that enables buyers to find sellers.[216] In the absence of state action, private brokers have arisen in some other states to mirror the function of a clearinghouse.[217]

A more sophisticated option is a water bank, which "stocks" water rights that have already had their use changed to mitigation, or have already been parceled into mitigation "credits,"[218] thereby shortening and cheapening the process of finding and having replacement water applied to a mitigation purpose.[219] Such water banks have arisen through the creation of special-purpose public and private banks,[220] and through the re-purposing of existing water banks, such as those established for temporary instream environmental purposes.[221] The ease of assessing the benefits of the major type of offsetting action (retiring a surface water right) suggests that the offset system is well suited to banking mechanisms. These should be able to avoid some of the problems of delay experienced in certifying CERs and wetland mitigation credits, and shortfalls in funding from in-lieu fees, all of which are products of a special-purpose process of quantifying and certifying offsetting actions.

In addition to measures to deal with the information problems

215. *See, e.g.*, Interview with Tim Davis, *supra* note 83 (describing the cost of hiring technical consultants for mitigation purposes, borne by the groundwater permit applicant as "very, very controversial"); *see also* Interview with Kevin Rein, *supra* note 68 (describing the attitude of groundwater right applicants to the costs involved in hiring technical consultants for mitigation purposes: "It's accepted. Absolutely.").

216. *See, e.g.*, Interview with Peggy Clifford, *supra* note 210 (referring to such a web page established during a period of drought).

217. Interview with Tim Davis, *supra* note 83; Interview with Kevin Rein, *supra* note 68.

218. *See, e.g.*, OR. ADMIN. R. 690-521-0100 (2014); STATE OF WYO., *supra* note 192, at 22-25 (outlining arrangements for the Wyoming Water Bank under Wyoming's Depletions Plan pursuant to the Modified North Platte Decree).

219. Interview with Brian Walsh, *supra* note 214.

220. *See, e.g.*, H.B. 24, 2011 Leg., 62d Sess. (Mont. 2011); Bob Lane, Chief Legal Counsel of Mont. Dep't of Fish, Wildlife & Parks, Address at Mont. 62d Leg. H. Natural Res. Comm. on H.B. 24 (Jan. 19, 2011), *available at* http://tinyurl.com/l9yn8rt.

221. *See, e.g.*, Interview with Peggy Clifford, *supra* note 210 (discussing Washington state's trust water program).

of thin markets, some state and local governments take an active role in "thickening" markets by themselves developing physical projects that create offsets.[222] This essentially socializes this portion of the transaction costs involved in offsetting. The state may also sponsor schemes to free up replacement water, for example through land fallowing programs, under which governments pay groundwater irrigators not to use their rights.[223] Such measures are relatively common in response to state requirements to offset groundwater pumping to meet compact obligations.[224]

Mechanisms have also arisen to lower the costs to proponents of precise quantification requirements, in the form of groundwater modeling that is necessary under currency approaches. A state itself may produce a large-scale groundwater model where demand for groundwater rights is high, thereby removing or reducing these costs for individual applicants.[225] Alternatively, private individuals may pool their resources to undertake collective modeling and offsetting, thereby reducing per-user costs.[226] Though this study uncovered no evidence of it in practice, one could also imagine a hybrid, staged version of state action and collective benefits. Under this approach, the state would pay for an initial groundwater model, then recoup the cost of doing so over time through fees for groundwater right applications, which would reduce per-capita costs.

Finally, "leasebacks" present a way to reduce costs related to

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222. *See, e.g.*, Water Banking Program, CENT. PLATTE NATURAL RES. DIST. (Dec. 2, 2014), http://tinyurl.com/mhoggmy; Interview with Brian Patton, *supra* note 68 (referring to the Yakima and Odessa regions of Washington State).

223. *See, e.g.*, Interview with Kevin Rein, *supra* note 68 (describing using the Conservation Reserve Enhancement Program for this purpose).

224. *See, e.g.*, Interview with David Heber, *supra* note 93 (describing New Mexico's "pump and dump" scheme, under which the Interstate Stream Commission purchased water rights and constructed wells in the Pecos Basin to provide replacement water to fulfill compact delivery requirements to Texas). *See also* Interview with John Harju, Assistant Adm'r, Ground Water Division, Wyo. State Engineer's Office, in Cheyenne, Wyo. (Nov. 8, 2011) (discussing Wyoming's efforts to comply with the requirements of the North Platte Decree (with Nebraska) to replace water by buying reservoir storage in federal reservoirs or entering into contracts to release stored water).

225. *See, e.g.*, Interview with Brian Patton, *supra* note 68 (in relation to the model for the Eastern Snake Plain Aquifer).

226. *Id.* (generally this occurs only where offsetting is required retrospectively, to avoid curtailing rights, rather than prospectively, as a precondition to obtaining a right). *See generally* Strawn, *supra* note 209 (referring to groundwater users organizing into groundwater districts for the purpose of collectively mitigating their actions, the benefit being smaller per-user costs).

purchasing the replacement water itself. Given that depletion to surface water caused by pumping groundwater increases with time, a state may require the ultimate amount of replacement water to be secured in advance of approving a new groundwater right, but may allow a decreasing portion of that right to be leased back to the current owner, in line with increasing depletions.[227]

B. *The Equity Challenge*

Despite their costs, even high-equivalence groundwater offset rules have the potential to create at least three species of distributional equity concerns. First, impacts on surface waters may be distributed so as to adversely affect certain communities. That is, like environmental markets, groundwater offset rules could lead to "hot spots" of impact and associated environmental justice concerns.[228] Under most groundwater offset rules, dewatering of stream reaches that supply public or ecological benefits is allowed where no water right is impaired. This could occur where groundwater pumping affects a river in a particular reach, and the location of the water right to be used as a source of replacement water to offset effects on a downstream water right is significantly downstream of the location of the first significant impact. In some cases, offset rules deal with this by allowing public protests based on detriment to public welfare.[229] While recognizing the potential for these hot spot impacts, it is interesting to note that a spatial redistribution of water that results from an offset transaction may actually increase environmental and public benefits associated with instream flows. This would occur where a surface water right is retired and dedicated to instream use upstream of the river reach within which depletion from groundwater pumping would be felt. The river reach between these locations would experience an increase in flows relative to the baseline situation. There is some evidence that this has occurred in practice.[230]

Related to hotspot concerns, a second equity concern relates to the potential economic impacts of redistributing water among sectors or geographic locations, even where there are no stream

227. Interview with David Heber, *supra* note 93.

228. Todd BenDor et al., *The Social Impacts of Wetland Mitigation Policies in the United States*, 22 J. OF PLANNING LITERATURE 341, 342 (2008); Womble & Doyle, *supra* note 8, at 233.

229. *See, e.g.*, N.M. STAT. ANN. § 72-12-3(D) (West 2014).

230. *See, e.g.*, OR. WATER RES. DEP'T, *supra* note 127, at 28-31.

impacts. This is a common concern with any type of water trading.[231]

Finally, equity concerns may arise from the distribution of the burden of offsetting. Some purposes of groundwater use—notably domestic purposes—are often exempt from offsetting requirements, whereas uses for a comparable or smaller volume, for a different purpose, may require an offset to be permitted. This has the potential to create frustration on the part of small non-exempt groundwater users.[232] It also gives rise to the potential for significant cumulative impacts. Groundwater offset rules in Washington State demonstrate that it is possible, however, to require offsets for usually permit-exempt domestic uses by requiring them as a precondition to another kind of approval, such as a building permit.[233] Rules that use market restrictions can be the cause of similar frustrations where a permit applicant must source replacement water from a zone in which water is more expensive relative to other zones.[234]

C. *The Communication Challenge*

Unsurprisingly, communicating often complex groundwater offset rules to stakeholders has proven to be a challenge, particularly where rules are relatively new.[235] Aspiring permittees need to understand many legal, technical, and practical issues, each of which can inspire indignation or disbelief. These issues include the need for a permit to pump groundwater; the fact that pumping groundwater can affect surface water with a variable time lag; the rule that pre-existing surface water rights trump new groundwater rights that affect them; the prohibition on obtaining a new groundwater permit unless pre-existing surface water rights are protected through offsets; and the realization that the offset process can be lengthy and expensive. Applicants may also find it difficult to accept the need to offset to protect against future

231. *See, e.g.*, discussion of permitting new water rights and changes to existing rights in *supra* note 123.

232. Interview with David Heber, *supra* note 93.

233. Ziemer et al., *supra* note 12, at 39-40.

234. Interview with Ivan Gall, Manager, Ground Water Div., Or. Water Res. Dep't, in Salem, Or. (Oct. 25, 2011).

235. *See, e.g.*, Lieberherr, *supra* note 81, at 32; Interview with Tim Davis, *supra* note 83 ("I think that's been the biggest struggle over the last, five years, is just getting people to understand the law [regarding mitigation requirements in closed basins]").

impacts in dry years when current conditions are good.[236] Experience of groundwater offset rules suggests that a concerted communication effort is required so that proponents—and stakeholders who may play a public review role in relation to proposed offset transactions—understand them.

D. *The Monitoring and Verification Challenge*

Monitoring the physical effectiveness of offsets—that is, the absence of net impacts beyond the acceptable level—is a noted gap in relation to many environmental offset programs.[237] It also appears as a gap in many groundwater offset rules. Few groundwater offset rules include requirements to see whether the system is actually working by determining whether offsets actually avoid impairing surface water rights. This is sometimes based on important physical reasons: it would be difficult to detect the results of offsets for relatively small volumes of replaced water where river flows are large and variable for many reasons.[238] Oregon's Deschutes Basin takes an alternative approach, recognizing this limitation. Rules for the program require reviews of the effectiveness of the pilot program at five-year intervals, and must annually evaluate the implementation of the rules, which involves determining "whether scenic waterway flows and instream water right flows . . . continue to be met on at least an equivalent or more frequent basis as compared to long-term, representative base period flows."[239] Other rules also include objectives relating to the evaluation of the performance of offsets, but these obligations have not yet fallen due.[240]

Where offsetting actions predominantly involve existing surface water rights—retiring them permanently or contracting for their non-use—the risks of not achieving equivalence in practice are relatively limited in nature, and arguably, degree. Risks of non-

236. Interview with Kevin Rein, *supra* note 68 (noting the difficulty that groundwater users have reconciling legal requirements to shut down wells when, due to a good rain year, groundwater levels are high; this gives rise to calls to relax regulation of wells).

237. Bronner et al., *supra* note 18, at 456; Gardner et al., *supra* note 33, at 235-40; Margaret S. Race & Mark S. Fonseca, *Fixing Compensatory Mitigation: What Will it Take?*, 6 ECOLOGICAL APPLICATIONS 94, 96, 99 (1996).

238. Interview with Shelley Keen, *supra* note 91 (in relation to high flows in the Snake River); Interview with David Heber, *supra* note 93; Interview with Ivan Gall, *supra* note 234 (in relation to the Deschutes River).

239. OR. ADMIN. R. 690-505-0500(2)-(3) (2014).

240. *See, e.g.*, NEB. DEP'T OF NATURAL RES. ET AL., *supra* note 63, at 11.

equivalence include (1) the replacement water provider continuing to divert the water, a risk that existing compliance mechanisms like metering and water masters address; (2) the replacement water provider activating "paper water" that was not previously used, which is best (and often) addressed up-front through the permitting process;[241] or (3) the replacement water being insufficient to offset the pumping depletion because the modeling did not precisely reflect real-world conditions, that is, a significant failure of quantification occurred. Additional monitoring or analysis of existing monitoring data may be able to detect this last risk, which would likely otherwise remain hidden. However, distinguishing between possible causes of differences in streamflow is likely to be difficult. Departmental resources would also need to be consciously dedicated to this task, since spare monitoring capacity may not be available.[242]

In certain situations, there may be additional risks of the "credit" not performing as expected. This is particularly the case where non-water offsets are accepted, for example environmental restoration works, or where non-conventional "pumps and pipes" sources of replacement water are used, for example, enhanced aquifer storage designed to discharge to a river.[243] In the last case, which mirrors the higher risk profile of wetland mitigation or carbon offsetting, greater monitoring is warranted. Washington

241. *See supra* notes 110 and 165-192, and accompanying text.

242. Interview with Peggy Clifford, *supra* note 210; Email from Shelley Keen, Manager, Water Rights Permit Section, Idaho Dep't of Water Res., to Rebecca Nelson, Program Leader, Comparative Groundwater Law and Policy Program, Stanford Woods Institute for the Environment and Bill Lane Center for the American West, Stanford University, and J.S.D. Candidate, Stanford Law School (Sept. 4, 2013) (on file with the author) (describing current use of watermasters to ensure the implementation of mitigation plans, but where these watermasters are often busy with their regular task of administering water rights in accordance with priority rules).

243. Interview with Brian Walsh, *supra* note 214 (stating that, before the implementation of Washington's state mitigation policy, "[I]f [mitigation] requires somebody to flip on a switch every Saturday morning or something to pump it will create havoc when the pump goes down or when the person dies. Trying to get accountability around a system like that is very hard."). A similar issue arises in relation to calculating consumptive groundwater use, where, for example, a septic system that returns water to the ground may be replaced in the future with a piped system, thereby increasing consumptive use in a way not accounted for through offsets. Interview with Dave Nazy, Hydrogeologist, Wash. Dep't of Ecology, in Olympia, Wash. (Oct. 27, 2011). This issue also has potential to manifest through across-the-board requirements to replace water into a river to offset existing uses based on average current consumptive use values, which may increase with the use of increased efficiency irrigation equipment. Interview with John Harju, *supra* note 224.

State's recent policy on groundwater offsetting—the only formal policy to accept non-water offsets—includes such detailed monitoring conditions.[244] The CDM literature highlights the desirability of creating consistent approval processes where project types can differ substantially and the importance of avoiding potentially biased verification processes.[245]

V. LESSONS AND CONCLUDING THOUGHTS

Thus far, this Article has set out a framework for evaluating groundwater offset rules based on a framework modified from the environmental offset literature and has applied this framework to produce the first comparative analysis of groundwater offset rules in the western United States. It shows that these rules generally seek to ensure a high degree of equivalence between offsets and impacts through detailed quantification requirements and a highly case-specific "currency" approach. It has also discussed key challenges associated with implementing such an approach, based on interviews with western state agency staff and a review of key institutional mechanisms that have arisen to deal with these challenges. The findings of this Article carry implications for the design of groundwater offset rules generally, as well as for offset systems that apply to other natural resources or that apply to groundwater in other legal contexts.[246]

A. *Lessons for the Use and Design of Groundwater Offset Rules*

1. *Potentially useful additional measures to address risks of non-equivalence of groundwater offsets*

Comparing the design of rules for environmental offsets with those for groundwater offsets uncovers additional, potentially useful institutional approaches to dealing with risks to equivalence. These could help deal with some of the implementation challenges being experienced in relation to groundwater offsets. Groundwater offset rules in the western United States have

244. WASH. DEP'T OF ECOLOGY, *supra* note 66, at 14-15.

245. Wara & Victor, *supra* note 46, at 19.

246. *See, e.g.*, CAL. ENERGY COMM'N, COMMISSION DECISION: GENESIS SOLAR ENERGY PROJECT, at Soil and Water 10-13 (2010), *available at* http://tinyurl.com/numarzk (discussing how groundwater-related offsets have been required as part of energy licensing processes, where groundwater consumption by the power plant would otherwise have significant impacts).

adopted precise quantification requirements and comprehensive currencies in a bid to ensure equivalence between offsets and impacts, but the result can be high costs and difficulties in communicating complex requirements. This approach may also fail to fully recognize the uncertainty associated with groundwater modeling—a noted problem in the area.[247] By contrast, environmental offsets, which have admittedly been criticized for adopting too simple an approach to currency,[248] have adopted two useful ways of compensating for the resulting risk of non-equivalence: mitigation sequencing, introduced in Part II.2, and offset ratios, which are either totally absent or rare in groundwater offset rules. Applied to groundwater offset rules, these measures could provide a lower-cost alternative to precise quantification and comprehensive currencies, as well as transparently deal with modeling uncertainty.

In addition, as suggested in Part Two, there are many types of impacts that groundwater pumping can have that are not covered by offset rules. These pose risks of externalities that are not controlled. The advent of non-water offsetting increases the risk of non-equivalence. These factors all point to the potential usefulness of using risk-reduction techniques like mitigation sequencing and offset ratios in groundwater offsets in at least some situations.

Mitigation sequencing could be expressed in groundwater offset rules as a requirement to achieve a certain level of water efficiency of the proposed use. In short: a groundwater pumper pays for the privilege of introducing a risk to a fully appropriated river by only being allowed to use water at a "best-practice" level of efficiency. This expression of mitigation sequencing would have a distinct advantage over its use in the wetland context, which has proven to be problematic.[249] Water use efficiency is relatively easy to define, and water efficiency goals are commonplace. In addition, because water using activities are likely to be common around the site of new extraction that is to be subject to an offset (since offset requirements apply where rivers are fully allocated to other users), there may be local benchmarks of water use efficiency. Relative to wetlands, the availability of these reference points may make implementing groundwater mitigation sequencing straightforward. This approach to groundwater

247. Nelson & Casey, *supra* note 61, at 8-15.

248. *Supra* note 36 and accompanying text.

249. *Supra* note 28 and accompanying text.

mitigation sequencing would also be consistent with growing interest in legal and policy measures to increase water use efficiency.[250]

Equity concerns with mitigation sequencing may arise, however. A groundwater pumper may well question the fairness of selectively imposing strict water use efficiency requirements given that earlier failure to robustly apply anti-waste doctrines to all water users[251] arguably caused the extent of appropriation and degree of water scarcity that makes offsets necessary in the first place. Efficiency improvements may also be more difficult to make in relation to some crop types and geographic regions than others. In addition, economic efficiency considerations may discourage a mitigation sequencing requirement, on the basis of data that shows that reducing water use by one unit using water efficiency infrastructure can be more expensive than simply buying one unit of water directly.[252]

Offset ratios greater than 1:1, used in environmental offsets, are another approach to the risk of remaining externalities. They can also be conceived as a more general way of dealing with uncertainty in equivalence calculations by requiring the provision of more than one unit of offset per unit of impact, to insure against the offset being less effective than assumed.[253] It is rare for a western United States groundwater offset rule to require more than one unit of replacement water per unit of calculated depletion,[254] and indeed, some rules explicitly prohibit this practice.[255] Yet perhaps offset ratios offer a useful way to address the remaining risk, the cost, and potentially also the communication challenges of precise quantification and comprehensive currency approaches to groundwater offsetting.

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250. *See, e.g.*, CAL. DEP'T OF WATER RES. ET AL., 20X2020 WATER CONSERVATION PLAN (2010), *available at* http://tinyurl.com/oqxqb9m.

251. *See generally* Neuman, *supra* note 82 (describing and evaluating the anti-waste doctrine that appears in many western U.S. state water codes and its potential for greater use in increasing water efficiency).

252. *See, e.g.*, AUSTL. GOV'T PRODUCTIVITY COMM'N, MARKET MECHANISMS FOR RECOVERING WATER IN THE MURRAY-DARLING BASIN: PRODUCTIVITY COMMISSION RESEARCH REPORT 128 (2010).

253. *See, e.g.*, Atte Moilanen et al., *How Much Compensation Is Enough? A Framework for Incorporating Uncertainty and Time Discounting When Calculating Offset Ratios for Impacted Habitat*, 17 RESTORATION ECOLOGY 470 (2009).

254. Interview with Dave Nazy, *supra* note 243 (referring to preliminary work on a proposed model for the Dungeness system).

255. *See, e.g.*, MONT. CODE ANN. § 85-2-362 (2014).

Groundwater offset rules could allow a groundwater pumper to minimize transaction costs by undertaking relatively simple and cheap hydrological analysis to calculate the replacement water required to offset proposed pumping, but then apply an offset ratio to account for the increased uncertainty of that approach.

Wyoming rules provide precedent for a "two track" groundwater offset system, which allows for a groundwater pumper to choose between over-estimating the required replacement water and undertaking modeling to more precisely quantify the depletion.[256] Technical review requirements of many groundwater offset rules suggest that policy innovations to minimize the burden posed by these technical requirements could be very valuable to both permittees and agency staff. The simplest type of offset assumption that would ensure equivalence would be to assume that one unit of groundwater pumped would immediately cause a stream to be depleted by one unit. In some cases, sourcing the same volume of replacement water may be cheaper than undertaking the hydrological investigations required for a precise analysis of depletion. This may be the case particularly where the groundwater permit application relates to a high-value use of groundwater, for example, mining, municipal, or industrial use. Groundwater may also offer advantages beyond surface water, such as reliability, location, and quality, which recommend seeking an offset groundwater permit rather than simply buying and using the surface water right that would be used as replacement water.

2. *Rules that allow non-equivalence*

Since the general purpose of offset rules is to achieve equivalence between impacts and offsets, rules that allow for, or even encourage strict non-equivalence, may seem anomalous. They tend to appear where non-equivalence is intended to lead to overall environmental benefit. The "watershed" approach to wetland mitigation is one such example, whereby a higher environmental benefit may be obtainable by restoring a different kind of wetland than the wetland that is proposed to be impacted.[257] Groundwater offsets also have some potential to achieve environmental benefits through non-equivalent offsets.

256. An applicant can choose to "assume that the water pumped has the same effects as a surface water diversion or may complete groundwater modeling to determine actual effects on surface water." STATE OF WYO., *supra* note 192, at 26.

257. *See supra* Part II.

For example, a state agency could choose to accept impairment of an instream flow in one location in return for replacement water purchased and dedicated to supporting another location (or the same location, but at a different time) that has higher ecological value. These possibilities come about because the marginal value of a unit of water is context-dependent, differing with reference to place and also the condition of a stream relative to some ecological tipping-point. As yet, Washington appears to be the only state that has a formal policy that seeks to take advantage of these differences in marginal value by allowing non-equivalent offsets that would increase overall ecological gain.[258] The agency discretion that is required when considering non-equivalent offsets, and Salzman and Ruhl's caution about the coincidence of agency and proponent interests in approving cheap, non-equivalent offsets,[259] both suggest the desirability of formal policies along with public review in these cases.

Similar to the instream flow situation, a reduction in available water to a consumptive user can have different effects depending on the nature of the use. A pasture irrigator who loses access to one unit of water will suffer a smaller economic penalty than a vineyard irrigator whose product has a higher economic worth per unit of water consumed. Groundwater offset rules that prohibit financial offsets seem to be inefficient where they conceive of impact only in physical terms, where the thing valued by the impaired water right holder is not the physical substance, but the money produced by using the water, and this can vary depending on the use impaired. That is, if the economic cost to the impaired surface water right holder would be less than the cost of replacing the depleted water, and there are no intervening values that would be affected, then efficient groundwater offset rules should arguably allow the transaction.

Both the instream flow and consumptive use situations recall a point raised earlier in this Article, being the importance of determining whether the offset system seeks to protect water rights or the (economic or environmental) value derived from water rights. This Article argues that there will be circumstances in which

258. WASH. DEP'T OF ECOLOGY, *supra* note 66, at 10 ("Out-of-time or out-of-place mitigation can be acceptable if it provides an equal or greater benefit to the environment (e.g., a more critical stream reach will have increased flow) than would be achieved through water-for-water or pooled mitigation.").

259. Salzman & Ruhl, *supra* note 71, at 676-79.

the latter will be desirable—as has been recognized in relation to wetland mitigation. This is not to say that states should change the underlying currency of the transaction (as defined by Salzman and Ruhl), for example, replacing references in water codes to equivalence in volume, timing, and location to equivalence in dollars. But perhaps rules could allow a proponent to show equivalence or overall increase in environmental or economic value in the case of instream and consumptive rights, respectively, and permit such a transaction to be approved with the agreement of the impaired right holder and, especially, appropriate public review.

3. *Expanding the use of groundwater offsets*

A final point on the design of groundwater offsets relates to their absence, and promise, in some states in the western United States. The laws of some notable groundwater-using western states—California, Arizona and Texas—recognize the surface water-depleting effects of pumping groundwater to only a very limited extent.[260] In addition, they manage groundwater and surface water using different levels of government, and different allocation systems or practices. These factors pose substantial barriers to addressing the fragmentation between groundwater and surface water management. In these states, trying to create connections between groundwater and surface water allocation is likely to be politically difficult where this would mean curtailing existing pumping.[261] On the other hand, a preventive mechanism based on offsets may be a more achievable way to recognize these interactions even across levels of government and different principles of allocation, as in Nebraska, discussed further below.

California's recent passage of AB1739, the Sustainable

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260. Rebecca Nelson, Groundwater Wells Versus Surface Water and Ecosystems: An Empirical Approach to Law and Policy Challenges and Solutions 20-24 (May 2014) (unpublished J.S.D. dissertation, Stanford University) (on file with the Stanford University Library system). *See also supra* Part I.

261. For example, various proposals to use legal mechanisms that focus on the common law doctrine of the public trust and a regulatory expansion of the definition of unreasonable use to achieve this in California have not yet been successful. Light v. State Water Res. Control Bd., No. SCUK CVG 11 59127 (Mendocino Super. Ct. Sept. 26, 2012) (invalidating regulations that applied to the Russian River watershed, which sought to declare as "unreasonable" diversions of surface water or stream-connected groundwater that occurred in the absence of a "water demand management program"); Thompson, *supra* note 70, at 295.

Groundwater Management Act, provides an interesting case for considering how groundwater offsets could be used in the context of a new legislative scheme that recognizes the potential for groundwater pumping to affect surface waters. Offsets could figure in the implementation of the new legislation in a variety of ways. New groundwater sustainability plans to be prepared by designated "groundwater sustainability agencies" will have the objective of achieving sustainable yield of groundwater in the basin, defined as the amount that can be withdrawn annually without causing an "undesirable result"—one of which is "[d]epletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water."[262] Offsets that restrict groundwater pumping on account of such adverse impacts might be implemented under the power of groundwater sustainability agencies to control groundwater extractions by "regulating, limiting, or suspending extractions" from individual wells or wells in the aggregate, or "otherwise establishing groundwater extraction allocations."[263] Offset rules are also likely to be a useful subject for consideration in the Department of Water Resources' regulations for evaluating groundwater sustainability plans and the implementation of sustainability plans, as well as its designation of best management practices.[264] Agencies will have a significant incentive to prevent groundwater pumping from depleting connected surface waters, given that the State Water Resources Control Board will ultimately have step-in powers in relation to certain basins where groundwater extractions "result in significant depletions of interconnected surface waters."[265] In this context, the Board should also consider the use of groundwater offset rules in identifying potential actions that could remedy deficiencies in groundwater sustainability plans prior to exercising its step-in powers, as well as in developing and adopting an interim plan for the basin if this becomes necessary.[266]

262. CAL. WATER CODE § 10721(w)(6) (West 2015).
263. CAL. WATER CODE § 10726.4(a)(2) (West 2015).
264. CAL. WATER CODE §§ 10729(d), 10733.2(a) (West 2015).
265. CAL. WATER CODE §§ 10735.2-10736 (West 2015).
266. CAL. WATER CODE § 10735.8 (West 2015).

B. *Lessons for the Use and Design of Natural Resources Offsets Generally*

1. *Thresholds for requiring offsets and cumulative impacts*

An important feature of environmental offsets is the presence of a quantified threshold of acceptable impact, above which an offset will be required in order to allow a project to proceed. Transparently stating this threshold is important to clarifying the potential for uncompensated damage, at least at the level of individual actions. However, it does not address the potential for small individual actions to have cumulatively significant impacts.

Groundwater offset rules in some western states do address this potential for cumulative impacts by regulating normally exempt groundwater uses and requiring them to be offset in particularly stressed basins, while allowing them to remain exempt from offsetting requirements elsewhere. This indicates a more formalized potential solution to the issue of cumulative impacts derived from the operation of thresholds—both numerical thresholds that allow impacts caused below an acceptable limit and those that exclude certain categories of impact. First, adopt a clear threshold of impact for individual actions in the default case; simultaneously, set a trigger value of cumulative impacts beyond which previously exempt or low-impact activities will be brought within the sphere of regulated activities, and ensure regular accounting of those impacts. Determining this trigger value up front in the rule design could minimize the potential for later political obstruction to the expansion of regulatory and offset requirements.[267]

2. *Approaches to dealing with the challenges of implementing offsets*

Rules for groundwater offsets across the western United States have the potential to create high transaction costs. Water banking mechanisms in groundwater offsetting may help address this by enabling aspiring groundwater pumpers to find owners of water rights that have already been approved for use to offset stream depletion.[268] Groundwater offset systems have also evolved very simple mechanisms that could help buyers of offsets to find sellers through online clearinghouse mechanisms that simply inventory

267. Charles Jonathan Nevill, *Managing Cumulative Impacts: Groundwater Reform in the Murray-Darling Basin, Australia*, 23 WATER RESOURCES MGMT. 2605, 2628 (2009).

268. *See supra* notes 220-223 and accompanying text.

available offsets, which should reduce this aspect of transaction costs.[269] Such mechanisms may provide a simple, low-tech way of addressing transaction costs in natural resources offsets more broadly.

3. *Different perceptions of the value of things protected by offset rules—threats and win-win solutions*

As described in Part Two, important criticisms leveled against environmental offsets are really disagreements about exactly what values the rules seek to protect, for example, ecological benefits as opposed to public benefits of environmental assets (approaching an ecosystem services perspective). This issue appears starkly in the case of groundwater offsets. The rules generally seek to protect water rights, but the thing that water right holders value about their rights can be very different depending on their use. Generalizing, instream flow holders value ecological benefits and consumptive users value economic benefits. The implications of differences in perceptions of these protected values are significant for the design of offset rules. They affect what should be included in a currency or market rules approach to ensure equivalence and what values are "left over" to be addressed only by public review. They also affect the types of information that offset process must produce to allow the public to play an informed oversight role. A value that is not deemed important enough to be included in currency or market restrictions, but is thought protected by the "catch-all" nature of the public review, may not actually be protected if the offset process does not produce any information about the value, which the public could use to make a decision about the desirability of the transaction. In this way, differences in valued functions can result in negative non-equivalent outcomes from offset transactions.

But differences in valued functions can also point to win-win solutions achievable through out-of-kind offsets that take advantage of these differences. If a potentially impaired surface water right holder values the economic benefit realizable through the right more than the right itself, then the groundwater proponent can use this to achieve a least-cost offset where buying replacement water would be more expensive than making a payment to the impaired right holder. Markets are inherently

269. *See supra* notes 218-219 and accompanying text.

about achieving win-win solutions based on differences in value, and offsets can be used to realize these solutions. In short, the example of groundwater offset rules suggests that non-equivalence, or differences in the value of the things protected by the offset system, may not always be negative, and offset rules should countenance allowing out-of-kind offset transactions accordingly, accompanied by appropriate safeguards.

4. *Offsets as instruments to deal with fragmentation in the administration of natural resources*

At a higher level, fragmentation of the administration of natural resources is a noted challenge in the western United States, and indeed around the world, as science increasingly recognizes connections between different elements of the natural environment. Some of these fragmented administrative arrangements may be well-entrenched and unlikely to change, regardless of the mismatch with scientific realities. There is therefore a need to reflect links between resources in law and policy while working with some degree of institutional fragmentation. Offsets provide a way of doing this, because at the permitting stage in relation to one resource, impacts on another resource—including impacts that are quantified under a different administrative structure for the second resource—can be taken into account.

Western United States groundwater offsets demonstrate the potential of offsets as tools to address regulatory fragmentation in natural resources. They enable groundwater regulators to consider impacts on surface waters regulated under different arrangements, whether that be because intrastate groundwater allocation must meet the requirements of interstate surface water compact requirements or because state-level water regulation is fragmented. Nebraska's administrative arrangements for groundwater offsets demonstrate this to the extreme, where groundwater offsets are possible even though local-level districts permit groundwater pumping and the state regulates surface water, and even though the principles used to allocate the two resources are fundamentally different.[270]

270. *See generally* Hoffman & Zellmer, *supra* note 13 (describing Nebraska's water laws in the context of analyzing their ability to facilitate adaptive, integrated management of surface water and groundwater).

It is not difficult to think of other connected natural resources that are administered by different levels of government. In the United States, these include water quality (federal) and water quantity (state or local); water quantity and land development (state or local); energy (federal and state) and water quantity; groundwater (state or local) and wetlands dredging or filling (federal). Where the effects of interactions between the use of separately administered but connected resources are considered serious and widespread enough to warrant large-scale action, but curtailing existing impacting actions is not tenable, jointly administered offset schemes might be a potential solution. To take a current specific issue, one could imagine, for example, city planners in California using groundwater recharge maps produced by local groundwater management districts under recent California water legislation[271] to assess the impact on recharge of a development that involves building extensive impermeable surfaces. As a condition of a development approval, they could then require a proponent of such a development to work with the local groundwater management district to offset the hydrological change. They could, for example, increase recharge by contributing to the development of a local aquifer storage and recovery project, they could buy and retire (or pay for the non-use of) groundwater rights equivalent to the reduction in recharge, or they could pay for landscaping changes that would reduce impermeable surfaces in another development.

5. *Natural resources which lend themselves to offset programs*

If making regulatory links between connected resources is seen as desirable, and offsets are considered a valuable way to make new regulatory connections palatable, then the question arises: what natural and institutional characteristics of a natural resource lend themselves to such an approach? The discussion of risks to equivalence at Part Two clearly indicates the following as desirable natural characteristics: a relatively low level of distinctiveness, which leads to inherently greater fungibility of impacts and benefits, and impacts and benefits that take effect immediately or almost immediately.

In institutional terms, it is instructive to contrast governance issues (record keeping, compliance) that have arisen in the

271. CAL. WATER CODE § 10753.7(a)(4) (West 2015).

wetlands and climate change contexts with the strong, pre-existing structures that are available to address these issues in the case of groundwater offsets (though it must be noted that compliance with groundwater offsets has not been studied empirically). Establishing offset rules is likely to be easiest where record-keeping and compliance activities already apply to the resources, for example activities that are subject to formal permitting requirements and ongoing administration, as in the case of local watermasters.[272] The hypothetical recharge-impermeable surface situation outlined above, for example, could take advantage of the pre-existing institutional infrastructure of building permits and plans and adjudicated groundwater rights, with the associated compliance systems, in establishing new regulatory and offset rules to connect these resources at a low cost relative to resources that lack those pre-existing structures.

C. *Concluding Thoughts*

In addition to being a significant and comparatively under-studied feature of western water law, groundwater offset rules are an instructive example of regulatory tools that can address institutional fragmentation in the management of connected resources more generally. They take advantage of a variety of different mechanisms for crossing institutional divides (state-local and NGO-government) and allocation regimes (prior appropriation-correlative rights). They demonstrate a group of solutions to one oft-cited problem of regulatory fragmentation, that is, regulating the impacts of exploiting one natural resource on a connected resource where those resources are administered by different levels of government. This may be useful in other states in which groundwater and surface water are regulated by different governments, like California, or even outside the water sphere, where two sets of natural resources are regulated by different governments, but impact each other.

It is important to recognize that offset rules will never ensure complete equivalence between impact and offset. This is demonstrated in various ways through the chronology of a groundwater offset. Constructing offset rules necessarily involves deciding what characteristics of a resource are valued for the purposes of designing rules that structure acceptable exchanges.

272. *See* WASH. DEP'T OF ECOLOGY, *supra* note 244, at 14-15.

Some values will necessarily be left out. Groundwater offset rules are directed to impacts on surface waters, or more specifically, surface water rights, but generally ignore the impacts that groundwater pumping has on ecosystems not protected by such rights. The task of offset rules is not to constrain activities that would normally be allowed to go ahead—just to make more flexible prohibitions on certain categories of impacts. Non-equivalence will also arise through the trade-offs inherent in weighing up the higher transaction costs, but higher benefits to equivalence of precise quantification requirements and comprehensive currencies, versus the lower costs but higher risks of market rules. And some measure of non-equivalence will also arise because of the practical impossibility of completely characterizing complex resources, like aquifers and groundwater.

More broadly, the issue of how water law reflects the complex, inter-connected nature of the water cycle is just one example of the modern struggle of natural resources laws to reflect the often complex and interconnected natural world that they regulate. By introducing flexibility into strict protections for connected natural resources, offset rules can achieve significant benefits for the economic, social, political, and potentially also environmental sustainability of a regulatory regime that imposes a cap on the exploitation of a natural resource. Realizing these benefits will involve dealing with challenges relating to cost, equity, communication, and monitoring. Current experience of western United States groundwater offsets shows that these and related implementation challenges are dealt with in markedly different and instructive ways in the groundwater context, as compared to the environmental context. The groundwater experience offers significant scope for inspiration to deal with issues of impacts on connected natural resources recognized to be as difficult as they are urgent.