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Regulation, Technology, and Water: "Buy-In" as a Precondition for Effective Real-Time Advanced Monitoring, Compliance, and Enforcement

Cameron Holley* and Darren Sinclair**

All environmental regulators must confront the question: how can they best achieve compliance and enforcement within their resource constraints? This has become a particularly vexing enquiry, as public budgets shrink *without* a commensurate diminishment of regulatory responsibilities. Yet, the rapid innovation and diffusion of new technology has the potential to bring some relief to regulators. Over the last decade, rapid advancements in technology (e.g., cost or size reductions in sensors) and global information infrastructure (e.g., the Internet) have allowed the easy and speedy capture and diffusion of information.[1] Satellites, remote sensing, drones, real-time monitoring and reporting, mobile handheld monitoring devises, novel civic data collection, developments in data analytics and "big data," all are increasingly commonplace.[2] These new monitoring and information technologies, it is argued, will not only make regulators' core business cheaper and faster, at least compared to inspectoral "boots on the ground," but the technology can make the invisible visible, increasing the ability to prevent, reduce and treat pollution, and drive compliance through transparency and accountability.[3] Such improvements in monitoring and information technology can impact the regulatory process other than the final stage of enforcement. Better information, for example, can contribute to the adoption of more effective regulation, planning, and permitting, which in turn can enhance the extent of compliance and therefore reduce the need for traditional enforcement.[4]

Although technological developments can have positive effects on compliance and enforcement, and thereby improve environmental outcomes,[5] they are no perfunctory

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1. Sabrina De Capitani di Vimercati et al., *Privacy and Security in Environmental Monitoring Systems: Issues and Solution*, *in* Computer and Information Security Handbook 835–53 (John R. Vacca ed., 2013).
2. *See* J.B. and Maurice C. Shapiro Environmental Law Symposium at the George Washington University Law School (Mar. 26–27, 2015); Sara Ann Wylie et al., *Institutions for Civic Technoscience: How Critical Making Is Transforming Environmental Research*, 30 Info. Soc'y 116, 116–26 (2014).
3. David Hindin, Using Next Generation Compliance Drivers in Permits and Rules, *Advanced Monitoring, Remote Sensing, and Data Gathering, Analysis and Disclosure in Compliance and Enforcement Symposium*, The George Washington University Law School, J.B. and Maurice C. Shapiro Environmental Law Symposium, Washington, D.C. (Mar. 27, 2015).
4. David L. Markell & Robert L. Glicksman, *A Holistic Look at Agency Enforcement,* 93 N.C. L. Rev. 1, 69–70 (2014).
5. De Capitani di Vimercati et al., *supra* note 1.

panacea. Novel monitoring and information technologies have given rise to new concerns around data privacy, data security, and regulatory reach.[6] Such concerns can produce anxiety and apprehension amongst regulated actors.[7] As Purdy's study of satellite technology in vegetation management illustrates, regulated communities can often be unwilling to accept automatic-monitoring systems like that which exists for speed cameras.[8] Although regulated actors can benefit from new technologies, through better management in the long term, or reduced delays caused by inspector visits, there may be increased costs in the short term (e.g., purchasing new technologies).[9] Of course, regulatory bodies may try to side step these issues by using their legislative powers to effectively compel regulated actors to install, pay for, or use advanced monitoring devices. In doing so, however, regulators risk generating political opposition, fuelling adversarialism, and undermining, rather than fostering, engagement. The resulting resistance from regulated individuals and firms can accordingly weaken the effectiveness of regulation.[10]

In this context, fostering "buy-in" from regulated actors to technology-based regulation can be both intrinsically valuable and instrumentally useful.[11] Good policy development routinely requires consideration of a policy's impacts, engagement of affected parties, and efforts to minimise adverse impacts.[12] As such, regulators need to engage stakeholders in the installation, maintenance, and application of new monitoring and information technologies.[13]

The need for engagement is particularly important given that the diffusion and use of new technologies does not occur in a social and regulatory vacuum. Rather, it is mapped onto existing regulatory landscapes, many of which have, for various reasons, historically favoured "light-handed," voluntary or co-regulatory arrangements over "top-down" regulation.[14] One regulatory landscape where this is particularly true is the agricultural sector. Here, political power, geographical isolation, and the primacy of private property rights have meant regulated actors have not been subjected to the same degree of monitoring and regulatory intrusion as polluting enterprises, manufacturing, and mining.[15] The presumption has generally been one of partnerships and voluntary schemes. Yet, with the advent of new technology, and its capacity to ignore geographic boundaries and remoteness, agricultural communities are now increasingly subject to new levels of regulation using real-time monitoring and information diffusion.[16] This is occurring particularly in the context of water quantity, which is the focus of this Article.

As in most regulatory regimes, water quantity monitoring systems can be classified in various ways, such as by their system architecture,[17] or their geographic extension (e.g., large scale, regional, or localized). Though there are examples of large-scale global water monitoring[18] and various local citizen led efforts,[19] some of the most significant reforms are government led and occur at the regional (e.g., state) and local (e.g., aquifer or river) levels.[20] To date, the majority of these reforms remain mono-functional, providing knowledge for a single application, namely the amount of water used.[21]

In its most basic form, monitoring the water use of a farmer or other individual is done by metering, which is a way to measure water extraction via flow and volume. The data produced assists users and regulators to base their decisions on sound information about consumption.[22] Metering

6. *Id.*
7. Stephen Raft & Greg Hills, Office of Water, N.S.W, Dep't of Primary Indus., NSW Sustaining the Basin Program: NSW Metering Project Business Case (2010); Office of Water, N.S.W, Dep't of Primary Indus., NSW Interim Water Meter Standards for Open Channel Metering (2013), http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/547124/meter_nsw_interim_water_meter_standards_open_channel.pdf; Mark P. McHenry, *Technical and Governance Considerations for Advanced Metering Infrastructure/Smart Meters: Technology, Security, Uncertainty, Costs, Benefits, and Risks*, 59 Energy Pol'y 834, 834–35 (2013).
8. Ray Purdy, *Attitudes of UK and Australian Farmers Towards Monitoring Activity With Satellite Technologies: Lessons to Be Learnt,* 27 Space Pol'y 202 (2011).
9. *Id.* at 206.
10. Robert Kagan, Adversarial Legalism: The American Way of Law (2001).
11. Dep't of the Prime Minister & Cabinet, Commonwealth of Austl., Guide to Implementation Planning (2012), http://www.dpmc.gov.au/pmc/implementation-planning/implementation-planning; Katie Burke et al., An Introductory Guide to Implementation 19 (2012); Geoffrey J. Syme & Blair E. Nancarrow, *The Social and Cultural Aspects of Sustainable Water Use*, *in* Water Policy in Australia: The Impact of Change and Uncertainty 230, 230–31 (Lin Crase ed., 2008); T.R. Tyler, Readings in Procedural Justice (2005).
12. *See* Syme & Nancarrow, *supra* note 11, at 244.
13. Office of Water, N.S.W, Dep't of Primary Indus., NSW Sustaining the Basin Program: Metering Project Socio Economic Assessment ii (2010).
14. Neil Gunningham, *Environmental Law, Regulation, Governance: Shifting Architectures,* 21 J. Envtl. L. 179, 206–07 (2009).
15. *See generally* Andrew Jordan et al., *Still the Century of "New" Environmental Policy Instruments? Exploring Patterns of Innovation and Continuity,* 22 Envtl. Pol. 164 (2013); Neil Gunningham, *Environmental Partnerships in Agriculture: Reflections on the Australian Experience*, *in* Partnerships, Governance and Sustainable Development: Reflections on Theory and Practice 115 (Pieter Glasbergen et al. eds., 2007).
16. Purdy, *supra* note 8; Robyn Bartel & Elaine Barclay, *Motivational Postures and Compliance With Environmental Law in Australian Agriculture*, 27 J. Rural Stud. 153 (2011).
17. *See* De Capitani di Vimercati et al., *supra* note 1, at 836.
18. For water quality, see U.N. Glob. Env't Monitoring Sys. Water Programme, *Data Summary*, GEMStat, http://www.gemstat.org/queryrgn.aspx (last visited Oct. 11, 2015). For water quantity, see U.N. World Health Org., *Water Supply and Sanitation Monitoring*, WHO, http://www.who.int/water_sanitation_health/monitoring/en/ (last visited Oct. 11, 2015) (reporting primarily on the status of water supply and sanitation sector).
19. *See* Kirk Jalbert et al., *Civil Society Research and Marcellus Shale Natural Gas Development: Results of a Survey of Volunteer Water Monitoring Organizations,* J. Envtl. Stud. Sci. (2013).
20. De Capitani di Vimercati et al., *supra* note 1, at 837.
21. Rather than multiple-function systems, data are collected and used by different applications and even for different purposes. *See id.* at 838.
22. Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania and the Australian Capital Territory and the Northern Territory, Intergovernmental Agreement on a National Water Initiative 87 (2006), http://www.nwc.gov.au/__data/assets/pdf_file/0008/24749/Intergovernmental-Agreement-on-a-national-water-initiative.pdf; Nat'l Water Comm'n, The National Water Initiative—Securing Australia's Water Future: 2011 Assessment 10 (2011).

technologies have been implemented in agricultural contexts for over a century (e.g., Dethridge wheels and mechanical meters).[23] However, in the last five years, governments have invested heavily in new metering technologies that have the ability to transform the regulatory process, in particular, compliance and enforcement, by freeing up scarce regulatory resources.[24]

One fundamental transformation has been new, more accurate, electronic metering, combined with remote data access through telemetry, which relieves regulators of the traditional burden of onsite checks.[25] In the multiplicity of water extraction points and the vast geographical distances in the farming community, electronic metering (combined with telemetry) can afford regulators the luxury to direct their compliance and enforcement activities to high priority targets. It also allows them to assume nontraditional regulatory roles, for example, where the responsibility for complying with water allocations is shared with water users. In such circumstances, regulators can, for example, emphasise education, communication, and water management. Moreover, to the extent regulators diffuse new real-time data on water extractions, it potentially fosters better management and higher compliance levels if regulated entities recognize that ease of access to information may make it easier for private enforcers or peers to identify and prove violations.[26]

Despite these benefits, there are potential obstacles to obtaining buy-in from regulated agricultural actors (e.g., privacy and cost concerns mentioned above).[27] A lack of buy-in from water users can have at least three significant implications for the effective implementation of new monitoring and information technologies, and their compliance and enforcement benefits. First, at the political level, a lack of stakeholder support may lead to political pressure from industry groups in opposition to the proposed reforms. From the perspective of policymakers, such opposition may risk undermining the roll out of the reforms, and ultimately delay the delivery of regulatory benefits.

Second, regulated actors who are unreceptive to new technology pose a potential risk to ongoing maintenance of many information and monitoring technologies. Such maintenance is central to accurately measuring environmental impacts and ensuring regulatory compliance. Of course, it will often be an offence if a person fails to ensure the proper operation of any monitoring equipment or takes action when equipment is not operating properly or is not operating.[28] In theory, it matters little what the attitudes of regulated actors are, as they will be under a legal obligation to comply. However, the relevant regulatory authorities arguably lack sufficient resources to adequately check monitoring devices or respond to noncompliant behaviour.[29] In this context, maximising buy-in and minimising recalcitrance will be central to ensuring monitoring technologies are properly maintained and wider water compliance is ensured.

Third, the provision of monitoring and real-time data access has the potential to enhance on-property water management and efficiency. Users can understand the impact of different farm management practices and more accurately benchmark water and other uses against best practice. Water users' acceptance and support of new and upgraded metering will be crucial to exploiting such benefits.[30]

In the face of these potential implementation challenges, this Article considers the issue of metering and information diffusion, a prominent example of technology-based regulatory reform, from the perspective of water user buy-in. In particular, it examines this through the lens of two case studies: first, the crucial role of meters, telemetry, and real-time data diffusion in Audited Self-Management ("ASM") in Canterbury, New Zealand, and second, the attitude of water users towards the installation of new government meters in New South Wales, Australia. Both New Zealand and Australia regulate agricultural water use and are considered leaders in water and natural resource regulatory reforms.[31] Moreover, the case studies provide fertile ground for examining the interface between new technology and regulation.

In New Zealand, for example, despite having the highest growth rate of irrigation in the Organisation for Economic Co-operation and Development ("OECD"), the uptake of water meters was minimal—only one-third of consented water takes were measured prior to 2010.[32] In response, New Zealand underwent major regulatory reform with the introduction of its Resource Management Regulations in 2010.[33] This ushered in the widespread adoption of monitoring water takes for irrigation purposes, and facilitated the complementary shift to the innovative ASM model in Canterbury, New Zealand. The ASM is a collaborative governance model that involves groups of farmers installing advanced real-time monitoring and data diffusion systems to manage their individual and cumulative effects on local water systems.[34] This management is subject to oversight by third-

23. *See, e.g.*, Stephanie Lavau, *Going With the Flow: Sustainable Water Management as Ontological Cleaving* 31 Env't & Planning D: Soc'y & Space 420, 426 (2013); R. Quentin Grafton & Deborah Peterson, *Water Trading and Pricing, in* Managing Water for Australia: The Social and Institutional Challenges 81 (K. Hussey & S. Dovers eds., 2007).

24. Seth Cutler, *Smart Water Metering Networks an Intelligent Investment?*, WaterWorld, http://www.waterworld.com/articles/wwi/print/volume-26/issue-5/regulars/creative-finance/smart-water-metering-networks-an-intelligent-investment.html (last visited Aug. 9, 2015).

25. Telemetry is a highly automated communications process by which measurements and other data is collected at remote or inaccessible points and transmitted to receiving equipment for monitoring, display, and recording.

26. Markell & Glicksman, *supra* note 4.

27. Raft & Hills, *supra* note 7.

28. *Water Management Act 2000* (NSW) c. 3 §§ 91H, 91J (Austl.).

29. *See* Cameron Holley & Darren Sinclair, *Compliance and Enforcement of Water Licences in NSW: Limitations in Law, Policy and Institutions*, 15 Australasian J. Nat. Resources L. & Pol'y 149, 169–71, 177–78 (2012).

30. Office of Water, *supra* note 13, at 20.

31. *See* Lee Godden & Anita Foerster, *Introduction: Institutional Transitions and Water Law Governance,* 22 J. Water L. 53 (2011); *see also* Julie Frieder, Approaching Sustainability: Integrated Environmental Management and New Zealand's Resource Management Act (1997).

32. N.Z. Ministry for the Environment, Measuring and Reporting Water Takes (2010).

33. Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 (N.Z.), http://www.legislation.govt.nz/regulation/public/2010/0267/latest/DLM3174201.html.

34. Office of Water, N.S.W. Dep't of Primary Indus., NSW Metering Implementation Plan Under the National Framework for Non-Urban Water Metering 8 (2013), http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/547257/metering_nsw_metering_implementation_plan.pdf.

party auditors and a regulator, who steps back from a traditional day-to-day enforcement role by accessing real-time data on the group's cumulative performance.[35] We examine this novel innovation by drawing on interviews conducted in 2011–2012 with participants in one of the first ASM pilots.

In Australia, a national program of metering installations and upgrades recently commenced in response to a range of monitoring limitations, including absent meters (e.g., only 65% of rural water extractions in the NSW Murray-Darling Basin were metered as of 2010)[36] and old or unreliable metering (e.g., recording errors reportedly ranged from +20% to -30% and +3% to -18%).[37] Major reforms at both national and state government levels are accordingly in the process of being rolled out, including over 80,000 new or upgraded meters.[38] In the case of New South Wales ("NSW"), home to the lion's share of Australia's food bowl, the Murray-Darling Basin, this has included rolling out various computer aided river management systems to improve river operations and efficiency,[39] and two major meter policy reforms: (1) the New South Wales Metering Project under the Sustaining the Basin package 2012–2018 ("NSW Metering Project");[40] and (2) the National Framework for Non-Urban Water Metering 2010–2020 ("National Framework").[41] We examine these reforms using data from a recent survey and interviews, conducted from 2012–2013, that examined compliance and enforcement in NSW, including views and experiences with monitoring, metering, and management.

This Article analyzes these two cases—ASM and metering policy reforms in NSW—to demonstrate the crucial role water user buy-in plays in determining the success or otherwise of the implementation of new regulatory technology (in the form metering, telemetry, and real-time information gathering and diffusion) as a potentially powerful policy tool for enhancing compliance.

The analysis commences by examining ASM, before turning to metering in NSW. In both cases this Article first outlines the legal and policy context, before drawing on the empirical data to examine the perceived benefits and issues of concern to water users relating to metering, information technology, and compliance and enforcement. Although the collaborative ASM model appears more successful at engaging water users and delivering compliance benefits than the larger scale roll out of meters across NSW, both cases evidence support for metering and the compliance benefits it can provide. However, many lingering barriers to water user support are also identified across both cases, including issues of cost, standards, benefits, transparency and data use, and diversity in local and regional conditions.

This Article accordingly considers options for enhancing water user buy-in by addressing information needs, policy concerns, and practical questions. It identifies six priority areas where environmental regulators should direct their attention to improve stakeholder buy-in, including knowledge and capacity for using new monitoring and information technologies, costs, meter benefits, transparency and use of data, accommodating local and regional variation, and a focused communication strategy. In so doing, this Article fills a knowledge gap about new monitoring and information technologies in agricultural and water regulation.[42]

I. Metering, Information Diffusion, and ASM in New Zealand

A. ASM—Legal and Policy Overview

ASM is an innovative model of water regulation located in the Canterbury region of New Zealand.[43] Canterbury contains 70% of New Zealand's irrigated land,[44] and a regional council known as Environment Canterbury ("ECan") regulates water extraction.[45] ECan has a long history of experimenting with collaborative governance approaches as a complement to traditional regulation.[46] Under New Zealand's Resource Management Act 1991 ("RMA"),[47] councils such as ECan have the authority to develop policies and plans to promote the sustainable management of natural and physical resources and to govern their use, development, and protection.[48]

35. *Id.*
36. This metering primarily covers the larger users in the major regulated river systems, major alluvial aquifers and the unregulated Barwon-Darling River. Raft & Hills, *supra* note 7, at 21.
37. Water Efficiency Div., N.Z. Dep't of the Env't, Water Heritage & the Arts, National Framework for Non-urban Water Metering Regulatory Impact Statement 3 (2009).
38. *Id.* at 8.
39. This has involved significant funding for meters and monitoring devices that can integrate models and real-time measurements with on-line data and control systems, and provides a range of fully customized user interfaces for the river operators. *See* DHI, *Improving River Efficiency in the Murrumbidgee River, Australia,* http://www.dhigroup.com/News/2011/07/12/ImprovingRiverEfficiencyAComputerAidedRiverManagementSystemForTheMurrumbidgeeRiver.aspx.
40. Office of Water, N.S.W. Dep't of Primary Indus., NSW Water Metering Scheme—Murray Pilot (n.d.), https://www.statewater.com.au/_Documents/Major%20Projects/Murray%20Pilot%20Metering%20fact%20sheets.pdf; *Sustaining the Murray-Darling Basin*, Dep't of Primary Indus., http://www.water.nsw.gov.au/water-management/water-recovery/sustaining-the-basin (last visited Dec. 19, 2015).
41. Office of Water, *supra* note 34; Austl. Gov't, National Framework for Non-urban Water Metering (2009).
42. *See* Kate Stoeckel & Harry Abrahams, *Water Reform in Australia: The National Water Initiative and the Role of the National Water Commission*, *in* Managing Water for Australia: The Social and Institutional Challenges (Karen Hussey & Stephen Dovers eds., 2007).
43. This Article does not aim to provide a comprehensive outline of ASM, its history, or its various legislative and policy design. For further discussion on these topics, see Cameron Holley, *Crafting Collaborative Governance: Water Resources, California's Delta Plan and Audited Self Management in New Zealand,* 45 ELR 10324, 10328–31 (Apr. 2015).
44. Canterbury Mayoral Forum, Canterbury Water Management Strategy: Strategic Framework 23 (Nov. 2009).
45. Holley, *supra* note 43.
46. *Id.*
47. At the time of writing, the RMA was the subject of national reforms and national reform proposals. *See RMA Reforms Programme 2013 and Beyond*, Ministry Env't, http://www.mfe.govt.nz/rma/rma-reforms-and-amendments/rma-reforms-programme-2013-and-beyond (last visited Oct. 11, 2015); Neil Gunningham, Landcare Res. N.Z. Ltd., Innovative Governance and Regulatory Design: Managing Water Resources 22 (2008) (earlier discussions of the RMA); Cameron Holley & Neil Gunningham, *Natural Resources, New Governance and Legal Regulation*, 24 N.Z. U. L. Rev. 309, 316 (2011); P.A. Memon & B.J. Gleeson, *Towards a New Planning Paradigm? Reflections on New Zealand's Resource Management Ac*t, 22 Env't & Planning B: Planning & Design 109 (1995).
48. Holley & Gunningham, *supra* note 47, at 316–18.

ASM is based on collaboration at a local geographical scale. Instead of ECan issuing individual licence requirements and monitoring actions of individual farmers (as in the traditional RMA system), water user groups control the behaviour of their members and monitor activities themselves (the self-management aspect), and report to the independent third-party and the regulator on achievement of agreed goals (the audit aspect).[49]

Although ASM can take many different forms,[50] collaboration is an essential feature.[51] Under the ECan approach, farmers form a collaborative group, typically a formal legal entity such as an irrigation collective, that self manages and monitors their cumulative water use and environmental effects on the local water system.[52] Through this group, day-to-day water management and compliance responsibilities are transferred to farmers under terms and conditions agreed upon with ECan. These conditions include a mix of performance, prescription, and process standards.

Prior to the ASM approach, ECan imposed individual performance standards in the form of specific water allocations.[53] Under ASM a performance standard remains; however, the standard is now a *collective* standard. In effect, ASM employs a 'bubble licence' whereby the irrigation group collaboratively pools together their existing water allocations and sets water quantity goals for their shared aquifer or catchment.[54]

Beyond performance standards and bubble licences, ASM also hinges on another crucial regulatory standard, in this case a prescriptive *technology* standard. Under existing regulation, many landholders are obliged to purchase and install water meters to accurately measure water extraction.[55] In the case of ASM, this requirement is extended to include telemetry and the provision of a robust real-time information monitoring and reporting system.[56] The intention is to diffuse individual extraction data and make this available to *all landholders* within the collaborative water user group *in real-time.* The government, in turn, can access real-time data on the ASM *group's* water use, measured against their collective performance standard in the bubble licence.

ASM also involves a process standard that requires collaborators to develop management rules, have third-party audit compliance with these rules, and periodically reflect and improve their overall management process and performance goals.[57] It is also worth noting that the ASM model is likely to be expanded to include other process- and performance-based standards, such as farm management plans addressing nutrient use, in addition to its conventional focus on water extraction limits.[58] Though the case examined here was beginning to experiment with management of biodiversity issues, the use of farm management plans in the case studied was not yet underway.

Finally, although ASM is voluntary, ECan has the capacity to use regulatory incentives to get stakeholders to come to the ASM table and genuinely collaborate. For example, ASM participants are afforded a measure of relief from traditional inspection, enforcement, prosecution, or other disciplinary measures.[59] This is, in effect, a form of co-regulation with water user groups assuming compliance and enforcement roles exist. In particular, participants are required to develop management rules that are subject to third-party audits to ensure compliance, as well as the group periodically reflecting and improving on the overall management process and performance goals.[60] However, they reserve the right to call in ECan if an individual persistently undermines the collective target, and fails to respond to the collaborative group's compliance actions.[61]

B. *ASM in Practice—Successes*

Drawing on fourteen interviews with government, farmers, and other nongovernment stakeholders in an ASM pilot study in Canterbury, the following analysis finds that ASM's design features have a range of strengths.[62] These strengths go a long way toward fostering successful buy-in and achieving effective compliance and enforcement. However, as discussed below, ASM also has some key weaknesses, not least of which involve concerns over cost, data transparency and access, and water users' ability to use the new technology.[63] The ASM pilot case was a collaboration involving twelve farmers in an existing irrigation scheme that used groundwa-

49. Andrew Curtis & Terry Heiler, Presentation to the N.Z. Ass'n of Res. Mgmt. Conference at Christchurch: Audited Self-Management Systems (Sept. 21–23, 2010).
50. Although the ASM approach is being explored in Canterbury, it is also a part of national discussions in New Zealand. *See generally* Land & Water Forum, Report of the Land and Water Forum: A Fresh Start for Fresh Water 26 (2010), http://www.landandwater.org.nz/; Land & Water Forum, Third Report of the Land and Water Forum: Managing Water Quality and Allocating Water 93–94 (2012), http://www.landandwater.org.nz/.
51. *See, e.g.*, Judith Earl-Goulet, *Audited Self Management at Environment Canterbury: The Current Approach* 2 (Sept. 6, 2011), http://ecan.govt.nz/publications/Council/lwcsc-asm-overview-150911.pdf.
52. *Id.*; Holley, *supra* note 43, at 10,329.
53. Resource Management Act 1991 § 14–15 (N.Z.).; Andrew Curtis & Terry Heiler, *supra* note 49.
54. Bubble licences have traditionally been used in the context of regulating air pollution. *See, e.g.*, Envtl. Def.'s Office, N.S.W., Clearing the Air 21–22 (2012), http://www.nature.org.au/media/1532/clearing-the-air-opportunities-for-improved-regulation-of-pollution-in-new-south-wales.pdf.
55. Resource Management Act 1991 § 360(1)(d); Resource Management (Measurement and Reporting of Water Takes) Regulations 2010, SR 2010/267, Regulation 6 (NZ); *see also* Cameron Holley, *Removing the Thorn From New Governance's Side: Examining the Emergence of Collaboration in Practice & the Roles for Law, Nested Institutions & Trust,* 40 ELR 10656, 10668 (July 2010).
56. Earl-Goulet, *supra* note 51, at 1.
57. *See* Eric Orts, *Reflexive Environmental Law,* 89 Nw. U. L. Rev. 1227, 1290 (1994–1995).
58. Earl-Goulet, *supra* note 51, at 2.
59. Resource Management Act 1991 (NZ) § 30.
60. *Id.* § 35.
61. *Id.* § 30.
62. The interviews were conducted face to face and each took approximately forty to sixty minutes. The fourteen interviews formed part of a larger series of interviews which covered topics not included in this Article.
63. The case study was examined in 2011–2012 and selected in consultation with ECan, with the intention of including a diverse range of circumstances (e.g., size, number of farmers, and homogeneity of water users). For each case study, a representative sample of irrigators, government, and other relevant stakeholders (e.g., industry bodies and consultants) participated in semi-structured interviews (*n = 14*). Each interview lasted approximately forty to sixty minutes. Consistent with the norms of social science research and the Authors' ethical responsibilities, this research does not identify any of the individuals who participated in the research by name.

ter pumped into channels for irrigation, and had been operating for a couple of years.

The findings suggested that significant benefits arose from ASM's prescription technology standard, in particular, the requirement to install telemetry, water meters, and a centralised group database and web interface. Under this approach, individual landholders not only had confidence that other landholders were abiding by collective agreements, but, crucially, where one or more landholders were found to be flouting such agreements, they were in a strong position to place peer pressure on them to comply, or risk breaching the collective bubble licence allocation. As one ASM respondent explained: "every member can go in [to the real-time data website] and see what their neighbors are doing and if they go over their entitlements we get very angry . . . it's absolute transparency. The system takes away the risk of abuse."[64]

Although individuals can access real-time extraction data of other group members, ECan has only restricted access to the *collective* extraction data.[65] This is consistent with the philosophy and practice of the performance standard—so long as the collective allocation is complied with, it is of no concern to government regulatory authorities as to how much individual landholders extract.

From the perspective of the regulator, this new data (facilitated by the prescription standard) still had considerable benefits. First, by stepping back from a day-to-day enforcement role, and accessing real-time data, the regulator could allocate scarce regulatory resources to where they are most needed. As they noted: "If we [the regulator] had gone and done the work of monitoring it would have cost a thousand hours of our time. Now, with the collective group providing the data via telemetry it might only cost fifty hours."[66]

Second, access to collective data in real-time allowed the regulator to identify instances of overuse as they occur. This had the distinct advantage of facilitating a more responsive enforcement approach that could reduce the risk of further breaches. As one ECan respondent commented: "It's fundamental that they have telemetry. You need to be able to see in real-time what your water level is and what its impacts are . . . it also allows you to take quick action and prevent further breaches by responding as they happen rather than on an annual basis."[67]

However, the effective operation of this new responsive role required a shift in thinking and practice on the part of the regulator, such that it was willing to take a substantial step back from conventional regulatory oversight, only to intervene at the request of the ASM water user group or in the event of a major transgression of the collective ASM water allocation. One respondent encapsulated this concept succinctly: "[T]he collective don't see themselves as the policeman, but you'll get spanked a few times by your peers and if that doesn't work then the regulator takes over."[68]

One of the key findings to come out of the ASM experience was the high degree of "ownership" afforded participants in the program. This in turn generated collective buy-in to the success of the scheme, and its use of new monitoring and information technology. The collaborative nature of ASM and its process standard empowered farmers to engage in face-to-face meetings and negotiations that fostered working relationships and gave them a specific say over how water should be managed in their area. This helped facilitate greater buy-in from water users into the technology and governance decisions, without farmers feeling overwhelmed by large external institutions. This collaboration was enhanced by participants having had a base level of preexisting trust or reciprocity that made it easier to engage in this process of collaboration. Importantly, the ASM model gave participants control over day-to-day decisionmaking about their water extractions—allowing them to plan ahead and take actions confident in the knowledge that they could overcome any short-term fluctuations in their water demand through internal arrangements.

A key to this control was ASM's performance standard that afforded additional flexibility to allocations and users operating within "the bubble." In particular, under ASM, members of the water user group were able to negotiate with each other as to the precise distribution of water between individual landholders over an annual allocation period. This reportedly provided flexibility to accommodate individual, temporal circumstances (e.g., different crop needs and cash flows) not possible under conventional performance standards.[69]

C. *ASM in Practice—Challenges*

Despite the successes described above, ASM also confronted some weaknesses. First, ASM's prescription technology standard required the funding (both upfront capital and ongoing operation) of metering, telemetry, and a database system. On the one hand, the findings suggested that ASM provided an ideal opportunity to kick-start the adoption of sophisticated metering and telemetry for low costs. For example, ASM participants used their bulk purchasing power to obtain the technology for a discount. As one respondent put it: "We can do more together than individually."[70] On the other hand, the upfront and ongoing costs to farmers were seen to be difficult, including outsourcing data base management to a commercial information technology operation and purchasing new telemetry systems. Mindful that ASM is voluntary in nature, these costs may pose barriers to individual farmers who otherwise see such expenses as outweighing the benefits of ASM. In this context, it is also important to note that ASM costs include more than just technology, but also paying for a licence or consent amalgamations, and the transaction costs (e.g, time, and travel to meetings) of establishing and maintaining a management structure.

64. Interview No. NZ2 with Farmer, in Canterbury, N.Z. (July 6, 2011).
65. Interview No. NZ1 with Regulator, in Canterbury, N.Z. (July 6, 2011).
66. *Id.*
67. Interview No. NZ4 with Regulator, in Canterbury, N.Z. (July 6, 2011).
68. Interview No. NZ11 with Industry Respondent, in Canterbury, N.Z. (July 8, 2011).
69. Interview No. NZ3 with Farmer, in Canterbury, N.Z. (July 6, 2011).
70. Interview No. NZ2 with Farmer, in Canterbury, N.Z. (July 6, 2011).

A second challenge related to data transparency and access inherent to ASM is a shift in thinking and practice on the part of the regulator and the adoption of new roles by regulated farmers. A number of respondents suggested these new roles had increased the risk of capture. This was particularly the case with nongovernmental organizations ("NGOs"), who reportedly saw the regulator becoming too "cozy" with farmers. As one respondent put it, ASM was like "putting the fox in charge of the hen house."[71] In this respect, independent auditors have a key role in ensuring reliable data reporting and process integrity. However, some respondents suggested this level of third-party transparency was insufficient. In particular they were sceptical of the auditor's current capacity to achieve these goals because "any third-party will have their own agenda or be paid by certain people."[72] There were also concerns that commercial operators lacked sufficient skills and capacities to credibly fulfill the auditor role[73] and ECan had little experience "auditing the auditors."[74]

Third, concerns also arose from ASM's process and prescription standards that require irrigators to have the necessary capacity and skills to use new software and technology. A number of respondents doubted whether the majority of farmers, absent any form of specific training, had the experience to meet these demands.[75]

Ultimately, ASM's voluntary collaborative approach hinges on farmers' willingness to genuinely collaborate in ASM. As one respondent put it: "ASM works best where people want to be in it and they see a benefit. It's a waste of time as a regulator trying to get people involved if they 'don't give a stuff.'"[76] A fundamental challenge for ASM then, is engaging with otherwise reluctant water users. Certainly ASM has strategies that can be successfully employed to ensure farmers see a benefit and agree to cooperate in using new monitoring and information technology to enhance compliance and enforcement. For example, ECan has promoted potential benefits such as greater flexibility, noted above. ECan also had recourse to a second tool, namely regulation. Most respondents suggested farmers engaged in ASM's collaborative approach to avoid the procedures and potential penalties associated with current regulation. As a government respondent explained, "industry [is] excited because [it] see[s] ASM as a way to stave off regulation . . . [it] would rather [a] collective does it than ECan driving around [its] farms and telling [the farmers] off."[77] In this case, the incentives appeared to be sufficient to bring a core group of farmers to the table to collaborate. Nevertheless, implementing ASM into situations where there are more potential participants and no preexisting water user group may pose substantial policy challenges.

71. Interview No. NZ18 with Regulator, in Canterbury, N.Z. (Nov. 22, 2011).
72. Interview No. NZ21 with Consultant, in Canterbury, N.Z (Nov. 23, 2011).
73. Interview No. NZ18 with Regulator, in Canterbury, N.Z. (Nov. 22, 2011).
74. Interview No. NZ21 with Consultant, in Canterbury, N.Z. (Nov. 23, 2011).
75. Interview No. NZ18 with Regulator, in Canterbury, N.Z. (Nov. 22, 2011).
76. Interview No. NZ16 with Farmer, in Canterbury, N.Z. (Nov. 22, 2011).
77. Interview No. NZ1 with Regulator, in Canterbury, N.Z. (July 6, 2011).

II. New and Upgraded Meters in New South Wales, Australia

A. *Metering in NSW—Legal and Policy Overview*

Compared to the New Zealand ASM experience, the application of metering and associated telemetry in Australia is less advanced. Certainty, water regulation and metering in Australia has a lengthy history. Under both common law and state legislation, numerous aspects of water extraction and use have been regulated, including water theft.[78] Various metering technologies have underpinned this regulation. However, their application has been patchy and uneven.[79] By the latter stages of the 20th century, significant weaknesses in this regulatory regime began to emerge. In particular, state governments were increasingly granting a substantial number of new water licences to irrigators and others, with generous extraction allocations attached.[80] Subsequent fears of over-allocation and severe water shortages prompted the Council of Australian Governments ("COAG") to usher in major national reforms, which ultimately gave rise to the *Intergovernmental Agreement on a National Water Initiative* ("NWI") in 2004.[81]

The NWI required each territory and state, including NSW, to overhaul their legislation and undertake regulatory activities to underpin these water reforms.[82] Water regulatory institutions were given responsibility for monitoring water users' compliance with a new market-based system of water allocations within their jurisdiction. In particular, states and territories were to ensure that adequate measurement, monitoring, and reporting systems were in place, to support public and investor confidence in the amount of water being traded, extracted for consumptive use, and recovered and managed for environmental and other public benefit outcomes.[83] In NSW, specific requirements were introduced for meter installation and recording water accounting data, but these tended to vary and were largely determined by individual water licence and approval conditions.[84]

By 2010, in an effort to enhance state and territory monitoring, given the abovementioned weaknesses in accuracy

78. *See Water Act 1912* (NSW) 17a-c (Austl.); Douglas Fisher, *A Sustainable Murray-Darling Basin: The Legal Challenges*, *in* Basin Futures: Water Reform in the Murray-Darling Basin 231 (Daniel Connell & R. Quentin Grafton eds., 2011); Holley & Sinclair, *supra* note 29, at 150.
79. *See* Poh-Ling Tan et al., *Water Planning in the Condamine Alluvium, Queensland: Sharing Information and Eliciting Views in a Context of Overallocation*, 474 J. Hydrology 38, 39 (2012).
80. Samantha Bricknell, Austl. Inst. of Criminology, Environmental Crime in Australia 109 (2010).
81. This Article does not aim to provide a comprehensive overview of Australian water regulation. *See also* Holley & Sinclair, *supra* note 29, at 183; Janice Gray, *Water Resources Regulation and Trading in Australia*, *in* Dereito das Infraestructuras: Um Estudo dos Distintos Mercados Regulados [Infrastructure Law: A Study of Regulated Markets] 765–67 (André Saddy & Aurilivi Linares Martínez eds., 2010).
82. *See* Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania and the Australian Capital Territory and the Northern Territory, *supra* note 22.
83. *See id.* at 80.
84. Clare McKay & Alex Gardner, *Water Accounting Information and Confidentiality in Australia*, 41 Fed. L. Rev. 127 (2013).

and coverage, the National Framework commenced and applied to all meters regardless of ownership, other than for resource monitoring purposes.[85] The aim is for national metering standards to provide an acceptable level of confidence in meter accuracy (with an in situ +/- 5% permissible error limit).[86] In the language of regulatory theory, this is a form of performance standard—whereby the outcome is prescribed, but not the technology (i.e., the type of meter can be mechanical or electronic).[87] It also describes the scale, detail, and frequency for uniform reporting.[88]

The actual priorities and targets for upgrading meters and installations are to be documented in State Implementation Plans ("SIPs").[89] In NSW there are two NSW Interim Water Meter Standards ("Interim Standards"), namely the NSW Interim Water Meter Standards for Closed Conduit Systems and the NSW Interim Standards for Open Channel Metering.[90] Each reflects the scope and intention of the National Framework and its requirements, including laboratory verification prior to installation, and certification after installation, of the +/- 5% error limit, and regular audits to that effect thereafter.[91] A key requirement of the National Framework is that meters must be pattern approved by the Australian Government's National Measurement Institute, and installed in accordance with ATS4747.[92] Importantly, though meters are to have the capacity for telemetry, that is, the sending of metered data wirelessly to a database that can be accessed remotely, there is no requirement for telemetry to be a part of the installation. All non-urban meters are to comply with the National Framework standards by July 1, 2020, unless otherwise exempted.[93]

A parallel and complementary development to the Interim Standards and National Framework is the NSW Metering Project. Utilising over AUD $200 million[94] of national funding, this is designed to help meet the sustainable water diversion limits in the Murray-Darling *Basin Plan 2012*.[95] The initiative aims to achieve efficiency gains of 120,000 megalitres of water.[96] Commencing in 2012, and following an initial pilot in the Upper Murray, the NSW Metering Project aims to install or upgrade meters to regulated, unregulated, and groundwater water sources across NSW (2500 meters on unmetered, unregulated water sources, 5000 to largely replace metering on groundwater, and 4000 additional meters on regulated river systems).[97] The intention is to create efficiency gains through better matching of extractions to water releases and allocations and is expected to deliver over 74,000 megalitres of water savings across NSW through, inter alia, increased meter accuracy and improved river operations.[98]

The NSW Metering Project emerged in response to a range of policy drivers, including water sharing in the Murray-Darling Basin, the need for proper water accounting to facilitate water markets and trading, compliance with national policy commitments (implementing metering), the need for accurate water meters, detection of illegal water extractions, and compliance with cease to pump rules.[99] It aims to improve water accounting, protect the security of entitlements, and improve the ability to implement water-sharing arrangements.[100] The National Framework and NSW Interim Standards will apply to new meters installed under the NSW Metering Project.[101] Importantly, going beyond the National Framework, the NSW Metering Project proposes that the vast majority of new meters be connected to a centrally controlled telemetry system that will provide real-time information on water extraction throughout the MDB.[102]

B. NSW Metering Upgrades in Practice—Successes

The level of support of water users regarding metering and metering upgrades was examined across three broad regions in NSW, namely Central West ("CW"), Murray and Murrumbidgee ("MM"), and North Coast ("NC").[103]

Following a mixed methods approach,[104] a survey[105] was first conducted from September to December 2012 across the

85. Ken Roberts, NSW Interim Water Meter Standards 5 (2009); Commonwealth of Australia, National Framework for Non-urban Water Metering Policy Paper 2–3 (2009), http://www.environment.gov.au/resource/national-framework-non-urban-water-metering-final-regulatory-impact-statement [hereinafter National Framework for Metering].
86. National Framework for Metering, *supra* note 85, at 1.
87. Cameron Holley, *Facilitating Monitoring, Subverting Self-Interest and Limiting Discretion: Learning From "New" Forms of Accountability in Practice*, 35 Colum. J. Envtl. L. 127, 142–44 (2010).
88. National Framework for Metering, *supra* note 85, at 2.
89. Roberts, *supra* note 85, at 5.
90. Office of Water, *supra* note 7; N.S.W. Dep't of Primary Indus., N.S.W. Interim Water Meter Standards for Closed Conduit Metering (2013).
91. National Framework for Metering, *supra* note 85, at 4.
92. *Id.*
93. *Id.* at 19.
94. "AUD" refers to the Australian dollar—the national currency of Australia.
95. Raft & Hills, *supra* note 7, at iii.
96. *Id.*; *see generally* N.S.W. Office of Water, Sustaining the Murray-Darling Basin (Aug. 28, 2013), http://www.water.nsw.gov.au/Water-management/Water-recovery/Sustaining-the-Basin/default.aspx.
97. Raft & Hills, *supra* note 7, at iii; *see also* Katrina Hodgkinson, *Media Release: NSW Secures $500 Million for Landmark Water Savings Push* (June 10, 2012), http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/549476/20120610-SUSTAINING-THE-BASIN-ANNOUNCEMENT.pdf.
98. Raft & Hills, *supra* note 7, at 20–21.
99. *Id.* at vi.
100. *Id.* at iii.
101. Office of Water, *supra* note 7, at 1.
102. Raft & Hills, *supra* note 7, at iii.
103. These regions were selected to represent a diversity of water sources (regulated rivers, unregulated rivers and groundwater); locations (MM and CW are both inland, while NC is coastal); a diversity of authorisations (e.g., licences, approvals and stock and domestic); and "at risk" water sources as defined by the Australian Government. Dep't of the Env't, Austl. Gov't, National Framework for Compliance and Enforcement Systems for Water Resource Management 5–6 (Mar. 2012), http://www.environment.gov.au/resource/national-framework-compliance-and-enforcement-systems-water-resource-management.
104. *See generally* John Creswell & Vicki Plano Clark, Designing and Conducting Mixed Methods Research (2d ed. 2011).
105. The survey design and the mail-out process employed a modified Dillman approach. *See* D.A. Dillman, Mail and Internet Surveys: The Tailored Design Method (2007). The survey was presented as a distinctive booklet and mailed with a cover letter and postage-paid return envelope. Two reminder/thank you notices were posted to respondents and non-respondents. All non-respondents were then sent a new mail package. Taking resource and practical constraints into consideration, the survey began with a raw list of 4500 licence and approval holders (approximately 1500 from each of three regions, including a full range of water users from large entitlement holders extracting water for commercial use to people extracting water for stock and domestic purposes). This list was refined to create a more targeted mailing list, including ensuring multiple works/licence holders would only receive one survey and removal of any repeat or incomplete addresses, as well as entries pertaining to local/state governments and commercial companies outside of NSW (who

three regions. The survey questions were designed to capture water users' views on, experiences with, and knowledge of compliance and enforcement of water extraction. Although the survey contained over 100 questions covering a range of topics, this Article focuses only on those questions relating to metering. The survey data was supplemented and tested through follow-up interviews in each region. This provided more in-depth understanding of people's views, knowledge and experiences with water metering, and compliance and enforcement more generally.[106] Interviews were conducted with forty-eight respondents across the three regions, approximately one-third in each.[107]

Overall, there was general support for metering of water extractions. The majority of the survey respondents had a positive attitude towards the value and benefits of metering (acknowledging that the survey encompasses those with and without meters, including those with no requirement to have meters, such as stock and domestic licences). In particular, there was widespread agreement that accurate measurement of water extraction by metering is necessary to sustainably manage water resources (66%).[108]

Table 1
Accurate measurement of water extraction by metering is necessary to sustainably manage water resources

	CW	MM	NC	Total
Strongly disagree	4%	2%	10%	5%
Disagree	10%	9%	26%	15%
Unsure	10%	8%	20%	13%
Agree	53%	50%	34%	45%
Strongly agree	23%	30%	11%	21%
N	194	200	214	608

The potential management benefits of metering and associated telemetry emerged as the other key issue amongst many of those supportive of metering. In terms of the survey, just over half of the respondents agreed that *metering is beneficial to managing their on-property operations* (52%).[109]

Table 2
Metering is beneficial to help me manage my on-property operations

	CW	MM	NC	Total
Strongly disagree	8%	6%	20%	12%
Disagree	27%	17%	34%	25%
Unsure	13%	6%	13%	10%
Agree	35%	49%	28%	38%
Strongly agree	17%	22%	4%	14%
N	142	172	157	471

As can be seen from Tables 1 and 2, there were significant differences in the responses from different regions in the survey, particularly between NC on one hand, and the CW and MM on the other. Although a majority of CW and MM agreed or strongly agreed with the importance of accurate metering and its on property benefits, this was not the case in NC.[110]

The interviews were broadly consistent with these findings, noting widespread in-principle support for metering but revealing differences between the regions, and, importantly the possible origins of these differences. In particular, the interview findings suggest that a greater level of engagement and experience with metering translates into more support for the installation of new meters (and associated telemetry). For instance, NC farms (e.g., crops and livestock) were less dependent on irrigation, and were often not required to have meters (unregulated). In contrast, in the MM region, a majority of respondents had, or were about to have, new electronic meters installed with telemetry. This was largely a function of their participation in irrigation schemes, in particular, with the operators of those schemes providing regular and detailed water information.

It is pertinent to consider, then, the underlying reasons behind, to the extent that it is present, support for new metering. To this end, the interviews, in particular, revealed two key themes: (1) improved compliance and (2) improved on-property management.

1. Improved Compliance

In terms of improved compliance, many MM respondents reported that the manipulation of delivery systems and old meters in order to mask water theft had been very common in the past. There were many examples cited, particularly relating to relatively unsophisticated mechanical meters on Deth-

were unlikely to have the desired knowledge and experience with on-property water use). A final survey list of was sent to 1381 CW, 1258 MM and 1339 NC properties (totalling 3978). The response rate was 22%. The survey further refined the above regions by focussing on two to six local government areas in each region that captured a diversity of water sources (regulated rivers, unregulated rivers and groundwater). The survey questions were designed to capture water users' views on, experiences with, and knowledge of compliance and enforcement of water extraction. Although the survey contained over 100 questions covering a range of topics, this article focuses only on those questions relating to metering.

106. These were conducted between February and June 2013. This included interviews with five stakeholders from land care and catchment management authorities. However, we do not draw on these stakeholder interviews in this Article, given its focus is on water users' views on metering and metering upgrades. Interviewees were selected to capture diversity, including large and small farms, different industry types (e.g., cotton, cane, rice), different water types (groundwater, regulated and unregulated rivers), a mix of those who had completed the survey and those who did not, those with and without meters, and those who had new or upgraded meters and those who did not. The follow-up interviews provided more in-depth understanding. For example, in the survey farmers were asked whether metering was beneficial to helping them manage their on-property operations. The interviews then enabled us to explore the particualrs of why metering was beneficial, and in what ways.

107. Each interview took approximately thirty to sixty minutes. As with most social research, the ethical and confidentiality requirements of the study require us to preserve the anonymity of specific interviewees.

108. *See infra* Table 1.

109. *See infra* Table 2. Note that this included responses from stock and domestic water users who have no meters.

110. *See id.*

ridge wheels that calculated water usage based on the number of wheel revolutions. As two irrigators explained: "[H]eaps of people were manipulating the system—one bloke went out with an angle grinder and cut-off 75mm of the water wheel blades"[111] (this reduces the number of turns, and therefore the number of meter "clicks") and "a farmer put his wheel on blocks so it was still turning, but more slowly."[112]

Collectively, MM respondents viewed metering improvements (and associated improved delivery systems) as making it far more difficult for less scrupulous operators to "cheat the system." For those respondents operating within an irrigation scheme, the general consensus was that the combination of new meters and a sophisticated in-scheme monitoring (whereby the irrigation scheme can closely monitor volumes and flows throughout the system remotely) was making such flagrant rule breaking virtually impossible. As one farmer starkly put it: "We used to have forty water bailiffs crawling around the place, but now it's all electronic."[113] And it is claimed that new electronic meters are less vulnerable to manipulation than older mechanical meters and water wheels: "It's very hard to steal water now. Electronic meters have made it very difficult."[114]

Within the CW, respondent views on compliance and metering varied according to their water sources. Those in CW irrigation schemes held views largely consistent with MM respondents and claim it has been getting harder and harder to break the rules for some time. New meters were accordingly a welcome continuation of this process. In contrast, unregulated surface water users in CW are currently not metered.[115] As such, the suggestion was that the implementation of meters in these circumstances could identify instances of noncompliance. Similarly, CW respondents with groundwater bores appeared to have substantially fallen outside the regulatory compliance net, even though they do have meters. For example, a number of respondents claimed that "their [groundwater] meters were never read," though others noted that theirs were "not functioning."[116] Another farmer bluntly stated: "[M]y meter is not working at the moment, but it does when you hit it with a hammer, so I just keep using it. The meter guy says nothing. They are not doing their job in regards to policing water, they are not uncovering the problems."[117] Perhaps not surprisingly, these latter respondents were more sceptical about the benefits of metering because they were either less convinced of government effectiveness in general or because they recognised that even a new meter requires regular calibration, maintenance, and data collection.

In contrast to CW and MM, NC water users rarely came close to using their annual allocations. Meters accordingly had little relevance in ensuring that the large majority of NC licence holders did not exceed their overall extraction limits. The consensus view was reportedly that, "We don't have much in the way of water thieving, most have enough water therefore don't need to steal it. The coast has a lot less incidences of illegal water takes than other areas of the state."[118] Further, as it was pointed out by one respondent,"metering is a waste of time on the small creeks up here, because you can't take more than your allocation, in any case."[119] In other words, there is not sufficient water available during dry periods when they need water to extract beyond their allocation.Nevertheless, there are periods in the NC when constraints on surface water availability lead to seasonal extraction restrictions. This is particularly true during dry spring months when surface water availability is reduced by the lack of rain.[120] In these circumstances, respondents did highlight instances of neighbours extracting water when there were extraction limits in place: "I know some landholders were taking water over twenty-four hours when there were twelve hour restrictions in place,"[121] and "when it becomes a viability issue, that's when the rules get broken. People pump when they are not allowed to."[122] As such, noncompliance is more likely to occur though breaking pumping restrictions than exceeding annual allocations. In these circumstances, some NC respondents recognised that meters could improve compliance with seasonal restrictions, and, as such, supported this.

2. Improved On-Property Management

Turning to the issue of improved on-property management, several MM respondents had or were about to have newly installed meters linked through telemetry to a centralised database, with real-time data access. This had occurred in tandem with irrigation schemes introducing sophisticated and remote electronic controls that allow for the distribution of precise amounts of water through the channels to individual licence holders. In many cases, water users are able to track their own water usage and make orders on-line, though a centralised management team respond remotely: "We pump from the creek using diesel pumps, and used to have old mechanical, propeller meters. Now we have an electronic

111. Interview No. MM2 with Farmer, in Murray & Murrumbidgee region, N.S.W., Austl. (Apr. 8, 2013).
112. Interview No. MM7 with Farmer, in Murray & Murrumbidgee region, N.S.W., Austl. (Apr. 9, 2013).
113. Interview No. MM13 with Farmer, in Murray & Murrumbidgee region, N.S.W., Austl. (Apr. 10, 2013).
114. Interview No. MM9 with Farmer, in Murray & Murrumbidgee region, N.S.W., Austl. (Apr. 9, 2013).
115. Note, however, that NSW has put in place a macro water-sharing planning approach to unregulated rivers that employs risk assessment, trading restrictions, and pumping restrictions to account for and manage water. *See* N.S.W. Office of Water, Macro Water Sharing Plans—The Approach for Unregulated Rivers: A Report to Assist Community Consultation (2d ed. 2011), www.water.nsw.gov.au/__data/.../macro_unreg_manual_web.pdf.
116. Interview No. CW8 with Farmer, in Central West region, N.S.W., Austl. (June 20, 2013).
117. Interview No. CW5 with Farmer, in Central West region, N.S.W., Austl. (June 19, 2013).
118. Interview No. NC11 with Farmer, in North Coast region, N.S.W., Austl. (Feb. 12, 2013).
119. Interview No. NC1 with Farmer, in North Coast region, N.S.W., Austl. (Feb. 11, 2013).
120. *See, e.g.*, Gavin Coote, *Water to Be Carted to Central West NSW Villages if Dry Conditions Persist: Council*, ABC News (July 14, 2015, 7:54 PM), http://www.abc.net.au/news/2015-07-15/water-to-be-carted-to-central-west-nsw-villages-if-dry-conditio/6620908.
121. Interview No. NC7 with Farmer, in North Coast region, N.S.W., Austl. (Feb. 11, 2013).
122. Interview No. NC14 with Farmer, in North Coast region, N.S.W., Austl. (Feb. 13, 2013).

flow meter that sends a signal. You can now look at your allocation and order on the computer."[123]

The general consensus amongst MM respondents was that the allocation, distribution, and extraction of water within irrigation schemes had become a finely tuned science. The ability to order and monitor extractions online had assisted with on-property water management. Detailed information about what they had taken, how much they had available, and when, allowed water users to plan for future irrigation needs and improve on-property water management. Indeed, some MM respondents extended this water management conceptual framework to welcome the use of remote satellite imagery to independently calibrate crop growth to their water allocations and extractions.

Even though most CW respondents did not have access to real-time data on their water extractions (from meters with telemetry), the concept drew praise from many respondents. As with MM respondents, they identified the potential benefits of allowing better on-property water management. Some stated, for example, "I do support the idea of telemetry, and would spend a couple of thousand on it,"[124] "telemetry would allow me to manage my property and pump much better if you get data in real-time. This is definitely an attraction. I have no hassles with the government getting the data as long as the farmers get access to it as well."[125]

C. NSW Metering Upgrades in Practice—Challenges

Though the above findings revealed widespread *in-principle* support for the installation of new meters, in many cases this support was qualified. As such, a common refrain from interviewees was, "I support meters, but . . . ." The "but" consisted of several concerns and misgivings. These varied across regions and mostly occurred within CW and NC regions. Also present, in a limited range of circumstances, was outright opposition. Most of these concerns arose from the interviews, as these allowed for "drilling down" in greater detail than possible through survey questions. Four key concerns are described below.

First, there was uncertainty about metering reforms and standards. Respondents in the CW region claimed there was considerable uncertainty about the government plans for metering. Chief amongst these were views that the government had been slow in deciding what metering standards would apply, when agreed standards would be applied, and indeed that reforms were continually delayed. As several CW and NC respondents put it, "government has decided to put in new meters, but haven't released the standards"[126] "we have been told they are no longer going to do telemetry"[127] and "the river meter was also supposed to be electromagnetic. But we have been told . . . that they have run out of money, and are not going to go ahead with the system, even though the original idea was good."[128] CW respondents claimed that this perceived uncertainty was having a negative impact on their ability to meaningfully engage in the process and had halted any plans they might have had to purchase new meters themselves. This confusion led to a number of respondents stating that they would not address metering until further notice from the government.

NC and CW respondents were also concerned that the government had been slow providing definitive guidance on meter selection: "[T]hey haven't been able to come up with a recommended meter to use"[129] and "I would prefer it if they gave you a choice of a couple of different meters."[130] Further, as one CW respondent noted, the uncertainty had contributed to "a political fight over metering," and that this in turn had resulted in a lot of "resistance."[131] According to one respondent, "[T]here is quite a lot of anger towards State Water and Office of Water, and a lot of confusion about the policy. The targets for metering are ridiculous."[132]

Second, there were concerns about the costs of metering. It was also suggested that there was uncertainty as to whether water users were required to pay for new meters or whether the government would purchase them. Central to such concerns was the view that farmers will be required to replace what they consider to be perfectly good meters. In the NC region, for example, several respondents indicated a reluctance to pay the up-front costs of meters, even though the government may in fact initially pay this cost. Further, there were concerns that water users would be required to place multiple meters to cover multiple extraction sites, covered by a single water licence, and that this would lead to a "blow out" in costs. In the case of MM respondents, in contrast, there was little concern expressed about the cost of meters. This may be because many relied on gravity flow for irrigation, reducing their associated investments in activities such as pumping, and that those who were recipients of new meters were not required to pay the up-front capital costs of meter installation. Instead, the operators under the private cooperative scheme or State Water had or were about to pay these costs. Further, MM respondents did not object to requirements to pay an ongoing maintenance fee in the form of an annual levee, with respondents viewing it as a relatively minor and justifiable imposition. In contrast, respondents in NC and CW, where large investment has often been made in pumps to extract water from rivers, were far more opposed to paying ongoing charges for the maintenance of new meters. As one NC respondent explained, "At a meeting the govern-

123. Interview No. MM13 with Farmer, in Murray & Murrumbidgee region, N.S.W., Austl. (Apr. 10, 2013).
124. Interview No. CW10 with Farmer, in Central West region, N.S.W., Austl. (June 20, 2013).
125. Interview No. CW12 with Farmer, in Central West region, N.S.W., Austl. (June 20, 2013).
126. Interview No. CW4 with Farmer, in Central West region, N.S.W., Austl. (June 19, 2013).
127. Interview No. CW6 with Farmer, in Central West region, N.S.W., Austl. (June 19, 2013).
128. Interview No. NC8 with Farmer, in North Coast region, N.S.W., Austl. (Feb. 12, 2013).
129. Interview No. CW11 with Farmer, in Central West region, N.S.W., Austl. (June 20, 2013).
130. Interview No. NC3 with Farmer, in North Coast region, N.S.W., Austl. (Feb. 11, 2013).
131. Interview No. CW3 with Farmer, in Central West region, N.S.W., Austl. (June 19, 2013).
132. Interview No. CW9 with Farmer, in Central West region, N.S.W., Austl. (June 20, 2013).

ment gave a presentation on costing of new meters, but it was too much, all the ongoing maintenance and costs, it was just another levy that they could jack up overtime, it's just bullshit."[133] Similarly, one CW respondent, despite supporting new meters, complained about ongoing operational costs.

Third, there may be difficulties in locating meters on properties. Though less of an issue in CW and MM, a number of NC respondents raised metering location as a major issue for their area. This was because they often moved their surface water extraction points in the river and were unsure how this could be accommodated by new meters. Issues about meter placement were compounded by "fast changing river profiles" and concerns about the impact of flooding, a feature of the NC region.

Fourth, there was mistrust about the governments proposed water savings. There were a significant proportion of respondents across the regions that questioned the claimed system-wide water reductions that metering would generate under the NSW Metering Project. In the case of some NC respondents, in particular, there was a fear that a failure to generate water savings would lead to an eventual reduction or removal of existing water allocations. In some cases, such views were exacerbated by a more generalised mistrust of government and government motives that had "spilled over" into the metering issue.[134]

In summary, there was widespread in-principle water user support for metering. This support was greatest in those regions and amongst those users who had more experience with meters (e.g., MM). This suggests that, in this case, familiarity breeds not contempt, but acceptance and support. Further, a majority of water users considered that metering could improve their on-property water management practices, even when some (and most in NC) did not yet have meters in place. Views on the benefits of metering for compliance varied between regions, with those in the MM seeing the strongest positive impact, those in the NC seeing the least, and CW falling somewhere between. Beyond these general views and perceptions, the findings reveal considerable uncertainty about meter roll out plans, and identify a number of practical issues that, again, reflected regional circumstances.

III. Discussion

The implementation of widespread real-time telemetered monitoring and information diffusion is arguably one of the most significant modern evolutionary steps in water regulation. In particular, advanced meters have the potential to enhance water accounting, deliver efficiency gains, and enhance compliance and enforcement by providing reliable and accurate extraction data, in many cases where none previously existed. And the addition of remote data access via telemetry is potentially transformative in diverting scarce regulatory resources away from checking and recording meter readings, thereby facilitating more strategic and preventative regulatory interventions. For water users, meters, whether more accurate, or where none previously existed, may assist in more efficient management of irrigation and the avoidance of unintended compliance breaches. The option of real-time data collection and online access via telemetry also has the potential to further enhance on-property management.[135] The presence of meters less susceptible to manipulation can also enhance equitable water use by reducing theft.

Across both the ASM and NSW cases, there was much common ground. The above findings demonstrated not only broad acknowledgement of the positive role of metering in managing water, but also the importance of having, and support for, accurate equipment. In particular, the findings from both cases demonstrated substantial support for telemetry, so long as water users, not just government, were afforded access to real-time data. Many of the NSW respondents were of the view that the combination of improved metering and the use of real-time water extraction data could improve the detection of illegal water extractions, discourage meter tampering and thereby ensure better compliance and equitable water extraction.[136] Similar views were evidenced in ASM context where new telemetry and information diffusion amongst group members and government had significant transparency, compliance and enforcement benefits. The findings also revealed perceived advantages to water users, in particular, through access to real-time water extraction data to improve on-property water management and facilitate greater flexibility within the overarching ASM bubble licences. Yes, ASM requires the existence or establishment of an institutional body, such as a water user group, to oversee the operation of the scheme, but it is the access to real-time feedback via telemetry extraction data that assists the landholders and regulators to effectively monitor current and projected usage to avoid exceeding waterallocations, or, in the case of under-utilising allocations, make surplus available to other members of an ASM scheme.

The overall tenor of responses in both NSW and ASM cases suggest that there is considerable scope for reforms to proceed with the support and engagement of, at least, a large majority of the water users. Despite this optimistic conclusion, the research reveals several gaps and uncertainties that appear likely to stymie the smooth implementation of the reforms, particularly in NSW, where numerous concerns were raised in interviews, but also in Canterbury, where despite fairly significant successes in ASM, there were also evident challenges.

In NSW, for example, there is a potential disconnect between government policy reforms and water user perceptions across the three regions—as noted above, many users are confident that their meters are effective so it does not necessarily follow that they would support their replacement by new, government owned or mandated meters. This was

133. Interview No. NC2 with Farmer, in North Coast region, N.S.W., Austl. (Feb. 11, 2013).

134. Cameron Holley & Darren Sinclair, *Deliberative Participation, Environmental Law and Collaborative Governance: Insights From Surface and Groundwater Studies*, 30 Envtl. & Planning L.J. 32, 47–48 (2013).

135. The same is evident in urban contexts. *See* Cara Beal et al., *A Novel Mixed Method Smart Metering Approach to Reconciling Differences Between Perceived and Actual Residential End Use Water Consumption*, 1 J. Cleaner Prod. 8 (2011).

136. Raft & Hills, *supra* note 7, at v.

because many water users felt they were likely to bear the cost (either up front or overtime). Similar concerns over cost were raised by farmers in ASM (albeit that they had bulk purchasing options via ASMs collaborative model). Other ASM respondents raised concerns about farmers' capacity to utilise the new monitoring and data reporting systems, though NSW interviewees reported considerable uncertainty about the standards being imposed and the ability of the proposed reforms to account for local conditions. Many NSW respondents also expressed a fear that the government might be intending to use meter data to reduce allocations or increase water prices. Although ASM's unique approach to providing only *collective* extraction data to the regulator seemed to allay concerns from water users in Canterbury, there were NGO concerns about data transparency and a perceived risk of capture.

In short, in both NSW, and to a lesser extent ASM, there is ground to be made up in garnering support for metering reforms.[137] Effective and worthwhile water reforms need community support.[138] Garnering such support requires a sound understanding of the perceptions potentially affecting metering changes and clear communication of the overall benefits to be achieved by the proposed reforms.[139] The above cases provide insights into these perceptions and the nature and extent of the policy and practical challenges confronting metering. Given evident barriers to buy-in, what can be said about enhancing opportunities for stakeholders to support future meter upgrades and installations? And where should authorities direct their communication, information, and education attention to enhance metering outcomes, and address suspicion around data use and transparency? The survey and interview findings suggest six priority areas where government agencies should direct their attention to improve stakeholder buy-in.

First, is water users' knowledge and capacity for using new monitoring and information technologies. Many NSW interview respondents without new meters installed by the government, or irrigation schemes, raised the issue of uncertainty over meter standards. For those who have existing meters in place, particularly those that are recent acquisitions, this led to uncertainty as to whether their meters would need to be replaced. Slow identification of nationally consistent meter pattern approvals compounded such confusion and concerns. Although such concerns were not raised in the ASM case, due to existing regulatory requirements,[140] concerns were raised regarding the disconnect between the capacity and skills of farmers and the new software and technology central to ASM's real-time monitoring and reporting. In short, ease-of-use is important to technology adoption.[141]

As such, these findings suggest policy makers need to ensure they assist water users by clearly communicating and educating water users about relevant standards and technologies applying to water users and how it impacts on their existing meters and practices.

Second, is technology costs, in this case the price of new meters. For those water users in NSW already with meters, some were concerned that "perfectly good meters" would be replaced unnecessarily, and they would in some way "foot the bill." For those without meters, some believed, albeit erroneously that they would be required to pay the upfront costs of new meters. Even amongst those who understood government, or irrigation schemes, would initially supply new meters, some NSW respondents were concerned that they would ultimately end up paying through either additional annual charges or a reduction in water allocations, thus mirroring the views of some irrigation associations. Even in ASM where members' bulk purchasing power had enabled water users to obtain technology for a discount, meter cost was seen to be a significant barrier to the wider roll out of ASM, where individual farmers may see such expenses as outweighing the benefits of ASM and uptake of new meter technology. In short, mechanisms are required to facilitate buy-in and adoption if technologies are expensive to introduce.[142] This could include consulting water users about their concerns, exploring possible financial support, as well as building understanding about who pays for meters and why.

Third, is meter benefits. This was an issue of greater concern in NSW than in ASM. Water users in ASM in fact experienced many benefits from new real-time monitoring. As previously discussed, these benefits arose because the ASM model coupled new technologies with both greater flexibility in water management under the bubble licence and reduced government oversight over individual users. NSW respondents also reported seeing such advantages to meters and telemetry. However, many were equally likely to pause and ask, "but what's in it for me?" Scepticism of the overall water savings that metering is purported to generate was evident. Users also doubted whether new meters would produce any real benefit for improved compliance and equity in water use.

Prioritising and sustaining communication to water users about the benefits of metering will assist in reducing such scepticism.[143] This could include the use of "demonstration cases," such as evidence from service focused water utilities of how digital metering and analytics of data sets in real-time, can benefit efficiency and excellence;[144] or programs like ASM that demonstrate the on-property benefits of metering. Introducing co-regulatory models such as the ASM, replete with reduced overnight and greater flexibility, could also help to enhance actors buy-in to new technologies; however, this

137. Andrew Gregson, Position Paper: NSW State Priority Project for Metering 2 (2011), http://www.nswic.org.au/pdf/Briefings/110913%20-%20Metering.pdf.
138. Syme & Nancarrow, *supra* note 11, at 243.
139. *Id.*
140. Resource Management (Measurement and Reporting of Water Takes) Regulations 2010, SR 2010/267, Regulation 7 (N.Z.).
141. Roberta McDonald et al., *Factors Influencing New Entrant Dairy Farmer's Decision-Making Process Around Technology Adoption*, J. Agric. Educ. & Extension 1, 12 (2015).
142. Katrin Millock et al., *Policy for the Adoption of New Environmental Monitoring Technologies to Manage Stock Externalities*, 64 J. Envtl. Econ. & Mgmt. 102, 113 (2012).
143. Adam Baumgart-Getz et al., *Why Farmers Adopt Best Management Practices in the US: A Meta-Analysis of the Adoption Literature*, 96 J. Envtl. Mgmt. 17, 23 (2012).
144. Cara D. Beal & Joe Flynn, *Toward the Digital Water Age: Survey and Case Studies of Australian Water Utility Smart-Metering Programs*, 32 Util. Pol'y 29, 29 (2015).

will be context specific (e.g., it remains an open question as whether AMS could be rolled out where there are numerous potential participants and no pre-existing water user group).

Fourth, is transparency and use of data. Many of the potential benefits of advanced meters, notably the freeing-up of substantial regulatory resources and facilitating improved on-farm water management, are predicated on the use of, and access to, real-time data. Yet, who has access to this data (e.g., regulator, regulated, third parties), in what form (e.g., aggregated or individual) and how this data will be used remain vexing questions. Concerns over these issues were evident to vary degrees in ASM and NSW. Though ASM's aggregated data provision to the regulator was supported by water users, NGO stakeholders raised concerns about transparency and accountability where data access was limited to regulator and paid third-party auditors.[145] In NSW, real-time telemetered data also had the support of irrigation industry groups and most respondents in this research; however, they were strongly in favour of water users having access to the real-time data from their own meters, and expressed a fear that the government might be intending to use data to reduce allocations or increase water prices. These findings suggest it is vital that policy makers not only consider how and to what extent data will be shared with relevant stakeholders, but also that the rationale for making these selections is clearly communicated to water users and other stakeholders.

Fifth, is accommodating local and regional variation. The NSW findings starkly revealed the challenges of accommodating regional and local variation. In terms of the former, one of the features of the NSW research findings is the striking difference in metering knowledge and experiences between the three regions. This has been recognised by government, in particular, through the introduction of a range of metering pilots in different regions, and the NSW Irrigator's Council has noted the importance of this issue in stating that NSW metering reform needs to be developed on "a valley-by-valley basis."[146] One potential approach to accommodating regional variation is to prioritise the roll out of meters in those regions that have the highest levels of irrigation and/or the greatest pressure on water supplies, together, which are likely to be at greater risk of water theft.

Beyond regional variations, a number of local practical issues were also highlighted in NSW regarding meter location. The NC interviews highlighted two practical concerns about the installation of meters, independent of their in-principle support for metering. Though these issues appeared most relevant to NC conditions, they may have wider applicability. First, there was the problem of where to place the meters in order to avoid them being subject to or potentially damaged by frequent flooding and rapidly changing riverbanks. In this respect, the capacity for meters to be easily transported, for example, to a point of safety in the event of a flood, or to accommodate different extraction points or irrigation outlets may be advantageous. A second, and related issue occurs when water users extract water from multiple points. This raises the possibility of requiring multiple meters for a single licence allocation, thereby increasing costs. In short, ensuring water users are engaged in metering policy reforms to identify and accommodate such variation, at relevant scales, should be a priority when rolling out of new technology. Further, in any given case, the gains made from such a tailored decentralised policy would increase with heterogeneity.[147] Although ASM is still at an early stage, it provided glimpses of a successful attempt to account for local and regional conditions. The pilot itself was chosen to capture conditions favourable to implementing new technology, namely a cooperative irrigation scheme likely to purchase technology and share information.[148] Water users also had a direct role in negotiating with the regulator to implement the meters and information technology in their locality.

Sixth, and finally, is communications strategy. Many of the above recommendations rest on engaging and communicating with water users. Policy implementation will inevitably be full of messages, channels, and targets operating within a broader communication system, and the interpretation of these messages depends on the different settings and contexts in which they are received.[149] Though the single small ASM pilot enabled a relatively straightforward communication process, as seen in NSW, when rolling out technology on larger scales this communication can be challenging. Whether or not water users embrace new monitoring and information technology will be influenced by their perception of the messages, and the information flowing from government levels.[150] As such, there is a need for departments and agencies to place their communication and education activities within a broader policy context.[151] In particular, it would be helpful if water users were afforded a basic understanding of plans and processes for the progressive implementation of new meters and meter standards. This may also outline, in a very simple and straightforward way, the cross functional boundaries within and between relevant government agencies and programs.

In the absence of such focussed and coordinated communication and education efforts, the risk is that the considerable goodwill towards metering that exists amongst many water users will dissipate. There is certainly growing recognition that governments have historically struggled to effectively consult and engage with water users to accommodate needs and circumstances.[152] Addressing this issue will be an ongoing challenge, as governments continue to advance rapid institutional change across the water sector.[153] The success of

145. Gregson, *supra* note 137, at 2.
146. *Id.* at 1.

147. Millock et al., *supra* note 142, at 112.
148. Baumgart-Getz et al., *supra* note 143, at 17; *see generally* Rick S. Llewellyn, *Identifying and Targeting Adoption Drivers, in* Changing Land Management: Adoption of New Practices by Rural Landholders 87 (David Pannell & Frank Vanclay eds., 2011).
149. Burke et al., *supra* note 11, at 14.
150. *Id.*
151. Dep't of the Prime Minister & Cabinet, *supra* note 11, at 1.
152. *See* Nat'l Water Comm'n, *supra* note 22, at 10; Holley & Sinclair, *supra* note 134, at 44–55; P.L. Tan et al., *Continued Challenges in the Policy and Legal Framework for Collaborative Water Planning*, 474 J. Hydrology 84, 86–87 (2012).
153. *See generally* Daniel Connell & R. Quentin Grafton, Basin Futures Water Reform in the Murray-Darling Basin (2011).

future policy will depend on how well governments broaden the constituency of civic engagement with agricultural contexts in a more meaningful manner.[154] Robust efforts to build citizens' trust in water institutions will be needed to implement new arrangements that achieve outcomes in an equitable, effective way, balancing bottom-up and top-down processes.[155] Without such attention, the perceived lack of genuine consultation will remain a key complaint and barrier to implementing metering reforms.[156]

IV. Conclusion

These case studies demonstrate both the benefits and some of the challenges of implementing metering and associated telemetry. In particular, the studies demonstrate the potential challenges and opportunities for generating buy-in to monitoring and information technology reforms in the context of the regulation of water extractions by non-urban water users. As noted earlier, metering technology has the potential to transform the compliance and enforcement role of regulatory agencies. The example of ASM in Canterbury, New Zealand, provides a tantalizing insight into the central role of metering and telemetry that allows water users greater control of and flexibility in the management, and compliance, of water extractions, albeit amongst a small, preexisting water user group. Whether such a model can be successfully replicated in other contexts, particularly with larger numbers of water users that may not have a preexisting relationship, remains unclear. One thing that is clear from the ASM pilot project, however, was that participant access to real-time extraction data, both for themselves and their peers, was central to its success. In short, this approach has significant opportunity to enhance water user's buy-in.

The example of the NSW Metering Project in Australia provides another complementary example of the importance of water user buy-in to the successful implementation of new technologies that have the potential to substantially shift the compliance and enforcement landscape. In this instance, though water users held generally favourable views towards metering and telemetry, they also held a number of concerns. The risk for policymakers is that in the absence of broad stakeholder buy-in to their planned metering programs, such concerns could, for example, generate political opposition to metering and a reluctance to maintain on-property meters. The challenge for policymakers, then, is to overcome such opposition or reluctance by generating buy-in to metering reforms.

This Article has provided some timely insights for policymakers and the literature regarding the implementation of monitoring and information technology. It has extended the understanding of water users' views, both positive and negative, of water metering and the potential challenges to generating buy-in to metering and information technology reforms. The comparative quantitative and qualitative empirical analysis of ASM in New Zealand and different areas within NSW has allowed the Article to explore different experiences and views on water metering and identify six recommendations for enhancing buy-in. Further research is needed to examine the results of new metering and information technologies in NSW and New Zealand; to understand to what extent buy-in from the regulated community is a precondition to the uptake of new monitoring technologies, beyond water meters; and to explore to what extent the findings from this study into water metering apply to other water regulatory contexts. Even so, this Article's detailed inquiry into water users' support for metering fills a key knowledge gap to better assist the achievement of this next step in water compliance and enforcement.[157]

154. Lee Godden & Ramond Ison, *From Water Supply to Water Governance*, *in* More Than Luck 177, 183 (Mark Davis & Miriam Lyons eds., 2010).
155. *Id*.
156. Gregson, *supra* note 137.
157. Stoeckel & Abrahams, *supra* note 42.