UNRAVELLING NESTED INSTITUTIONAL ARRANGEMENTS

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ABSTRACT

Common pool resources (CPRs) are noted for their excludability and subtractability issues and early academic commentary stressed that due to the resources' complexity and uncertainty, management efforts were futile and a "tragedy of the commons" was the end result. Recent academic commentary has challenged this end result and has elaborated institutional design principles to sustainably manage CPRs which include the need for nested institutional arrangements (NIAs). However, little is known about how to move between the two extremes, that is, how we change public policy in a move towards and the sorts of institutional innovations that lead us to greater sustainability. This research begins to unravel nested institutional arrangements. It develops a framework for what constitutes a nested institutional arrangement and measures their effect on groundwater policy changes (frequency, type, magnitude) under different conditions of uncertainty as applied to a comparative case study between the Great Lakes Basin (high uncertainty; Ontario, New York) and the Ogallala Aquifer in the U.S. Midwest (low uncertainty; Nebraska). This dimensional mapping reveals the centrality of the nature of the linkages between governance units (especially linkage functionality), linkage complementarity and the effects of diffuse authority structures. In short, it is possible to unravel what an NIA is from the various strands in the literature and to develop linkages between NIAs and outcomes for particular situations (e.g. high vs. low uncertainty areas) in relation to common pool resources (e.g. groundwater). The results provide theoretical guidance for the study of groundwater policy changes by staking out the broad parameters of a strategy for groundwater policy change.

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List of Abbreviations and Acronyms

ACWBSPP	Advisory Committee on Watershed-Based Source Protection Planning (Ontario Ministry of the Environment)
Ag. Cda.	Agriculture Canada
AG Off.	Attorney General's Office (NE)
Assoc. State Dkg. Wat. Admin.	Association of State Drinking Water Administrators
AMWA	American Municipal Water Association
AWWA	American Water Works Association
BWRM	Bureau of Water Resources Management, DEC, NYS
CA	Conservation Authority (Ontario)
CAMC	Conservation Authorities Moraine Coalition
CEO	Code Enforcement Officers (New York)
CO	Conservation Ontario
COHYST	Cooperative Hydrology Study
Cons. Auth.	Conservation Authority (Ontario)
Cons. Part.	Consultation Partners
Consul. Partners	Consultation Partners
CPNRD	Central Platte Natural Resource District
CPR	Common Pool Resource
Cty. SWCD	County Soil and Water Conservation District
DEC	Department of Environmental Conservation (New York)
DEC BWRM	Department of Environmental Conservation (New York) Bureau of Water Resources Management
DEC Div. Law En.	Department of Environmental Conservation (New York) Division of Law Enforcement
DEC GW Br.	Department of Environmental Conservation Ground Water Branch (New York)
DEC GW Mgt. Div.	Department of Environmental Conservation (New York) Ground Water Management Division
DEC Off. of Hear.	Department of Environmental Conservation (New York) Office of Hearings
DEC WHP Ad. Com.	Department of Environmental Conservation (New York) Wellhead Protection Advisory Committee
Div. Law En.	Division of Law Enforcement
Div. Legal Aff.	Division of Legal Affairs
DLA	Division of Legal Affairs, DEC, NYS
DOH	Department of Health (New York)
DOH Bur. Wat. Sup.	Department of Health (New York) Bureau of Water Supply
DOH BWSP	New York State Department of Health Bureau of Water Supply Protection
DOH Cty. Hth.	Department of Health (NE)
DOH Cty. Hth. Dept.	Department of Health County Health Department (New York)

DOH En. Hth. Div.	Department of Health (NE) Environmental Health Division
DOS	Department of State (New York)
DOS Div. Code En.	Department of State (NY) Division of Code Enforcement
DOS Off. Ad. Hear.	Department of State (NY) Office of Administrative Hearings
DDT	Dichlorodiphenyltrichloroethane
DNR Field Off.	Department of Natural Resources (NE) Field Offices
DRBC	Delaware River Basin Commission
DU	Ducks Unlimited
DWR GW Div.	Department of Water Resources (NE) Ground Water Division
DWSRF	Drinking Water State Revolving Fund
EAB	Environmental Appeal Board (Ontario)
En. App. Bd.	Environmental Appeal Board (Ontario)
ENGO	Environmental Non-Governmental Organization
Envir. Defense	Environmental Defense
EPA	Environmental Protection Agency (United States)
EPA Reg. 2	Environmental Protection Agency (US) Region 2 Office
EPA Reg. 7	Environmental Protection Agency (US) Region 7 Office
EPA Dkg. Wat Div.	Environmental Protection Agency (US) Drinking Water Division
ESWWDA	Empire State Water Well Drillers Association
G/FLRPC	Genesee/Finger Lakes Regional Planning Council
GLBAC	Great Lakes Basin Advisory Council (New York)
GL Basin Adv. Coun.	Great Lakes Basin Advisory Council
GLWWRP	Great Lakes Water Withdrawal Registration Program
GSC	Geological Survey of Canada
GW Fdn.	Groundwater Foundation (NE)
GW Protect. Coun.	Ground Water Protection Council
IAD	Institutional Analysis and Design
ICWBSP	Implementation Committee on Watershed-Based Source Protection Planning (Ontario Ministry of the Environment)
ID	Irrigation District
Irr. Dis.	Irrigation District
Land/Water Pol. Br.	Land/Water Policy Branch, ON Ministry of the Environment
LBNRD	Little Blue Natural Resource District
Legal Ser. Br.	Legal Services Branch Ontario Ministry of the Environment
L. Gov't	Local Government
LNM	League of Nebraska Municipalities
LWPB	Land and Water Policy Branch, Ontario Ministry of the Environment
MHLTC	Ministry of Health and Long Term Care (Ontario)
MNR	Ministry of Natural Resources (Ontario)
MNR GLB	Ministry of Natural Resources (Ontario) Great Lakes Branch
MNR LWB	Ministry of Natural Resources (ON) Land and Waters Branch
MNR Reg. Off.	Ministry of Natural Resources (Ontario) Regional Offices

MOE	Ministry of the Environment (Ontario)
MOE DWPB	Ministry of the Environment (Ontario) Drinking Water Program Branch
MOE EAB	Ministry of the Environment (Ontario) Environmental Approvals Branch
MOE Env. App. Br.	Ministry of the Environment (Ontario) Environmental Approvals Branch
MOE Imp. Com.	Implementation Committee on Watershed-Based Source Protection Planning (Ontario Ministry of the Environment)
MOE LSB	Ministry of the Environment (Ontario) Legal Services Branch
MOE Op. Div.	Ministry of the Environment (Ontario) Operations Division
MOE Pol/Plan. Br.	Ministry of the Environment (ON) Policy and Planning Branch
MOE PPB	Ministry of the Environment (ON) Policy and Planning Branch
MOE Reg. Oper.	Ministry of the Environment (Ontario) Regional Operations
MOE T. Ex. Com.	Technical Experts Committee on Watershed-Based Source Protection Planning (Ontario Ministry of the Environment)
MOE WPB	Ministry of the Environment (Ontario) Water Policy Branch
MOE Water Res. Br.	Ministry of the Environment (ON) Water Resources Branch
MOE WRB	Ministry of the Environment (ON) Water Resources Branch
NARD	Nebraska Association of Resource Districts
Nat. Assoc. of Cities	National Association of Cities
Nat. Res. Com.	Natural Resource Commission (NE)
Nat. Res. Defense Council	Natural Resources Defense Council
Nat Wat. RA	National Water Resources Association
NAWC	National Association of Water Companies
NCA	Nebraska Cattlemen Association
NDEC	Nebraska Department of Environmental Conservation
NDEC GWU	Nebraska Department of Environmental Conservation Ground Water Unit
NDEC/Q	Nebraska Department of Environmental Conservation/Quality
NDEQ	Nebraska Department of Environmental Quality
NDHHS	Nebraska Department of Health and Human Services
NDNR	Nebraska Department of Natural Resources
NDOH	Nebraska Department of Health
NDOH EHD	Nebraska Department of Health Environmental Health Division
NDWR	Nebraska Department of Water Resources
NDWR GWD	Nebraska Department of Water Resources Ground Water Division
NDWR WAD	Nebraska Department of Water Resources Water Administration Division
NGPC	Nebraska Game and Parks Commission
NE	Nebraska
NE Wat. R.A.	Nebraska Water Resources Association

NIA	Nested Institutional Arrangement
NGWA	National Ground Water Association
NGWF	Nebraska Groundwater Foundation
NNRC	Nebraska Natural Resources Commission
NRD	Natural Resource District
NaRWA	National Rural Water Association
NPDES	National Pollutant Discharge Elimination System
NRWA	Nebraska Rural Water Association
NSIA	Nebraska State Irrigation Association
NY, NYS	New York State
NYCRR	New York Code Rules and Regulations
NY Rural Wat. As.	New York Rural Water Association
NYRWA	New York Rural Water Association
NYSDEC	New York State Department of Environmental Conservation
NYSDEC GWB	New York State Department of Environmental Conservation Ground Water Branch
NYSDEC GWMB	New York State Department of Environmental Conservation Ground Water Management Branch
NYSDEC GWMD	New York State Department of Environmental Conservation Ground Water Management Division
NYS Dept. Ag. & Mkts.	New York State Department of Agriculture and Markets
NYSDOH	New York State Department of Health
NYSDOH BWSM	New York State Department of Health Bureau of Water Supply Management
NYSDOS	New York State Department of State
NYS GS	New York State Geological Survey
NWDA	Nebraska Well Drillers Association
OFA	Ontario Federation of Agriculture
OGWA	Ontario Ground Water Association
OLWR	Ontario Low Water Response
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
OMMAH	Ontario Ministry Municipal Affairs and Housing
OMOE	Ontario Ministry of the Environment
OMNR	Ontario Ministry of Natural Resources
ON	Ontario
O. Reg.	Ontario Regulation
ORWC	Ontario Rural Wastewater Centre
OWRC	Ontario Water Resources Commission
OWRC GWB	Ontario Water Resources Commission Groundwater Branch
OWSPPIC	Implementation Committee on Watershed-Based Source Protection Planning (Ontario Ministry of the Environment)
OWSPPTEC	Technical Experts Committee on Watershed-Based Source Protection Planning (Ontario Ministry of the Environment)
PTTW	Permit-To-Take-Water

Reg/Cty Plan. Coun.	Regional/County Planning Council
Regs.	Regulations
Res. Div., OWRC	Research Division, Ontario Water Resources Commission
rqts.	requirements
RSO	Revised Statutes of Ontario
Rur. Wat. Dis.	Rural Water Districts
SDWA	Safe Drinking Water Act
SPDES	State pollutant Discharge Elimination Program (New York)
SPP	Source Protection Planning
SRBC	Susquehanna River Basin Commission
SWAP	Source Water Assessment Program
SWCD	Soil and Water Conservation District
SWP	Source Water Protection
SWPP	Source Water Protection Plan
TECWBSP	Technical Experts Committee on Watershed-Based Source Protection Planning (Ontario Ministry of the Environment)
UN-L C/S Division	University of Nebraska-Lincoln Conservation and Survey Division
U.S.	United States
USDA Nat. Res. C.S.	United States Department of Agriculture Natural Resources Conservation Service
USDA NRCS	United States Department of Agriculture Natural Resources Conservation Service
USEPA	United States Environmental Protection Agency
USEPA DWD	United States Environmental Protection Agency Drinking Water Division
USGS	United States Geological Service
USGS WRD	United States Geological Service Water Resources Division
UTLTSCRCA	Upper & Lower Thames St. Clair Region Conservation Authorities
UTRCA	Upper Thames River Conservation Authority
Water Well B. U.	Water Well Business Unit, ON Ministry of the Environment
Wat. Pol. Task Force	Water Policy Task Force
Wat. Res. Div., USGS	Water Resources Division United States Geological Service
Wat. Sys. C.	Water Systems Council
WHP	Wellhead Protection
WHPAC	Wellhead Protection Advisory Committee
WHP Advis. Com.	Wellhead Protection Advisory Committee
WHPP	Wellhead Protection Plan
WPTF	Water Policy Task Force
WRR	Watershed Rules and Regulations
WSC	Water Systems Council
WWBU	Water Well Business Unit, ON Ministry of the Environment
WWSCLB	Water Well Standards and Contractors Licensing Board

Chapter One

Strategizing Policy Change in Uncertain Environments

"what to do?"

1.1 Introduction

This thesis is about determining the effects of nested institutional arrangements on the type, frequency and magnitude of policy change for a common pool resource: groundwater[1]. The broader question is: How do you change public policy? This is a straight forward question but no straight forward answer exists. How do you enact legislation where none previously existed such as was the case with source water protection in Ontario in 2006 or with well driller[2] registration and certification requirements in New York[3] in 1999? Or, how do you improve on existing legislative and regulatory frameworks so they better address the problem at hand such as with the addition of environmental considerations in the evaluation of Permits-To-Take-Water (PTTW) in Ontario in 1999 or in water transfer permits in Nebraska in 2003?

This is not a trivial matter. Numerous public policies affect our daily lives and we do not necessarily agree with all of them. So, how *do* you change public

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[1]Two spellings of groundwater are found in the literature. This thesis utilizes groundwater.
[2]References to "well driller" or "driller" refer to *water* well drillers unless explicitly stated.
[3]References to "New York" or "NYS" refer to New York *State*.

policy? One answer, "anyway you can", may be reasonable but offers little insight in how to go about the task. Visions of people writing letters to politicians, participating in demonstrations and making backroom "deals" between various leaders come to mind. How one plots a course of action is, however, left unanswered. In other words, we need to explicate how institutional structures which shape and mediate individual actions affect the policy change process.

Group theories such as pluralism and corporatism sharpen our focus by bringing attention to particular actors in the policy change process. Pluralist theories, for example, emphasize the role of interest group interaction and see the resultant policy changes as largely a competition between said groups. Often missing in these interpretations, however, are the "active" roles governments generally and individual government departments have in the process. Note that their role is largely circumscribed to implementing the desires of interest groups and/or mediating the competitive and often conflictual process (Dahl, 1967; Smith, 1990). Moreover, governments are presumed to have no interests of their own, which is not the case (Olson, 1965). Furthermore, institutions themselves are marginalized in explanations of changes in public policy.

Recent developments in pluralist theory recognize the aforementioned critiques yet are themselves limited. Reform pluralism, for instance, explicitly recognizes the fact that the political process offers both opportunities and constraints thus limiting the participation of non-institutionalized groups in the policy process. Group-government interactions, built on the concept of policy communities, can vary from a highly institutionalized one where each governance unit is an intricate part of the governance process (e.g. corporate pluralism) to a minimally institutionalized one with many participants continually entering and exiting the policy process (e.g. issue networks) (Richardson & Jordan, 1979; Jordan & Richardson, 1987; Smith 1990; Heclo, 1978). The problem is that while institutional dimensions are recognized in these relationships, linkages between governance entities are not explored nor are their effects on the policy change process.

Corporatist theory largely addresses some of these concerns. It explicitly recognizes the role of the state in the public policy process and the institutions involved, albeit indirectly, in that institutions structure patterns of interactions between interest groups and between the state and interest groups (Schmitter, 1979). The problem is that corporatist theory offers little in terms of explanatory power in relation to changes in public policy. Rather, the theory is largely limited in describing a particular set of state/society organization found in a few countries (e.g. Germany) and, as such, offers little insights for others (e.g. Williamson, 1989).

Alternatively, the examination of how legislatures, the courts and government departments, our institutions, function has a long history and offers mechanical explanations of how or why certain policies are or are not reached (e.g. Dawson, 1970; Weaver & Rockman, 1993; Pal & Weaver, 2003). Institutions matter, moreover, history matters. Note that changes in public policy are constrained and shaped by the institutional structure and ideas at hand, as well as, their legacy. In other words, policy change is path dependant (Campbell, 1998; Peeters, 1999;

Rothstein & Steinmo, 2002). As helpful as these state-centric or historical institutionalist theories are, many limitations exist. For instance, exactly how individuals function, are motivated and are mobilized is largely missing in these investigations as are how variations in rules might affect outcomes (Thelen & Steinmo, 1992). This is important and leads to difficulties in trying to address collective action problems such as that found when examining groundwater governance. Note that in such investigations, much depends on individual incentives and motives which are shaped by the rules in place when deciding whether or not one contributes in a positive fashion to the sustainable use of the resource. Simply put, more is needed from institutionalist approaches.

Institutions matter but so do individuals. And, it *is* the public choice approach that includes the individual, critical in strategizing and initiating policy change whether they are within the government or not, as one of three core elements of public policy analysis (e.g. Sproule-Jones, 1993). In this process, individuals are continually adaptive and utility enhancing entities constrained by given institutional arrangements with the evaluation (i.e. outcomes) of public policy relating back to the same said individual citizens (and not larger entities such as groups). Institutional arrangements, the second core concept of public choice theory, are the laws and regulations and the processes to make and change such laws and regulations. Many examples exist including property rights and, as noted above, such institutional arrangements both constrain and facilitate individual actions. Individual preferences as mediated by institutional arrangements also depend on the nature of the good, the third core public choice concept. The degree to which goods are subtractable and excludable affects the institutional arrangements devised to manage the good and an individual's preferences towards the good (Sproule-Jones, 1982, 1996). Goods[4] that are highly subtractable combined with great difficulty in excluding their consumption, such as groundwater, the focus of this dissertation, are particularly difficult to manage sustainably. Note that whatever quantity of groundwater I use necessarily reduces that available for others to use. Furthermore, it is difficult and costly (e.g. monitoring/sanctioning) to exclude others from using groundwater. Efforts to sustainably manage the resource through the assignment and enforcement of property rights and the development of binding contracts necessarily entail transaction costs which can be prohibitive and contribute to unsustainable resource use.

Transaction costs have long been recognized in public choice theory. Downs (1957), for instance, elaborated a model of rational forms of political behaviour for citizens and governments alike. Much of the focus was on individual citizens and their (dis)inclination to act. Detailed in Downs' analysis was a method of how citizens act to reduce transaction costs associated with becoming informed. Downs deduced that individuals delegated, most likely to persons closely related to them (not necessarily family), to varying degrees the procurement, analysis and evaluation of information in order to reduce transaction costs associated with voting (pp. 220-238).

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[4]Subtractability and excludability dimensions of goods produce three other types of goods in addition to common pool goods discussed in this dissertation. They are: pure private goods (high subtractability, low excludability costs; e.g. TVs); toll goods (low subtractability, low excludability; e.g. parks), and pure public goods (low subtractability, high excludability; e.g. weather forecasts).

In addition, he elaborated an individual's inclination to vote based on the associated costs (pp. 260-278). Left out of this analysis was the object of what they were trying to change, that is, the actual item they selected to act for and why.

Buchanan and Tullock (1962) partially addressed this in detailing a rule-based utilitarian approach to activity collectivization (e.g. government provision). In short, they identified that the collectivization of an activity occurred when the costs of doing so to utility maximizing individuals were less than the private voluntary organization of the activity. Note that these costs include both external costs (due to the actions of others and beyond the direct control of an individual) and decision-making costs (due to one's participation in an activity) which tend to be less in smaller decision-making units due to the inclusivity of decision-making rules (less bargaining required). Note the centrality of the individual constrained by the institutional structure, including associated costs, in the analysis.

Similarly, Olson (1965) elaborated a theory of groups and public goods for collective action which has been both challenged and refined over the years (e.g. Udéhn, 1993; Lupia & Sin, 2003; Hansen, Mitchell & Drope, 2005). Olson's central findings were that collective action through rational, self-interested individuals aggregated in groups tended to occur when groups were either small or when some form of coercion (good or bad and from government rules or social norms) existed, and that collective action ceased before the optimal level of benefits were reached for the group as a whole. Note the implied transaction costs through the coercive measures used. Moreover and for large scale complex common pool problems, activity collectivization in smaller groups as identified by Olson (and by Buchanan & Tullock) misses the fact that they alone may not be able to adequately address the problem. In fact, addressing large scale groundwater problems through the disaggregation of the problem into smaller groups necessitates interaction between such groups and such transaction costs may be greater than those found in fewer yet larger groups. As such, a renewed focus on institutional dynamics centred on the linkages between individual groups is required.

The question is: What is the relationship between institutions and individuals on the effects of policy changes in common pool problems? Answers to this question will help stake the parameters for a strategy of groundwater policy change. This is no easy task and addressing public policy change through group behaviour is difficult to achieve. And, it *is* about more than just group size (see Udéhn, 1993). Seasoned politicians and bureaucrats, with their knowledge of the "system" and resources, are often frustrated with the process. For interest groups and average citizens, trying to change public policy can be an even more difficult and daunting task. Knowledge of the policy process including when, where and which meetings to attend to voice one's concerns is essential. This, however, conceals the many ingredients needed to successfully address public policy (e.g. Pross, 1992; Burt, 1990; Gamson 1975; McCarthy & Zald, 1977; Tilly, 1978) which include the following:

• <u>Adequate financial and other resources</u>. Voicing one's concerns often means becoming enlightened on the subject in question and developing proposals to address deficiencies. Inevitably, this requires a considerable amount of time researching, contacting and meeting with people and travelling to various meetings; all of which have high transaction costs. The need for monetary resources is even more acute if one needs to hire a specialist such as a hydrogeologist to examine and assess a problem.

• Organizational capacity to address the problem. Most problems are sufficiently complex to be beyond the ability of one person to "do" everything. This means having more than one person in order to address the various parts of the problem. For instance, some people could principally focus on researching the problem, others could develop courses of action and yet others could focus on implementing their plans of action and communicate with relevant authorities and other groups and organizations.

• Leadership. Effective leadership is needed not only to co-ordinate and manage the above internal activities of an interest group, but also to push their agenda forward within the government apparatus which often includes collaboration and co-operation with other interest groups, individuals and government departments in the process.

• Institutionalization in the policy process. An interest group or organization needs to become recognized as an or *the* interest group or organization to be consulted when changes are contemplated in a particular policy. This includes groups working with a government organization, on its own as a policy maker or in a coalition with others. It is also usually a by-product of the longevity and relevance of an organization predicated on adequate financial resources, organizational capacity and leadership, among other things.

The above points emphasize the significance of transaction costs and, more generally, the effects of institutional arrangements on individuals and their ability to affect the policy change process. To this end, and grounded in the public choice tradition, both transaction cost analysis and the Institutional Analysis and Development framework have emerged. Transaction cost analysis focuses on the transaction as the unit of analysis. As Coase (1937) long ago explained, firms are alternative governance structures in addition to having a production function. They continue to expand until the cost of an additional transaction is equal to or greater than facilitating that transaction through exchange via the market system. Implicit in the analysis is the desire to minimize transaction costs.

Transaction cost analysis has greatly expanded in recent years (e.g. Williamson, 2000; Rindfleish & Heide, 1997; Rao, 2003). Of note is Williamson's (1975, 1985) disaggregation of transaction costs[5] into their attributes (uncertainty, bounded rationality, opportunism) which is related to different governance structures and their associated organizational costs and competencies to reveal the best (cost-based) course of action (e.g. minimal costs). Markets, for instance, are the preferred option for low asset specificity transactions whether they occur frequently or not. At the other extreme, heirarchies (within the firm) are the preferred governance structure for transactions that involve high asset specificity. Between these two poles, Williamson proposes a bilateral governance structure (e.g. shared ownership of transaction specific assets) for frequent and substantial transactions and trilateral

[5]Williamson (1985) considers both ex ante transaction costs, the costs associated with crafting an agreement, and ex poste transaction costs, the costs of monitoring and conflict mediation.

governace structures (e.g. third party arbitration) for infrequent and less substantive transactions.

Transaction cost analysis with its endogenization of property rights coupled with the core concepts of neoclassical economics (collectively termed the "new institutional economics") has wide appeal. Note the application of Williamson's insights in many fields including that of privatization, marketing, organizations theory and collective action problems (e.g. Rothenberger & Truffer, 2005; Rindfleish & Heide, 1997; Ting, 2002; Lubell, Schneider, Scholz & Mete, 2002). Wide appeal does not entail consensus and, as many have stated (e.g. Peters, 1999), transaction cost analysis has little to say for how rules emerge and change over time. de Jong and Nooteboom (2000), for instance, have termed the approach as one of comparative statics; it is based on one shot events (non-dynamic), is ahistorical and not path dependent (p. 13). As such, it is unable to explain long-term supply relationships. In short, opportunism exists in transactions and safeguards are needed for its curtailment, yet such safeguards often depend on the nature of the relationship, specifically, its past and future possibilities for its duration which entails committment and trust (intentional[6]) both of which directly relate to the repetitiveness of the interactions (pp. 11-24).

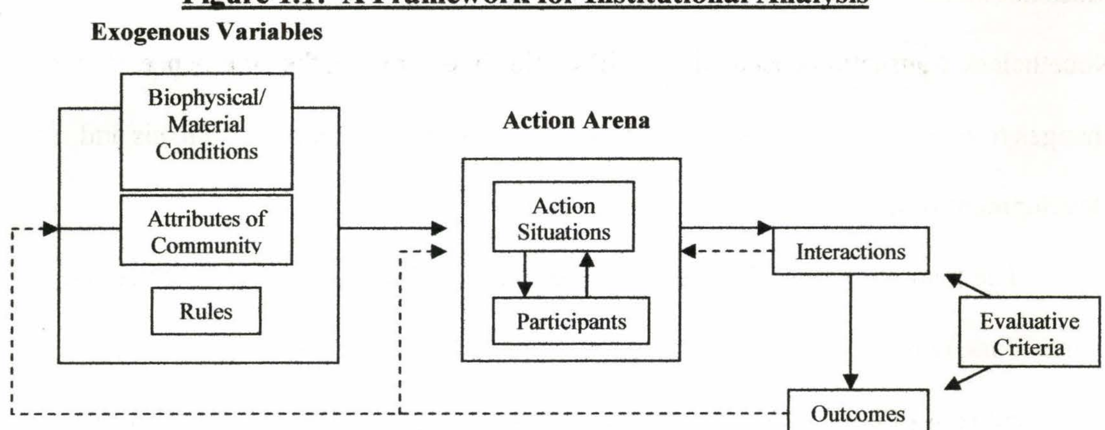
Indeed, the repetitiveness of the interactions matters. Note that prior committments and changes in bargaining power can limit a firm's ability to change its governance arrangements (Argyres & Liebeskind, 1999). Trust is also more likely to

[6]Intentional trust refers to expectation an exchange partner "will do no harm or neglect of that possibility" (Nooteboom, 1996, as cited in de Jong & Nooteboom, 2000, 21).

"deepen" in repetitive interactions (Gulati, 1995), as well as, decrease transaction costs and increase information sharing (Dyer & Chu, 2003). This can lessen uncertainty and opportunistic behaviour. Others, such as Marshall (2005) go so far as to dismiss transaction cost analysis due to its static nature since it prohibits adaptive and collaborative environmental management. This is due to the theory's concept of farsightedness which is the ability to anticipate future problems and build into current institutions mechanisms for adaptation. Thus, Marshall argues that farsightedness allows individuals to "*perfectly anticipate*, and plan contingencies for, all the consequences" and "ensures events *can be predicted perfectly*" and proceeds to detail a political economy approach to comparative analysis of complex institutional choices (p. 70; emphasis added). In the rush to detail, and as provocative as his preferred approach is, his dismissal of transaction cost analysis is overstated. As Rindfleisch and Heide (1997) remind us, Williamson's concept of farsightedness "does not include the ability to "specify complete decision trees" (p. 48)." Nonetheless, transaction cost analysis' difficulties in examining the emergence of and changes to rules is noted, a problem not unfamiliar to the Institutional Analysis and Development framework.

The Institutional Analysis and Development (IAD) framework originated out of the Workshop in Political Theory and Policy Analysis at Indiana University in the 1980s and is most closely associated with the work of Elinor Ostrom (e.g. Ostrom, 1990, 2005) with significant refinements from many scholars including Sproule-Jones (1989, 1993, 2002), Blomquist (1992), and Schlager (1994). Similar to transaction cost theory above, the centrality of individuals is assured in the quest to determine the institutional effects on individual preferences and related outcomes. At the heart of the framework is an "action arena" where individuals interact in particular situations as shown in Figure 1.1. Note that it is here, in the action arena, where transaction costs are subsumed (Ostrom 1990, pp. 192-206, 2005, pp. 32-35). Action arenas are, in turn, impacted by exogenous variables which include the biophysical and material conditions (e.g. characteristics of goods such as subtractability and excludability), attributes of the community (e.g. acceptable norms of behaviour, preference homogeneity), and rules and their configurations which structure relationships (e.g. entry/exit, information). In short, the exogenous variables structure the nature of action situations which produce interactions. In turn, the interactions either feed back directly into action situations or produce outcomes which feed back into action situations and the community attributes.

Figure 1.1: A Framework for Institutional Analysis*



*Adapted from Ostrom, Gardner & Walker, 1994, p. 37.

The IAD framework is also notable for a second key characteristic: multiple tiers of decision-making. It explicitly recognizes the fact that multiple action arenas are "in play" simultaneously (and similar to new institutional economics's four levels of social analysis), with each affecting different sets of rules. Operational level rules (e.g. appropriation) are impacted by collective choice rules (rules used to make operational rules) which are, in turn, impacted by constitutional choice rules (e.g. rules used to determine who is eligible to detemine collective choice rules) (Ostrom, 1990, pp. 52-53). These multiple tiers are termed "rule stacks" by Sproule-Jones (2002, pp. 69-70) and are further disaggregated in the next chapter.

Care should be taken to note the fact the IAD framework is a *framework* and not a theory. As Ostrom (1999) explains, frameworks "help identify the elements and relationships among these elements that one needs for institutional analysis. Frameworks organize diagnostic and prescriptive inquiry" (pp. 40-41). In contrast, theories, she continues, "enable the analyst to specify which elements of the framework are particularly relevant to certain kinds of questions and to make general working assumptions about these elements" (p. 41). It was this IAD framework that was used to develop a *theory* of common pool resources (Ostrom, 1990). In particular, it shows how formal organization to address collective action problems can be acheived endogenously. To this end, eight institutional design principles have been elaborated with the eighth principle being the need for nested institutional arrangements to address large common pool resource problems.

The IAD framework, due to its subsumption of transaction costs, offers more robust explanations of policy change, however, even it fails to provide complete explanations. Admittedly, no framework or theory is all encompassing. For instance, note that the IAD framework and CPR theory has difficulty in explaining rule emergence and evolution, the same problem that plagues transaction cost analysis. However, unlike the latter, CPR theorists have recently elaborated a method for rule evolution (Crawford & Ostrom, 1995; Ostrom, 2005). Yet, this work is largely done in static contexts, that is, in one shot interactions with stable institutional structures and preferences. A more dynamic examination is required, one that examines repeated interactions to more fully capture the effects of trust and committment as outlined by transaction cost analysts. At the same time, this examination needs to be placed in the larger context of how rule changes impact changes in the type, frequency and magnitude of policy change. It is these ingredients that are necessary (though insufficient) in devising a strategy of policy change in common pool resources such as groundwater. Moreover, this task needs to be placed within the variable that affects most large scale complex CPRs—uncertainty, a topic which is examined in the next section.

To summarize, we need to explicate how institutional structures which shape and mediate individual actions affect the policy change process so as to devise a strategy for addressing groundwater policy change, that is, how we move towards greater sustainability of the groundwater resource. It was shown that while CPR theory, rooted in the IAD framework (public choice approach) integrates these elements, it nonetheless needs to be extended to better account for the repetitive nature of real life situations so as to capture the effects of commitment and trust. Furthermore, this examination needs to be situated in the larger context of how rule changes impact changes in the type, frequency and magnitude of policy change under varying conditions of uncertainty.

1.2 Uncertainty and Groundwater

As complex as knowledge of the policy process and group dynamics is, conditions of uncertainty can further complicate matters. The lack of knowledge about aquifers and groundwater movement can seriously impede management efforts. Similarly, reducing that uncertainty through increased scientific knowledge about groundwater's natural physical characteristics aids its management but unless that knowledge is coupled with similar social science knowledge in regards to human systems such as institutions and rules, groundwater's management may yet prove elusive. Note here that uncertainty refers to both the natural physical groundwater dynamics and to social systems of human interaction (e.g. Wilson, 2002; Gunderson, 2003; Ostrom, 2005). Furthermore, a distinction is made between risk and uncertainty, following Knight (1921), where risk exists when the probabilities of future actions can be measured and therefore planned action (e.g. insurance) can be taken. For instance, groundwater contamination due to fuel spills can be measured with relative probabilities given traffic flows and densities, fuel tank designs and road construction techniques, and appropriate plans can be taken to reduce or even mitigate the risks (e.g. alternative fuel tank designs). Uncertainty, on the other hand, refers to the inability to calculate the probabilities of particular actions that lead to specific outcomes such as the effect of large water withdrawals on water supply. What is the probability, for instance, that withdrawing two million litres of water per day near Guelph, Ontario affects the City of Waterloo's municipal wells thirty-five kilometres away? The answer is: We do not know.

Our understanding of groundwater dynamics is rife with uncertainty. Uncertainty exists, for instance, in relation to groundwater flow. We know that groundwater is part of a complex and continuous interconnected system that is termed the hydrological cycle where water is constantly in motion above, on or below the earth's surface. However, the measurement of water movement, including groundwater, through the associated transpiration, sublimation and evaporation processes, all part of the hydrologic cycle, is not easily done (OMNR, 1984).

Further complications arise in relation to water infiltration and percolation rates. These processes are affected by the permeability of surface (e.g. soil vs. pavement) and sub-surface materials (e.g. soil types), as well as, the porosity of the sub-surface geological materials. Loose materials, for example, such as gravels and sands, are typically much more porous than sedimentary rocks though not all pores or voids are active in groundwater flow (Freeze & Cherry, 1979; Schwartz & Zhang, 2003). These factors alone introduce much uncertainty and have major implications for groundwater withdrawal especially in regards to ease of withdrawal and pumping rates without even considering the management of this resource.

Uncertainty is further increased given the current knowledge of groundwater flow characteristics. Note that our knowledge is limited to measuring only certain components of groundwater flow (laminar flow) and does not account for larger flow rates (turbulent flow) which are nearly impossible to measure (Freeze & Cherry, 1979; Driscoll, 1986).[7] Groundwater flow is also dependent on the ease with which it moves through different subsoil mediums (hydraulic conductivity) which vary in thickness, and the type of subsoil medium which affects its direction (Freeze & Cherry, 1979; Schwartz & Zhang, 2003). The measurement of any one of these factors is problematic yet combining them in a long chain of factors greatly diminishes any capacity for predictability and greatly increases uncertainty.

Other factors affect uncertainty levels surrounding groundwater. These include difficulties associated in the determination of aquifer sizes, aquifer types, storage capacities, recharge and discharge rates, as well as, connections between aquifers and with lakes, rivers and streams. For instance, Schneider, Negley and Wafer (2005) found that connections between aquifers and Oneida Lake in New York occurred up to one hundred metres into the lakebed while extending out up to ten kilometres inland on the lake's west side. Further note that these types of connections can be "disrupted" due to impervious mud and clay layers that can form on lake bottoms, leave much smaller recharge and discharge areas for the lake-groundwater interface and, as a result, may exaggerate "droughty" periods (Driscoll, 1986).

Karstic aquifers (e.g. limestone) are also problematic. They often have solutionally enhanced openings, due to slightly acidic moving groundwater, which can range from small finger like openings to large "caverns...tens of meters wide and hundreds of meters in length" (Schwartz & Zhang, 2003). The importance of karstic

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[7]Flow is termed laminar when water flows slowly through the ground in ribbon-like patterns through pore openings. Turbulent where large quantities of water move through constricted openings at a fast rate of speed such as near wells or in streams and rivers. Note that individual water particles follow irregular paths through the voids (see Driscoll, 1986).

aquifers is readily seen in the fact that they can facilitate turbulent flow which means that groundwater or contaminants can move through the aquifer much quicker than in regular porous mediums. In fact, Worthington, Smart and Ruland (2002) demonstrated in the post-Walkerton, Ontario groundwater tragedy studies how the Walkerton area is situated above a karst aquifer and that the studies that delineated the possible range from which contamination could have come from grossly underestimated groundwater movement because calculations were not based on the existence of a karst aquifer. Due to a karstic landscape and its faster groundwater travel times, a spring, identified in the Walkerton study, rejected as a possible contaminant source due to too long a travel time, may, in fact, have been a source of contamination. The study's findings refuted the travel time of other studies of thirty days and demonstrated a travel time of as short as 1.1 days due to the karstic terrain. This means that contamination may have come from much further abroad (the spring, in this case, or elsewhere), and not necessarily "from the one farm which [was] implicated as the likely source of most of the bacteria" in Justice O'Connor's Report because under karstic terrain, movement can range from hundreds to thousands of meters per day (Worthington, Smart & Ruland, 2002; O'Connor, 2002). This finding has significant implications for groundwater source protection plans and contaminant studies, as well as, the design of hydrological studies which need to be "based on the assumption that karst features may be present and would include tracer testing as an important part of the hydrological investigations" (Worthington, Smart & Ruland, 2002; also, see NYSDOH, 2000 for details of a similar incident that occurred at the Washington County Fairgrounds in New York in 1999).

Contaminants also greatly increase uncertainty related to groundwater. Contamination sources are plentiful and include threats from underground storage tanks and pipelines (and chemicals in the petroleum compounds such as MTBE; Jacobs, Guertin & Herron, 2001), septic tanks (Gillis, 2001; Nantel, 1995), pesticides (Canter, Knox & Fairchild, 1987), nitrates (Celico, Musilli & Naclerio, 2004; Environment Canada, 2001) and landfill sites (Environment Canada, 2001). Uncertainty increases due to the fact each contaminant (and their component parts) binds differently to geological materials and each possesses unique plumes that migrate and spread at different speeds through aquifers (e.g. float, mix, sink; see Palmer, 2003). Also note that contaminant spread is affected by groundwater flow previously discussed and one quickly begins to see that groundwater remediation is a difficult endeavour complicated by the fact that one cannot see the actual resources or contaminant plume, which all contribute to high uncertainty levels beyond traditional levels of risk in policy determination and implementation.

1.3 Importance of Groundwater

High uncertainty levels related to groundwater, though frustrating, should not negate efforts to effectively manage the resource. On the contrary, groundwater is far too valuable a resource to have minimal oversight. Note that groundwater is a key source of drinking water due to its abundance and quality. For instance, about forty-six per cent of Americans (USGS, 2004) and thirty-one per cent of Canadians

(Rutherford, 2004) rely on groundwater as their drinking water supply. These figures, however, mask regional disparities. Approximately twenty-nine per cent of the population of Ontario, one third of New York's population and eighty-seven per cent of Nebraska's population rely on groundwater as their source of drinking water (Rutherford, 2004; NYSDEC, 1990; Glennon, 2002, p. 31). These statistics shadow the fact that the rural populations of each jurisdiction rely almost exclusively on groundwater for their needs when compared to their urban counterparts (e.g. Rutherford, 2004) and note that these groundwater reliance figures are conservative given they do not include other uses of groundwater (e.g. manufacturing).

The figures also conceal the relative abundance of groundwater locally, regionally and globally. Of the total water available globally, only 2.75 per cent is fresh water with the rest being saline water in the oceans. Of this 2.75 per cent, only 0.68 per cent is groundwater found to a depth of four kilometres (Hiscock, 2005). Regionally, Canada possesses twenty per cent of the world's fresh water though the majority of this is tied up in glaciers (Boyd, 2003). It is also not clear what volume of water is contained in Canada's aquifers (Rivera, 2004). Note that twenty per cent of the world's fresh surface water is found in the Great Lakes which represents ninety-five per cent of the U.S.'s and eighty per cent of New York's fresh surface water supply (Legislative Commission, 2004). An additional amount of twenty-five per cent to the above figures is contained as groundwater in Great Lakes Basin aquifers and note that two thirds of the base flow in streams flowing into the Great Lakes is supplied by groundwater (Grannemann, Hunt, Nicholas, Reilly, & Winter, 2000;

Coon & Sheets, 2006).

Groundwater is also of superior quality. It has been long recognized, for instance, that naturally occurring groundwater has "few suspended solids, small concentrations of bacteria and viruses, and often only minimal concentrations of dissolved mineral salts" when compared to surface water supplies, making it an excellent source of drinking water (Schwartz & Zhang, 2003). Note that these superior qualities mean that less treatment is required for public consumption. The economic, environmental and health benefits of groundwater make its effective management and regulation paramount. Effective management, however, is dependent on many factors including accurate resource quantification, its usage, management options and basic hydrological principles.

1.4 Groundwater's Unique Characteristics

Groundwater management also needs to take into consideration its unique characteristics. Groundwater is an example of a common pool resource (CPR). CPRs are valued natural or man-made resources available to more than one person, subject to degradation due to overuse and are noted for their excludability and subtractability issues (Dietz, Dolšak, Ostrom, & Stern, 2002). It is very difficult to exclude one from taking groundwater given the resource is considered to be mobile (recall underground flows). This is further complicated by the fact that consumption and/or withdrawals can be unpredictable, that is, they can vary from season to season and may be weather and/or economically dependent (e.g. agricultural activities) and, aquifer recharge rates are difficult to establish. Subtractability issues arise in that what one person consumes subtracts from what is available to others. Simply put, what I consume subtracts from what my neighbours have available to draw from, and if I increase my consumption, my neighbours have proportionately less groundwater in the aquifer for their use.

Excludability and subtractability attributes of CPRs lead to two problems which hinder the resource's successful management. First, excludability issues lead to the problem of free riding. Free riding occurs when it is not feasible to exclude a user or make them contribute to the costs of developing or maintaining the resource. As Dietz, Dolšak, Ostrom and Stern (2002) detail, free riding occurs when one can make use of the resource while taking only one's costs and benefits into consideration. Free riding can be solved by the acceptance or adoption of rules such as position, boundary, and authority rules[8] that take social costs into consideration with the rules' success dependent on their legitimacy, enforcement and congruence with the resource itself (Ostrom, 1999). Second, the groundwater resource, due to its subtractability, can be overused leading to its depletion or degradation. Subtractability issues can be addressed through various ways including limits on pumping activity. Once again, the rules' success is dependent on accurate information about the resource, its legitimacy and enforcement, among other things.

Other CPR attributes can affect their successful management. These include

[8]An example in regards to groundwater withdrawals could involve two positions (permit holders, adjudicators) with associated boundary rules (e.g. permit holders need to be of legal age, own said property; adjudicators to have min. ten years natural resource adjudication experience...) each with specific authority (e.g. permit holders can use as much water as is reasonable but must not sell the water to others; adjudicators can modify permits in cases where an infraction has occurred).

technological factors, the resource's interdependence with other natural systems, its renewability and scale. In particular, the resource's interdependence and scale issues are of prime importance for groundwater management. Natural systems are, after all, interdependent on different scales and times depending on their functional relationships to each other (Sproule-Jones, 2002). This can be easily seen in groundwater management connections that exist between aquifers and streams, rivers, lakes and wetlands acting as recharge and discharge sites, as well as, the effect of vegetation on artificial recharge rates previously discussed. Groundwater systems are not related in a linear fashion but must be thought of as dense complex interconnected webs. Also important here are scale issues suggesting that the larger the scale of the resource, the more complex the institutional arrangements will need to be to effectively manage the resource.

1.5 Addressing Groundwater Policy Change

The question arises: Do high levels of uncertainty and complexity combined with groundwater's unique characteristics hinder its effective management? Gordon (1954) certainly thought so when he elaborated his economic theory of a common property resource in relation to the fishery. In an often quoted passage, he states,

> [t]here appears, then, to be some truth in the conservative dictum that everybody's property is nobody's property. Wealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another...the fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today (p. 135).

It was Hardin (1968), however, that popularized this concept through his example of an overgrazed meadow and labeled it the "tragedy of the commons". A "tragedy of the commons" is but one result of many and dependent on a host of factors including open access to the resource and the lack of communication and coordination between parties (Hess & Ostrom, 2004). At the heart of this dilemma is how to make individuals voluntarily contribute to a resource's maintenance when they lack direct ownership. As Ostrom (1990) has detailed, various proposals have been elaborated including direct government control and management of the resource in question. Similar arguments exist in favour of a resource's privatization where individuals truly value the resource since they bear the full economic costs of mismanagement. The point is that these solutions are externally driven and imposed on individuals. Furthermore, government management is not necessarily better and markets can and do fail (Alder & Ward, 2001; Tietenberg, 2002; Rose, 2002). Alternatively, Ostrom shows how collective action that incorporates both private and public entities, that is, driven from the bottom up, where governance entities can communicate and coordinate their actions in repetitive action situations can lead to the sustainable management of common pool resources as was the case with Swiss alpine meadows and Spanish and Philippine irrigation systems (e.g. Ostrom, 1990, 2005).

This suggests that groundwater *can* be effectively managed. It also suggests that multiple governance units will be involved in the process due to the different functions required in policy implementation and change. These include resource management and enforcement activities which are often dispersed between municipal, provincial/state and federal levels of government.[9] Land use planning, for instance, is largely controlled at the municipal level in both Canada and the U.S., yet the issuance of PTTWs in Ontario is done at the provincial level and water withdrawal registration in New York is done at the state level. This can often lead to conflicts and, in the end, accountability is often diluted since people do not know who to hold responsible when their water well goes dry: Do they blame the local council or the provincial or state government?

At the same time, media and the public alike cry out for the different governments to work together, that is, co-operatively, and in ways that complement each other's efforts to minimize overlap, duplication and to ensure the public interest is protected whether that is the environment or public health. It is, however, much harder to identify how the different layers of government are to work together (see Ostrom, 1990). What role and functions can each government layer assume? How should the various government layers report to each other and the public? Who is to be held accountable and for what are they to be held accountable? Combined, the above conditions can frustrate efforts by those wanting to affect public policy change.

Moreover, how do individuals and groups alike structure how they address groundwater policy change? More specifically, what elements should they try to get changed? To improve groundwater quantity management, for instance, should efforts be directed at raising water withdrawal thresholds required for permits or registration

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[9]Consideration should also be given to the oscillating interest in water governance by state actors (de Loë & Kreutzwiser, 2007), as well as, the diversity of related goals (Muldoon & McClenaghan, 2007).

(option 1), instituting a water withdrawal permit or registration program in the first place (option 2), and/or taxing metered water withdrawal consumption (option 3)?

The above choices reflect differences in the type, frequency and magnitude of groundwater policy change. For example, raising water withdrawal limits (option 1) can potentially be done faster than instituting a brand new water withdrawal program. It is presumed that less work will be required to achieve the change in policy since a variation of the policy already exists. However, this may not be the case if the attempt to raise the water withdrawal limit is considered large or significant and/or if the limit has been recently raised. Similarly, the choice to institute a water withdrawal program in the first place (option 2) would necessarily take longer since much study and consultation is required in relation to a whole set of issues. In other words, it is not just about addressing the withdrawal limit but rather the need exists to also look at other factors such as how the limits will be enforced, who will pay for such enforcement, as well as, overall program management. The change in policy required is considered significant and large in magnitude in relation to simply raising withdrawal limits. Finally, the choice between the institution of a water withdrawal permit or registration program (option 2) or metering and taxing groundwater consumption (option 3) reflects a choice in the type of policy instrument used to address the problem. It also necessitates a change in the setting of the policy instrument since one also has to decide at what level to set withdrawal limits or at what level to tax water withdrawals and potentially increases the time required to change groundwater policy.

Which of the above options should one choose? This is important because time and funds are limited. Often, since politicians are elected for a four or five year time frame, they may not look beyond that time horizon (Glennon, 2002, p. 213). Why would they since they may not be around to reap the personal benefits of such decisions? Knowing this, what can a bureaucrat, an individual or interest group realistically hope to achieve within that time frame to at least improve conditions related to their issue of concern? This is even more important in light of the fact such stakeholders may have different policy goals and preferences thus potentially affecting their strategic choices, not to mention the various transaction costs involved. Should they accept an increased threshold for triggering a water withdrawal permit or registration that is lower than desired knowing that it may increase its chances of being implemented? Likewise, should they elect to institute a water withdrawal permit or registration program over the taxing of metered consumption accepting that the institution of taxes is often unpopular and vigorously opposed which may, in turn, dramatically increase the time required for such a change to occur?

These are not easy questions to answer. Further limitations occur in the fact that people often face limited financial resources, as well as, the previous transaction costs. As such, what can they *afford* to do given their financial (not to mention human) resources. Financial limitations are also not limited to those outside of government. For example, the Ontario Ministry of the Environment suffered significant cutbacks in the mid-1990s while New York experienced a similar situation at century's turn (McKenzie, 2002; S. Bates, 2002). In these situations, what can bureaucrats feasibly accomplish to improve the groundwater policy framework? Moreover, in view of the circumstances, what should those outside of government attempt to address?

Individuals, groups and governments rarely succeed on their own. People usually need to work together and the need for such overlapping governance arrangements operating at different levels, that is, nested institutional arrangements, is documented (Ostrom, 1990). However, the effects of nested institutional arrangements on the type, frequency and magnitude of policy change have not been addressed. In effect, we know what a "tragedy of the commons" looks like. Gordon (1954) and Hardin (1968) have provided us with vivid examples of such tragedies. We also know the institutional design principles that lead to the sustainable management of a common pool resource. Ostrom elaborated such principles in 1990 which she and others have worked to refine since then (e.g. Hess & Ostrom, 2003; Blomquist, Schlager & Heikkila, 2004; Ostrom, 2005). But, how do we get there? That is, how do we move from a "tragedy of the commons" to a sustainably managed resource? Moreover, how do we move between the two points on the tragedy-sustainability continuum when we are already somewhere between them, when the distance between the points is uncertain, as well as, the location of the "points"? This is what this thesis is about. It begins to unravel nested institutional arrangements.

1.6 Objective of Thesis

This dissertation has both theoretical and practical relevance. It begins to unravel the effects of nested institutional arrangements, required for successful common pool resource management, on public policy change under different conditions of uncertainty. Specifically, it examines their effects on the type, frequency and magnitude of groundwater policy change in situations of uncertainty. It does so to explicate how individual action which is shaped and mediated by institutional structures in repetitive interactions affects the policy change process so as to devise a strategy for addressing groundwater policy change, that is, how we move towards greater sustainability of the groundwater resource.

In order to achieve this goal, a framework is developed from the literature of what a nested institutional arrangement (NIA) is. In essence, NIAs are disaggregated into the number of vertical and horizontal governance units, the nature of the linkages (functional, strategic) among governance units, and into the complementarity of the linkages. These components are then used to examine changes in groundwater policy (water takings, well driller regulations, source water protection) in the Great Lakes Basin (Ontario, New York) and the Ogallala Aquifer[10] in the U.S. Midwest (Nebraska). This dimensional mapping reveals the relationship between the density, nature and complementarity of nested institutional arrangements and groundwater policy change, an issue CPR theory does not address. As such, this research further develops CPR theory in three ways:

- Develops a framework for what constitutes a nested institutional arrangement;
- Endogenizes and takes account of the repetitive nature of stakeholder

[10]The term Ogallala Aquifer is used instead of High Plains Aquifer. See s. 3.2 (e) for clarification.

interactions in the policy change process;

- Identifies the effects of nested institutional arrangements on the type (policy goals, instruments, instrument settings), frequency, and magnitude of policy change (degree of change);
- Explains the above variations in regards to groundwater policy changes under varying conditions of uncertainty.

Theoretical developments aside, the research is also of practical relevance. It describes the development and implementation of groundwater management policy in different institutional settings. The examination of groundwater management in a highly developed aquifer, such as the Ogallala and where uncertainty is low, may provide clues for the development and management of lesser developed systems, such as in the Great Lakes Basin. The research identifies cross-scale linkages and provides clues where effort can be directed in order to achieve different types of groundwater policy change. As such, the research is both descriptive and prescriptive in nature.

1.7 Layout of Thesis

The thesis is divided into eight chapters. Chapter 2 examines common pool resource theory and reveals a gap in the literature. That is, while CPR theory advocates the need for nested institutional arrangements, little is done to clearly define them and the effects of such arrangements on the type, frequency and magnitude of policy change are not addressed. Chapter 3 examines the methodological framework that forms the basis of this investigation and introduces our cases. Chapters 4, 5, and 6 present the data for each case, Ontario, New York and

Nebraska respectively. Each of these chapters begins with an overview of groundwater management for each jurisdiction, then methodically addresses the independent variables in relation to each of the dependent variables. Chapter 7 analyzes and discusses the data from the previous chapters in terms of the type, frequency and magnitude of groundwater policy change. The conclusion in Chapter 8 summarizes the study and examines some of the implications that arise as a result.

1.8 Summary

This introductory chapter has set the agenda for the thesis. Specifically, in the desire to change public policy, one must strategize what elements to address. Any such consideration needs to take account of time and efforts (transaction costs), as well as, the financial and human resource constraints involved. In relation to groundwater, it also needs to endogenize uncertainty in the process. Groundwater's importance and unique characteristics have been elaborated to demonstrate the elusiveness of its management. Though frustrating, groundwater can be successfully managed and need not devolve into a "tragedy of the commons". On the contrary, institutional design principles have been elaborated to guide the successful management of common pool resources such as groundwater and include the need for nested institutional arrangements. As such, we know the two poles on the tragedy-sustainability continuum yet need to develop clues for how to move between the two. This includes knowledge of the effects of nested institutional arrangements on the type, frequency and magnitude of groundwater policy change; information which can be used in the formulation of a strategy to address groundwater policy change.

Chapter Two

Common Pool Resource Theory and Policy Change

"searching for clues"

2.1 Introduction

The first chapter highlighted the importance of nested institutional arrangements (NIAs) in the management of common pool resources (CPRs). Moreover, it argued for the need to know the effects of NIAs on the type, frequency and magnitude of groundwater policy change. Simply put, if we know CPRs can be sustainably managed through various institutional principles including NIAs, and, we want to move towards groundwater's sustainable management, then the question becomes: How do we get there? More importantly, how do we get there given different levels of uncertainty, different levels of resources (e.g. financial, human) and different time periods? How can different NIA configurations be modified in different CPR situations? In short: How do we devise a strategy for action? Knowledge of the effects of NIAs on the types, frequency and magnitude of groundwater policy change would be beneficial since it would provide us with clues on how to structure a strategy for action (e.g. What types of policies change the fastest given set NIAs?). In short, a strategy for action is required and this strategy is built from the ground up, that is, clues for such a strategy may be found in CPR theory where NIAs are of prime importance yet their effects on the type, frequency and magnitude of policy change is left largely undeveloped.

This chapter reviews the literature on common pool resources and how two schools of thought have emerged in response to Hardin's "tragedy of the commons"; privatization of the commons through the assignment of property rights and binding contracts. However, neither school of thought examines the relationship between NIAs and policy change, a concept central to both.

2.2 The Nature of Common Pool Resources

There is wide discussion in the literature over the two major characteristics of CPRs—excludability and subtractability. In terms of groundwater policy, excluding people from pumping groundwater is a costly endeavour, and what one person pumps subtracts from what is available for others to use.[11] Excludability and subtractability lead to two problems which hinder the successful management of CPRs. First, difficulties with excludability lead to the problem of free riding which occurs when it is not feasible to exclude or make a non-contributing user of a resource contribute to the costs of developing or maintaining the resource. Second, groundwater, due to its inherent subtractability, can be overused leading to its depletion or degradation.

Hardin (1968) has argued that excludability and subtractability dimensions of

[11]It is noted that CPRs have other attributes such as quantification problems that can affect their successful management yet the focus here is on the two defining attributes. For an overview of the others see, for example, Sproule-Jones, 2002, p. 59-60.

CPRs lead to a "tragedy of the commons". Using the example of a pasture where all people have equal access, he argued that people will add more animals to graze on the pasture since they receive the full benefit for each additional animal, yet only pay a part of the costs resulting from overgrazing. The result is that more animals are added leading to the pasture being overgrazed to the point of failure. This result is, however, but one option which is dependent on a host of factors including the lack of communication and coordination between CPR users, the lack of binding agreements between the parties involved, and the fact that the parties have incomplete information with full access to the resource (Hess & Ostrom, 2004).

Scharpf (1997), for instance, has modeled Hardin's outcome as a prisoner's dilemma game using game theory. Moreover, Scharpf has shown how, if binding commitments, communication and negotiation are possible, better outcomes are possible through cooperation than from self-interested unilateral action. This can be seen in the "battle of the sexes" game where the game is one of coordination with conflict over distribution. In this case, both parties are better off regardless if one or the other defects. In addition, the game of "chicken" might be a plausible result whereby parties cooperate to prevent a preemptive move by their counterpart. However, in any of these successful outcomes, much depends on active and effective enforcement levels (Loáiciga, 2004).

Numerous solutions to CPR problems have been proposed including arguments for privatization through the assignment of property rights to the resource and binding contracts which are examined in the next two sections within the context of NIAs and policy change.

2.3 The "Tragedy of the Commons" and Property Rights

The assignment of property rights has been advocated as a solution to the "tragedy of the commons" (for a brief review, see Ostrom, 1990, pp. 12-13). In fact, it is even inherent in Gordon's and Hardin's work in that only if the commons were privately owned then they would be of value to someone since the private owner would have incentive to ensure its proper care. It may be easy to argue for the privatization of the commons but quite another to actually achieve it since changes to property rights (e.g. creation) can be highly conflictual often creating "winners" and "losers" due to their multifaceted nature, as well as, the underlying legal regime of water rights.

(a) Components of Property Rights

Property rights are multifaceted. They include rights to access, withdrawal, management, exclusion and alienation (Schlager & Ostrom, 1992; Sproule-Jones, 2002). The right to withdrawal, for instance, refers to who has the right to appropriate groundwater, but note that this right may be limited given rights of access (in relation to being able to enter private property and drill a water well). Complexity increases when, for example, the right to manage the groundwater resource is posited in the broader community among multiple interests. Such is the case in relation to well construction where environmental departments, health departments and interest groups (e.g. well driller associations) jointly administer related programs. Similarly, exclusion (e.g. who decides who has access rights) and alienation (right to sell/lease exclusion and management rights) rights affect both access and withdrawal rights.

Three points are important here. First, private property rights are composed of several components which can be grouped into many different "bundles of rights". Second, each of these bundles is necessarily associated with different legal positions. For example, a property owner typically possesses all of the components yet someone authorized to use groundwater may only have access and withdrawal rights. Furthermore, legal positions are affected by different levels of stakeholder adaptability which necessarily affects groundwater's management (Sproule-Jones, 2002). Note that an individual, a corporate or non-corporate entity may all be authorized groundwater users (legal position) yet their organizational structure affects how quickly (and thoroughly) they can access and withdraw groundwater. Third, these property rights components, associated bundles and legal positions are spread over different governance levels as shown in Table 2.1. These multiple governance levels of rules are termed "rule stacks" (Sproule-Jones, 2002) and represent different scales of analyses. Operational choice rules largely affect day-to-day decisions of where, when and how to withdraw resource units (e.g. groundwater). Collective choice rules are rules about rules, that is, "they are rules about how operational rules are reviewed and changed" (Sproule-Jones, 2002). Lastly, and not shown in Table 2.1, are constitutional choice rules which determine who is eligible and what rules are to be used to make collective choice rules and operational choice rules (e.g. a country's constitution, underlying water rights (discussed below)). Constitutional choice rules are the slowest rules to change followed by collective choice rules and operational choice rules. This third point introduces issues of scale in relation to groundwater governance, that is, the need for nested institutional arrangements since property rights are dispersed over at least two or more governance layers and the potential exists to have many different yet overlapping governance units addressing each property right or bundles of property rights at the same level.

Table 2.1: Property Rights and Governance Levels

	Owner	Proprietor	Claimant	Authorized User
	Collective Choice Rules			
Management	✓	✓	✓	
Exclusion	✓	✓	✓	
Alienation	✓			
	Operational Choice Rules			
Access, Withdrawal	✓	✓	✓	✓

The question becomes: How does one create private property? This necessarily involves changing rules (e.g. boundary rules) and much work has been done by Ostrom and others in developing a method of mapping rule changes (e.g. Crawford & Ostrom, 1995; Ostrom, 2005). Note that rule changes typically involve multiple stakeholders dispersed over and between multiple governance layers. In other words, existing nested institutional arrangements are automatically part of the process and the need exists to investigate their effects on changes in policy, something the property rights thread in the CPR literature does not address.

The creation of or changes to private property is no easy task. Note that bundles of property rights, legal positions and existing nested institutional arrangements imply the existence of relationships between the various "actors" and/or governance units. Care must be taken to "get the relationships right" which involves issues of commitment (e.g. government, community), agency (e.g. deregulate, privatization) and decision-making (e.g. transaction costs) (Schlager, 2005). Getting the relationships right is, nonetheless, difficult to achieve since, at times, it is difficult to specify the bundles in question (Heller, 2000) which introduces the potential for conflict in the process. Note that changes in property rights is a redistribution process which often produces "winners" and "losers", that is, some people will gain additional rights (winners) while others will see their rights curtailed (losers). As such, compensation issues need to be considered in any property rights orientation (Schwidt & Globerman, 1996) which often introduces the courts into the process to adjudicate disputes with the courts able to both aid and/or frustrate the process (Sproule-Jones, 2008; Blomquist, 1992).

This discussion on the process of privatization of the commons ignores the fact that privatization is not always desirable. Simply put, it does not always work well in all cases (e.g. Tietenburg, 2002; Rose, 2002) and the transition to a form of a blended system of private and common property to effectively manage a resource is problematic and underscores the difficulty involved in changing property rights and in creating new forms of nested institutional arrangements (see Williamson, Brunckhorst & Kelly, 2003). Furthermore, private interests may simply give way to corporate greed (Johnston, 2006) and privatization ignores the implications of gender and power differences (Zwarteveen & Meinzen-Dick, 2001). As a result, conflict often escalates, the importance of the courts and other conflict resolution institutions may increase, while the web of institutional arrangements increases in complexity.

The discussion also ignores the factors leading to privatization such as groundwater dependency and ideology (e.g. Blomquist, 1991; Somma, 1997).

(b) Legal Regime of Water Rights

Attempts to create and/or change property rights need to take into consideration the underlying legal regime of water rights which form the basis for groundwater management in both the U.S. and Canada with some important variations. These water rights are briefly reviewed here to both deepen our understanding of property rights in relation to water issues and to illuminate the complexity involved in relation to nested institutional arrangements.

The basis for groundwater rights in the eastern U.S. (and a few central states), Central and Atlantic Canada remains in the English Common Law concept of riparian rights for surface water. Riparian rights are the legal rights landowners possess when their land abuts either a river or other body of surface water. They do not confer ownership rights but are rather rights to the "natural flow and quality of that water, subject to the same rights as [a] neighbour" (Sproule-Jones, 2002, p. 64). In essence, rights to the resource were vested in the land under which the resource flowed. Note, however, that English Common Law distinguished between underground streams and percolating waters. Underground streams are subject to the same riparian rights that apply to surface water and include the right to access, transfer and obstruct while the right to divert and pollute the waters is not included. How one was to determine at that time if an underground stream existed, given limited hydrological knowledge, is unknown. Percolating waters are governed by the rule of capture discussed below.

In much of the western U.S., western and northern Canada, water rights are vested in the resource itself and not attached to the land. Groundwater rights, in this case, follow the prior allocation system or rights are assigned on a first come, first served basis. In times of shortages, the most senior water license holder is allowed to meet his/her requirements in full even if it means extinguishing the resource for use by less senior water rights holders (Percy, 1988; DuMars & Minier, 2004).

Different legal regimes have evolved from these water rights doctrines. First, the rule of capture has developed in many areas including Texas. Under this regime, groundwater rights are attached to the property in question and the property owner has full access to percolating waters for as much water as they desire even if it harms a neighbour's groundwater rights. The limitation is that a landowner in the U.S. cannot "maliciously cause injury to another" with similar limitations in Canada, such as being unable to "[drive] a shaft from his property diagonally into a water deposit underlying his neighbour's land" (DuMars & Minier, 2004, pp. 42-43; LaForest, 1973, p. 415 respectively). No prioritization of groundwater rights exists under the rule of capture.

Second, the legal regime of reasonable use dictates that, just as riparian rights affect surface water, one can make use of any groundwater provided the usage does not negatively affect the use of groundwater by others. In short, the groundwater rights here are attached to the land and limitations differences exist between jurisdictions of whether one can divert water to other land areas not overlying the resource (Percy, 1988; DuMars & Minier, 2004).

Third, prior appropriation regimes have developed as previously discussed.

Fourth, a correlative rights doctrine has developed in many areas, such as parts of New Mexico. Groundwater rights are assigned based on the surface area of the land overlying the aquifer in question. A landowner has the right to use "his share in proportion to the overlying land owned by him" (DuMars & Minier, 2004, p. 43).

Groundwater rights also have implications for the establishment of new sources of drinking water for municipalities, as well as, for existing rights holders. For instance, the doctrine of reasonable use which bans water transfer off properties prohibits the use of groundwater as a municipal water supply (Richardson Jr., 2002). Municipalities would be transferring the resource off the property where it is pumped and selling it to householders for consumption. Furthermore, as Richardson Jr. (2002) argues, groundwater rights are inadequately incorporated into current legal systems. Groundwater rights holders must revert to the law of "nuisance", "takings" or "loss of lateral subjacent support" for redress, which do not directly deal with the problem at hand. In other words, suing one *directly* for affecting the groundwater under your property is rare, rather, one has to sue a third party if a neighbour's use of groundwater has interfered with the private use and quiet enjoyment of their land, such as draining the aquifer to the point where land subsidence occurs causing damage to one's home. Note that in this case, one is suing the neighbour under the law of nuisance (loss of quiet enjoyment and use of property) and not directly for the groundwater infraction (see Richardson Jr., 2002).

Difficulties with groundwater rights, especially in the expensive litigation that often ensues, have led others to argue for the management of groundwater under the public trust doctrine. Broadly stated, the *public trust doctrine* asserts that "certain common properties are reserved for the sovereign for the benefit of the public" (Swenson, 1999, p. 363). The public trust doctrine originally involved only navigable waters but has developed to include recreational activities and groundwater rights though the groundwater rights component is dependent on tributaries attached to a navigable lake or river. To date, states have been reluctant to use the public trust doctrine largely due to assertion of collective values over individual rights though additional pressures on groundwater may change this perspective, especially since under the public trust doctrine, states can reallocate groundwater rights to meet current conditions and pressures (Swenson, 1999). Arguments for the greater use of the public trust doctrine have also surfaced during the recent review of the Great Lakes Annex (Kidd, 2003).

These different groundwater rights doctrines are at the root of groundwater management policy. For instance, New Mexico has developed a system based on correlative rights for aquifers with very low recharge rates while they use the prior allocation system along with a conjunctive groundwater - surface water system for the other aquifers. Central and Eastern Canada, on the other hand, rely on the reasonable use doctrine based on riparian rights with a permit system. Texas relies exclusively on the rule of capture while western Canada and northern Canada largely use a system of prior allocation combined with a permit system. Much variation exists in groundwater management regimes with some people arguing that most differences exist more in function than in form. That is, little has changed to alter the "heart" of groundwater rights allocation even while threatened with water scarcity, while much has changed in the form of intervention restraining individual actions in order to enhance security in the groundwater rights (Emel & Brooks, 1988). It also highlights the limited adaptive characteristics of legal regimes when facing water scarcity issues.

Note that the property rights strand in the literature is preoccupied with defining the rights involved including legal positions and the process of establishing or changing the rights in question. The very complexity associated with property rights, at the very least, suggests the need for and/or assumes the existence of nested institutional arrangements yet the NIAs themselves are not investigated for their effects on policy change.

2.4 The "Tragedy of the Commons" and Binding Contracts

The second major strand in the CPR literature examines binding contracts as a possible solution to the "tragedy of the commons". This strand emphasizes (a) the identification and testing of institutional design principles; (b) the need for nested institutional arrangements; (c) the advantages and disadvantages of different institutional arrangements; and (d) collective choice configurations of rules for sustainable and unsustainable CPRs, each of which are examined below.

(a) The Identification and Testing of Institutional Design Principles

Ostrom (1990) has explored the multi-faceted nature of binding contracts[12] and has elucidated eight institutional design principles, shown in Table 2.2, for

[12] Situations where stakeholders directly devise a contract and ask a third party (e.g. court) to enforce it forcing the parties to monitor each other and report enforcement problems.

successful CPR management including the need for nested institutional arrangements (Design Principle Eight). However, it is not clear what is meant by nested institutional arrangements. Ostrom defines them as "appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities...organized in multiple layers of nested enterprises" (Ostrom, 1990, p. 90). She further states that both stakeholders and governance arrangements need to be organized in multiple "nested levels" without which "will produce an incomplete system that may not endure over the long term" (Ostrom, 1990, p. 102). However, it is neither stated how these nested institutional arrangements are to occur nor how they are to be joined, though it is inferred that different governance layers (e.g. levels of government) exist in successful CPR management situations with each layer possessing different amounts of institutional autonomy (See also Selin & VanDeveer, 2003). Reeve (2003) and Marshall (2007) begin to address this gap. Reeve details nested governance principles while Marshall elaborates on how the allocation of tasks can be assigned (when designing nested institutional arrangements) within the framework of subsidiarity. Neither, however, addresses the effects of nested institutional arrangements on the type, frequency and magnitude of policy change.

Table 2.2: Ostrom's Eight CPR Institutional Design Principles*

1.	Clearly defined boundaries.
2.	Congruence between appropriation and provision rules and local conditions.
3.	Collective choice arrangements.
4.	Monitoring.
5.	Graduated sanctions.
6.	Conflict resolution mechanisms.
7.	Minimal recognition of rights to organize.
8.	Nested enterprises.

*See Ostrom, 1990, pp. 90-102 for a full explanation of these principles.

Particular challenges exist with layering in relation to reconciling parallel institutions working within a similar governance structure. Different linkages may be required in these situations as Nilsson's (2001) examination of communal grasslands grazing management in Tanzania demonstrates in relation to devising nested institutional arrangements where a strong traditional governance framework (e.g. clan) exists in combination (parallel) with "official" bureaucratic practices. This difficulty is not restricted to divisions between traditional and official practices as Aggarwal (1998) has demonstrated difficulties in reconciling parallel "official" governance regimes in relation to international institutions, an example of a large scale CPR.

Moreover, vertical layering is but one part of nested institutional arrangements. The second part, and much less discussed in the CPR literature, is horizontal nesting. Horizontal nesting, as Brook (2004) notes, refers to linkages across space but at the same level of organization. For instance, individuals and institutions that carry out monitoring and enforcement activities, both formal and informal, can be linked through the sharing of information and/or infrastructure. Selin and VanDeveer (2003) characterize horizontal linkages as governance (overlapping, ideational) and actor linkages (member organizations, individuals). While the CPR literature is largely silent on these kinds of linkages, the literature in public administration is much more fruitful in this area. Of note, Sproule-Jones (1979) has documented substantial non-hierarchical coordination in the management of estuarine water quality in the Lower Fraser River where fifty-four organizations had 781 coordinative arrangements. These arrangements were typified as being irregular and non-planned, regular and non-planned or integrated and planned and encompassed such implementation arrangements as contracts, referrals, committees, working agreements and tacit agreements. Linkage types and associated management techniques are further developed in Sproule-Jones (2000), yet none of these studies, CPR or otherwise, address the effects different linkages have on policy change.

In fact, the CPR literature on nested institutional arrangements is mainly descriptive in nature concerned with identifying design principles for successful CPR management with an associated plethora of research that tests their robustness. As discussed above, Nilsson's (2001) investigation is one such example. In addition to pointing out the need to consider parallel institutions and related linkages, he found that Ostrom's institutional design principles are robust and explain much of why grasslands management in Tanzania is a failure.

Sarker and Itoh (2001) report similar findings. They examined the robustness of Ostrom's design principles in relation to a Japanese irrigation CPR, that is, in a developed economy, something Ostrom's study did not encompass. Again, the design principles, including nesting, are found to be "basic, well configured, and unique" though they modify design principle seven, the minimal recognition of rights to organize, in order to fully explain successful irrigation institutions.[13] Important as this study's findings may be, its findings are still limited given the homogeneity of Japan's population which closely mirrors the developing countries in Ostrom's study.

[13]Sarker & Itoh add "[the] non-interventionary investment in the physical capital entrusted to appropriators' organizations" to design principle seven (Sarker and Itoh, 2001, pp. 98-99).

In short, more work needs to be done in heterogeneous populations before a more definitive answer can be attained.

Similarly, Heikkila (2004) examines the need for clearly defined boundaries. Drawing on the local public economy theory, she finds that clearly defined boundaries, that is, when the physical boundaries of the resource and the institutions do not coincide, are not necessarily an impediment to interjurisdictional coordination. As such, she suggests that the CPR boundary requirement be reconceptualized so that institutional boundaries reflect local problems and not necessarily the resource. This is perhaps overarching in scope and a more nuanced version is required. Perhaps boundary conditions could be relaxed providing both sources and impacts are encompassed within the jurisdiction, a point Paehlke (2001) makes in his investigation of institutional scale issues. This would allow for the complexity of the resource to be more fully considered "in the equation" since the resource may not respond as quickly as desired to management techniques.

However, one must keep in mind that managing the resource is a function of integrating environmental and social systems. To this end, Brunckhorst, Coop and Reeve (2006) detail a method for delineating and matching social landscapes to environmental landscapes to capitalize on local civic involvement. In short, matching institutional and resource boundaries is pointless if a community's social patterns of interactions largely lie outside of those boundaries since, in such cases, a community is likely to take less interest in resource management issues (see also Brunckhorst & Coop, 1999; Brunckhorst & Reeve, 2006). As such, Heikkila's boundary reconceptualization suggestion is insightful though in a broader way than she imagined. Matching social and environmental landscapes means a new array of nested institutional arrangements yet how to achieve such arrangements is not clear nor are their effect on groundwater policy change.

(b) The Need for Nested Institutional Arrangements

Other studies, both in homogeneous and heterogeneous populations, are largely descriptive in nature and delineate the need for nested institutional arrangements (e.g. Latham, 2002). Similarly, Alder and Ward's (2001) examination of Australia's ecosystem-based oceans policy documents the rules in use and the lack of nested institutional arrangements hindering the policy's success. Both studies argue for the need to facilitate co-ordination and integration across and between different governance levels yet do not characterize the complexity of nested institutional arrangements nor do they relate the arrangements to policy change.

Others have documented the need for nested institutional arrangements that include all levels of governance, especially intermediary levels such as regional and national levels in the global-local continuum, to ensure local level efforts are not trampled (e.g. Brook, 2004; Bray, 2000; Rose, 2002) with some ignoring the need to include outside basin stakeholders in nested institutional arrangements (e.g. Blomquist, 1992). Studies, such as Tucker (1998), dismiss the need for nested institutional arrangements due to local peculiarities yet discuss such factors as market integration and national economic instability. At the very least, these factors suggest the need for nested institutional arrangements since it would be extremely difficult to imagine how a solitary institution could address all the factors to ensure successful CPR management. Again, none of these studies, while valuable in many ways, address the different configurations of nests and their effect on the type, frequency and magnitude of policy change.

(c) The Advantages and Disadvantages of Different Institutional Arrangements

Issues of nesting are issues of scale in relation to governance arrangements and a body of literature has developed examining these issues. Initial research in this area has focused on deciphering the appropriate level of governance arrangements for a problem at hand. Upper tier governance arrangements are preferable because they include economies of scale (Harrison, 2002), may possess superior technical expertise (Paehlke, 2001), are less susceptible to external shifts in product demand which can deplete a resource (Rose, 2002; Paehlke, 2001), may better ensure consistency of standards across a region (Harrison, 2002; Paehlke, 2001), and may possess superior legislative powers to address problems (Fletcher, 2003).

On the other hand, proponents of lower tier governance arrangements argue that these arguments are overvalued. They stress that local arrangements are in a better position to understand local problems and devise effective and innovative solutions which their diversity fosters (Harrison, 2002), can always contract out technical expertise (Sancton, 2000), can better address complex common pool resource issues and adapt to environmental changes due to their vested interest in the local area and more tightly connected social structure (Duinker, Matakala & Zhang, 1991), and can better promote democratic accountability since they are "closer to the people" (Buck, 1989).

These competing lines of argument are both helpful and of little use. On the one hand, they delineate some of the positive and negative characteristics of governance arrangements at various scales. However, they can also be of little use since they do not address how different levels of management can cooperate and develop nested institutional arrangements that capitalize on the advantages each offer while minimizing their negative effects. Even Paehlke's (2001) assertion that governance should occur at jurisdictions large enough to encompass both sources and impacts is of limited use since it does not detail governance arrangements. It does though suggest nested institutional arrangements are necessary in that "jurisdictions large enough" implies overlap in functions and jurisdictions necessitating cooperation.

Recent academic work has focused on cross-scale interactions. Young (2002), for instance, deepens our understanding of scale issues in that he argues for the need to understand the interplay between institutions both vertically and horizontally and between functional interdependencies and strategic links. He notes that successful results are more than a function of the allocation of tasks among and between institutions operating at various levels, rather, the need exists to ensure that cross-scale interactions produce complementary actions. The relationship between cross-scale links and policy change are, however, not explored. Berkes (2002) builds on both of Paehlke and Young's arguments in arguing for the need to match cross-scale institutions with the scale of ecosystems. This argument is similar in nature to Paehlke's argument above, however, Berkes extends the argument by detailing some of the characteristics of this governance including the need to facilitate self-organization in cycles of change, to enhance social learning and to increase adaptive capacity. Four management approaches that enable cross-scale linkages are also detailed: eco-system management, adaptive management, participatory rural appraisal, and participatory action research. In the end, Berkes argues for adaptive management since it is designed to incorporate uncertainty in the process and allows for learning from failures and successes though the effects of adaptive management or the other management approaches are not examined in relation to policy change.

(d) Collective Choice Rule Configurations of Sustainable and Unsustainable CPRs

The failure to address the complexity of nesting configurations and their effect on the type, frequency and magnitude of policy change is significant in that, as Sproule-Jones (1995) notes, rule configurations affect, to a large extent, what can be done in CPRs. Rules matter, but how rules evolve may be more important because it can reveal the nuances of the situation at hand, as well as, provide clues for how policy change may be achieved. It is not only the rules themselves that matter but the relationships that they establish (Sproule-Jones, 2006). Though Sproule-Jones does not elaborate on the types of relationships that could be established, it is hypothesized here that these relationships could include those between stakeholders, such as functional roles, and also the relationships between rules. Important in this line of argument is the need to examine how the relationships impact the type, frequency and magnitude of policy changes.

To this end, the relationship between nested institutional arrangements conceptualized as collective choice rule configurations and the physical attributes of the CPR resource have been the subject of recent research. Schlager, Blomquist and Tang (1994) demonstrate how differences in the degree of mobility and storability in fisheries and groundwater lead to the creation of different CPR institutional arrangements. In situations of high mobility and low storability, such as fisheries, institutional arrangements tend to address technological externalities. In comparison, where mobility is low and storability high, such as that found with groundwater, better information and control lead to the ability to address a wider range of CPR dilemmas. In short, the authors recognize the fact that CPRs vary in their physical attributes, which impacts the design of institutional arrangements.

Schlager and Blomquist (2005) have extended this line of inquiry. They note that fisheries and groundwater are similar in other physical attributes (invisibility and complexity), which create different incentives for learning and adaptation. In applying Ostrom's (1986) institutional arrangements as sets of rules (boundary, position, scope, information, authority, aggregation and payoff rules), rule configurations are delineated that are more likely to contribute to unsuccessful (tragedy) and successful (sustainable) CPR management where conditions of invisibility and complexity are present. In short, the authors delineate the two extreme poles along the tragedy-sustainability continuum characteristic of CPR management (with the said conditions).

However, neither Schlager, Blomquist and Tang (1994) nor Schlager and Blomquist (2005) address the gap between the two poles. They do not state what happens when stakeholders move along the tragedy-sustainability continuum. Successful CPR management infers that policy change is required in order to adjust to changes in the resource, to stakeholders and/or to the action situation including different types of policy change and the frequency and magnitude of policy change. Moreover, the relationship between the complexity of nested institutional arrangements and policy change is unexplored. How complex should nested institutional arrangements be? What are the characteristics of nested institutional arrangements? What are links in nested institutional arrangements? And, how do the characteristics and complexity of nested institutional arrangements affect CPR policy change? These types of questions are left unanswered, yet this type of information is vital to those wanting to affect positive groundwater policy change, that is, a move towards successful management of groundwater resources since it can provide clues for how to affect desired change.

To an extent, Ostrom (2005) addresses some of these shortcomings by elaborating on a method for analyzing institutional change, that is, how rules evolve over time. Sub-categories (e.g. boundary: land, shares, membership) of collective choice rule configurations (boundary, position, scope, information, authority aggregation and payoff rules) are mapped revealing how rule configurations evolve over time based on a largely hypothetical case.[14] Other processes of institutional change are also explored such as changes via imitation of another jurisdiction's

[14]Though reference is made to the development of specific questions based on the analysis of numerous case studies, the set of possible changes is hypothetical. For instance, specific changes are addressed as "farmers *might* then decide to…make four new rules", "farmers *might* find themselves in a changed economic situation…which *may* lead them to decide" and "*[i]f*, however the farmers are heterogeneous…then they *may* find themselves" (emphasis added; Ostrom, 2005, pp. 18-26).

institutional arrangements, non-enforcement of rules, conflict resolution through judicial bodies, and changes in exogenous variables (biophysical system, community, higher level rules).

As important as the method of coding rule evolution is, the rule configurations are not related to the type, frequency or magnitude of policy change. For someone wanting to address positive groundwater policy change, few clues are revealed to aid them in the process. What actor configurations exist behind the rules and how are they connected with each other? Moreover, how are these actor configurations related to changes in rules? Essentially, rules are constructed among different stakeholders with each having a particular agenda and possessing different amounts of information, time and other resources (e.g. personnel, money). These stakeholders are linked individually and collectively through governance units and layers, and it is through these links that positions are advanced and rules devised. However, the complexity of the links that lead to interactions and their effect on policy change is not detailed. The point is that while different rule configurations may lead to CPR tragedies and sustainability, one must also examine the "glue" that binds governance units and layers in nested institutional arrangements, and determine what they contribute to the policy change process.

In short, the CPR literature does not unravel nested institutional arrangements in terms of their effect on policy change in different degrees of uncertainty. While rule configurations matter, the CPR literature is largely preoccupied with the "bundling" of property rights and/or the exploration of binding contracts to address the "tragedy of the commons". Neither approach examined is largely focused on the examination of the characteristics of nested institutional arrangements nor on their effects on the type, frequency and magnitude of policy change. However, it is within this second thread of literature where recent work has depicted rule configurations of successful and unsuccessful CPR management and has at least one method for moving between the two tragedy-sustainability extremes. Even this recent work does not relate rule configurations to the type, frequency and magnitude of policy change.

The effect of nested institutional arrangements on policy change is the critical component of this investigation. CPR theory details the need for nested institutional arrangements in order to successfully manage a common pool resource, such as an aquifer. Different types of changes may require different types of nested institutional arrangements in order to be successful, yet CPR theory offers little guidance in disaggregating nested institutional arrangements and their effect on policy change. As shown in the next section, nested institutional arrangements are disaggregated as the number of governance layers and units acting on the resource, the nature of the linkage between governance units and layers (functional, strategic), and the complementarity of the linkages in order to assess the effects of nested institutional arrangements on the type, frequency and magnitude of groundwater policy change. Taken as a whole, this approach extends CPR theory by beginning to unravel nested institutional arrangements in terms of linking nesting configurations to specific policy changes. As such, this study complements Schlager and Blomquist's investigation. They infer that policy needs to change to ensure sustainability and identify the two poles in the tragedy-sustainability continuum yet do not address the relationship between rule configurations and the type, frequency and magnitude of policy change. Furthermore, this study complements Ostrom's method of analyzing institutional change by disaggregating NIAs and relating the nesting components to the type, frequency and magnitude of policy change.

2.5 Summary

This chapter highlighted the main findings of the literature review. In particular, the common pool resource theory literature is preoccupied with elaborating property rights or binding contracts as solutions to the tragedy of the commons. Property rights were found to be multi-faceted and embedded within a larger framework of water rights, both of which highlighted the complexity and need for nested institutional arrangements. Binding contracts largely address (a) the identification and testing of institutional design principles; (b) the need for nested institutional arrangements; (c) the advantages and disadvantages of different institutional arrangements; and, (d) collective choice rule configurations of sustainable and unsustainable CPRs. However, the CPR theory literature fails to address the complexity of nested institutional arrangements and their effect on policy change. This is significant because successful CPR management infers that policy change is required in order to adjust to changes in the resource, stakeholders and/or the decision-making situation (action situation).

Chapter Three

Research Design

"one approach"

3.1 Introduction

This chapter explains the research methods used to achieve the goals of the dissertation. It reviews basic definitions and details the conceptualization, operationalization and measurement of the dependent and independent variables. Timelines, data sources and case selection are also covered. The chapter concludes with an examination of related challenges and summarizes the outcomes.

This study focuses on discerning the effect of nested institutional arrangements on groundwater policy change under different conditions of uncertainty. While many factors affect policy change including institutions, actors and power dynamics, the focus of this investigation is on the institutional elements. The dependent variable is groundwater policy change while the independent variable is nested institutional arrangements. Schematically, this relationship is as follows:

<u>Independent Variable</u>		<u>Dependent Variable</u>
Nested Institutional Arrangements	⇨ ⇨ ⇨	Groundwater Policy Change

The research design outlined here is a comparative analysis and employs the "most similar systems" approach in examining groundwater policy change from 1958 to 2006 in the Ogallala Aquifer and the Great Lakes Basin.

3.2 Definitions

An examination of the research question demands that key concepts be clarified. As such, the following definitions are used for the purposes of this study:

(a) Nested Institutional Arrangements

Nested institutional arrangements are different configurations of governance units, with each unit possessing different amounts of institutional autonomy over the resource. This includes both vertical and horizontal nesting and combinations thereof. Vertical nesting refers to different hierarchical layers of governance such as local municipal governments, state or provincial governments, federal governments, regional governments (e.g. intra-regional: Conservation Authorities/Districts, Counties; inter-regional: USEPA Regions), local community groups and private organizations. Horizontal nesting refers to interconnected governance units across space and at the same level of organization (e.g. NYS Department of Environmental Conservation and the NYS Department of Health).

(b) Groundwater Policy Change

Groundwater policy change refers to changes in common and statutory laws, and guidelines and regulations in relation to access, withdrawal (water takings, well driller regulations) and protection (wellhead protection) of groundwater.

Policy change can also be either endogenously or exogenously driven. Endogenously driven policy change is conceived as a learning process and includes the ongoing evaluation of and deliberate efforts to change current policy given new information and past experience (Hall, 1993). Exogenously driven policy change is a result of changes in the policy environment (e.g. government re-organization, changes in the resource (lower groundwater levels), new governance units (actors) entering the policy process) (Heclo, 1974). Note should be made that exogenously driven changes occur outside the policy process (Hall, 1993).

Furthermore, the two types of policy changes are intertwined. Any endogenously driven changes will be carried on within the framework of responses to exogenous factors. Any attempts by governance units, for instance, to evaluate a water taking permit system must necessarily take into consideration changes in economic development strategies by a government which may decide to promote agricultural expansion and productivity via increased irrigation practices. Similarly, exogenously driven changes in policy such as the development of wellhead protection plans in response to groundwater contamination from toxic chemical spills in another part of the country must necessarily consider the efficacy of existing local groundwater protection activities.

Regardless of whether policy change is endogenously or exogenously driven, the research design outlined in this chapter, in particular, the characterization of NIAs into the quantity of governance units, the nature and complementarity of linkages among the governance units, applies equally to both. Note that the point of departure for the thesis is not to identify the source of the policy change, rather it examines the institutional arrangements leading up to and immediately after changes in policy to discern the effects of NIAs on the type, frequency and magnitude of policy change. In short, this thesis is interested in what governance units were involved leading to the policy changes and how these governance units were linked to each other and not in the impetus for the policy change.

(c) Different Conditions of Uncertainty

Uncertainty, as stated in the introductory chapter, refers to the inability to calculate the probabilities of particular actions that lead to specific outcomes on a periodic basis (Knight, 1921). It specifically refers to both the natural physical characteristics of groundwater and to the human systems involved in its management. A low level of uncertainty, such as that surrounding the Ogallala Aquifer, means that the aquifer has been much studied and that the aquifer's physical parameters are well known. This includes specific knowledge about the following characteristics:

- The physical size of the aquifer;
- The depth of the aquifer;
- Volume of groundwater in the aquifer;
- Yearly or monthly withdrawal rates;
- Recharge capacities; and,
- Groundwater – surface water connections (including wetlands, lakes).

For instance, recharge rates for the Ogallala Aquifer are well known as are its size and depth (e.g. Sloggett & Dickason, 1986; Kromm & White, 1992; Sophocleous, 2005). Conversely, the Great Lakes Basin is associated with high uncertainty levels. Note that recharge rates, associated aquifers and aquifer/lake connections are poorly understood. In fact, a major impetus for creating the NY well driller registration and certification program was for the NYS Department of Environmental Conservation to mandate submission of well driller logs to facilitate aquifer delineation (NYSDEC, 2000; NYSDEC & ESWWDA officials, interviews, 13, 09 July 2007).

(d) Collaboration

Collaboration is broadly defined based on Wondolleck and Yaffee's (2000) definition. It is based on Gray's (1985) definition where "tangible resources" (e.g. money, labor, information) are pooled by two or more stakeholders to address problems which neither could sufficiently tackle on their own. Wondolleck and Yaffee broaden the definition to emphasize the need for relationships to "cross boundaries, defined by organizational affiliations, interests, perceptions, geography, or jurisdiction" (p. xiii).

Note that any contribution of tangible resources by multiple stakeholders and the development of cross boundary relationships, that is, linkages, involves varying degrees of trust. The culture of collaboration based on social norms including trust can greatly aid or take away from collaborative efforts. As Ostrom (2000) notes, social norms can evolve to support cooperation when external rules or monitoring are absent, yet the presence of such comprehensive external frameworks negates the need for the formation of internal social norms since cooperation is strictly enforced. Moreover, a moderate external framework "discourages" the formation of social norms and increases the likelihood of non-cooperation (pp. 147-148). In short, context matters in the examination of collaborative endeavours. Care is thus taken to document and illuminate the nature of the relationships leading to legislative and regulatory changes and initial implementation activities. Furthermore, it is noted that collaborative efforts are wide ranging and may be both formal (e.g. local governments and Regional/County Planning Councils in New York working to voluntarily develop a Wellhead Protection Plan (WHP)) and informal (e.g. the Ontario Ministry of the Environment (OMOE) contacting and working with the Ontario Ground Water Association (OGWA) to address enforcement issue(s) against a driller rather than formally issue the driller an offense notice (citation/ticket)) (G/FLRPC, n.d.; OGWA & OMOE (retired) officials, interviews, 25 September & 13 October, 2006).

(e) Ogallala Aquifer vs. High Plains Aquifer

This thesis utilizes the term Ogallala Aquifer to refer to the principal hydrogeologic units underlying eight US Midwest states (see Appendix III). It explicitly recognizes that the Ogallala Aquifer is one of several hydrogeologic units known by natural scientists as the High Plains Aquifer which also includes hydrogeologic units from the Brule and Arikaree formations and younger associated sediments (Weeks, Gutentag, Heimes, & Luckey, 1988). Yet, the term Ogallala Aquifer is used since it is the one generally understood and recognized by *social* scientists.

(f) Water Takings

The term water takings is used to refer to groundwater withdrawals, pumping and transfers. Similarities with the judicial use of the term in relation to property rights (e.g. compensation) are recognized however its use in this thesis is unrelated to such interpretations. Rather, the term water takings was selected for use due to the need for consistency in terminology across jurisdictions in addition to the need for commonly understood definitions.

3.3 Dependent Variable: Conceptualizing, Operationalizing and Measuring Groundwater Policy Change

Groundwater policy change is conceptualized as changes in actual groundwater policy in relation to water takings, well driller regulations and wellhead protection plans. These policies are selected for their representativeness of CPR research in terms of access and withdrawal issues, as well as, quality concerns. Water takings policies directly affect where, when and how much groundwater is allowed to be pumped, as well as, who is allowed to appropriate the resource. Well driller regulations affect limits on those performing well drilling operations. Similarly, wellhead protection plans and source protection plans address quality concerns in terms of regulating allowable activities surrounding water wells. These groundwater policies are operationalized in terms of the core property rights that they affect which Schlager and Ostrom (1992) have elaborated as being access/withdrawal, management, exclusion and alienation rights. These rights are summarized in relation to the groundwater policies in Table 3.1.

In addition to assessing changes in the underlying rights found in groundwater policies, changes in groundwater policy will also be assessed in terms of their frequency and magnitude. Both of these variables are captured in Hall's (1993) Orders of Policy Change framework. According to Hall, the magnitude and frequency of a policy change can be characterized as changes in policy goals, policy instruments, and policy settings (calibration of the policy instruments). Changes in

Table 3.1: Property Rights Associated with Water Takings, Well Driller Regulations, Wellhead Protection Plans*

Property Right	Description	Water Takings Example(s)	Well Driller Regs. Example(s)	Wellhead Protection Plan Example(s)
Access	Rights to enter a defined physical property.	Residency, Licensing, Technology.	Licensing, Technology.	Plan Designer Certification.
Withdrawal	Rights to obtain "products" of a resource.	Water takings permits.	Well drilling permit.	Scope of Plans (e.g. Fuels, Nitrates, Pesticides, Septic Tanks…)
Management	Rights to determine how, when where withdrawal may occur including changes to the structure.	Pumpers, Municipality...	Well Drillers, Municipality…	Industry, Municipality…
Exclusion	Right to determine who has an access right including the transference of this right.	Pumpers, Municipality, Regional Authority...	Well Drillers, Regional Authority…	Industry, Municipality…
Alienation	Right to sell or lease management and/or exclusion rights.	Pumpers, Municipality, Regional Authority	Well Drillers, Regional Authority…	Industry, Municipality…

* Adapted from Schlager & Ostrom, (1992).

policy goals are the most difficult to achieve and, therefore, also the slowest to occur. Policy instrument changes are more frequent and easier to achieve while changes in policy instrument settings are the easiest to achieve and occur most frequently. It is noted that Hall's framework is used as a heuristic device to give some indication of the degree and frequency of groundwater policy change. As such, no inference is made that changes in a policy's goals necessarily imply changes in policy instruments and settings. Similarly, no inference is made that a change in policy instruments necessitates a change in policy settings. For instance, applying Hall's framework to groundwater policy changes, a change in permitted water takings from 50,000 to 65,000 litres per day would indicate a policy instrument setting change and would be classified as a frequent change. In comparison, instituting a limit for water takings of 50,000 litres per day when none existed would indicate a change in policy goals. Similarly, a change from voluntary to mandatory well drilling permits would indicate a change in policy instruments while the removal of exemptions for agricultural water well permits would reflect a change in policy settings and policy goals (depending on context).

To be clear, the frequency of policy change is defined as how often changes in policy goals, policy instruments and policy instrument settings occur expressed in years. It is hypothesized that policy goals will change infrequently (e.g. 10+ yrs.), policy instruments fairly frequently (e.g. every few years to 10+ yrs.) and policy instrument settings frequently (e.g. every year to every few years). The *magnitude* of policy change is defined as the degree (i.e. how large) of policy change that occurs expressed as changes in policy goals (large), policy instruments (medium) and policy instrument settings (small).

3.4 Independent Variable: Conceptualizing, Operationalizing and Measuring Nested Institutional Arrangements

Conceptualizing nested institutional arrangements is problematic due to the lack of literature on what constitutes such an arrangement. The literature focuses on detailing the need for nested institutional arrangements, yet has not characterized these arrangements beyond our basic definition of different governance units each possessing different amounts of institutional autonomy over the resource which includes both vertical and horizontal elements. While short on details, this definition suggests three dimensions characteristic of nested institutional arrangements: the quantity of governance units acting on the resource in relation to groundwater policy; the nature of the linkages among the governance units; and the complementarity of the linkages. These dimensions are examined below while associated timelines and data sources are discussed in sections 3.5 and 3.6 respectively.

(a) Quantity of Governance Units

An assessment of the quantity of governance units acting on the resource is important in determining the complexity of nested institutional arrangements. CPR theory suggests that many (more than one) supportive governance units facilitate successful resource management, yet does not detail what quantity of arrangements works better. Specifically, differences may exist in groundwater policy change depending on the number of governance units acting on the resource. Is a critical mass necessary to affect desired groundwater policy change?

The quantity of governance units acting on the resource is operationalized by dividing it into its vertical and horizontal components. For the vertical component, a physical count of the number of governance layers that impact water takings is to be made. For instance, water permits assessed at the regional level only would indicate a count of one vertical governance layer, whereas water permits assessed at the regional level combined with adjudication mechanisms located at the local, provincial/state and federal levels would indicate a count of four vertical governance layers. Similarly for the horizontal component, a physical count of the number of governance units *at the same level of organization* that impact, for instance, well driller regulations, is to be made. Licensing regulations and related adjudication activities determined solely at the state level would reflect a count of two horizontal governance units at the state level. On the other hand, state licensing regulations combined with adjudication mechanisms located at the local, state/provincial and federal levels would reflect a count of one local level, two state/provincial levels and one federal level of horizontal governance units. Care will also be taken to identify and take stock of informal governance arrangements, such as working agreements and tacit agreements, where and when possible (see Sproule-Jones, 1979). While less visible, these types of arrangements are often vital to the functioning of the regulatory framework. In short, measuring the number of governance layers and the number of governance units in the same layer serves as an indication of the complexity of nested institutional arrangements.

(b) Nature of Linkages Among the Governance Units

Whereas knowledge of the number of vertical and horizontal linkages is helpful in unraveling the complexity of nested institutional arrangements, it nevertheless, provides little information about how the governance units or layers interact, that is, the institutional interplay. For instance, how do horizontal governance units at a particular level interact? What connects governance units? The need for nested institutional arrangements suggests institutional interplay, yet the nature of this interplay needs to be elaborated in terms of its effect on groundwater policy change.

Institutional interplay is operationalized as functional interdependencies and strategic links (Young, 2002). Functional interdependencies arise when an institution's core activities are linked with another institution or institutions in either socioeconomic or biogeophysical terms. An example of a functional interdependency is efforts by a local conservation group to enhance stream flows for fish habitat (through groundwater withdrawal limits) and efforts by agricultural associations to promote crop productivity through irrigation expansion. The two are inherently linked and success or failure of either group can be expected to have effects on the other (in this case, negative).

Strategic interactions in political design and management, on the other hand, arise through the intentional actions of actors to forge connections between or among institutions in the pursuance of their goals. For instance, the same conservation group wanting to enhance stream flows could form strategic links with sporting (fishing) associations in order to enhance their effectiveness. The nature of linkages will be assessed through a content analysis of the core activities of the main governance units. The type of linkage (functional/strategic) will be noted to ascertain the relationship between the nature of linkages among governance units and groundwater policy change.

(c) Complementarity of Linkages Among the Governance Units

An assessment of the complementarity of linkages among governance units acting on the resource is important because while many vertical and horizontal linkages can exist, unless they are complementary, as CPR theory suggests, successful CPR management remains elusive. Linkage strength is operationalized as similarities in governance vision (goals), level of communication, and frequency and type of collaboration. A strong complementarity (strong linkage) would be indicated by close similarities in governance unit visions (goals), frequent communication and partnership or collaboration in many smaller projects or in one or a few larger activities in regards to groundwater governance. Similarly, a weak complementarity would be indicated by divergent goals, infrequent communication and few, if any, collaborations in groundwater governance activities.

In order to determine similarities in governance unit visions (goals), a content analysis of the mission statements and mandates of the main governance unit actors will be done. This comparison will note the number and type of complementarities with the greater the number of complementarities in goals indicating higher overall complementarity and strength of the linkage. Note that the measurement of similarities in governance unit visions is done ordinally, that is, similarities are ranked as either nil, low, moderate or high. It is recognized that ordinal measurements in nonquantitative research are difficult to achieve (Geddes, 2003) yet as King, Keohane and Verba (1994) note, "[t]he key point is to *use the measure that is most appropriate to our theoretical purposes*" (original emphasis; p. 153). With this in mind, the purpose is to decipher the degree of similarity in governance visions between governance units. This is a ranking which ordinal measurement is well suited (Sedlack & Stanley, 1992). The point is we need to know if a high similarity in governance vision leads to a particular change or not. We do not need to know whether a 95% similarity versus a 90% similarity leads to a particular change (and which would be done either via intervals or ratios in terms of measurement units). As such, measuring governance vision similarities ordinally is both suitable and sufficient. For the purposes of this investigation, and as detailed in Appendix I, similarities in governance visions are classified as high, moderate, low or nil (non-existent). Note that a situation could occur where goal complementarity is non-existent (nil) or moderate yet governance units perform complementary roles formalized by formal agreement (e.g. contract). These types of situations would be captured in collaboration levels which are discussed further below.

Communication levels are measured by taking stock of the frequency of meetings, position papers/proposals put forth by the main governance units and the frequency of personal communications, such as telephone calls, letters and individual meetings, between governance units. A nominal measurement of the frequency of meetings and position papers/proposals can be achieved by tracing the proceedings surrounding groundwater policy change. In addition to this, interviews with key individuals from the main governance units will be used to assess the frequency of personal communication between groups, as well as, the frequency of meetings and number of position papers/proposals. It may be the case that some individuals from twenty or twenty-five years ago cannot be tracked down. In these cases, interviews with other individuals within the same governance unit that were involved in the process will be done. This is not a perfect solution but will provide a measure of what happened which can be corroborated with information garnered from other governance units in the process for accuracy. The greater the frequency of meetings, position papers/proposals and personal communication indicates a higher overall complementarity among the governance units.

Finally, information about the frequency and type of collaboration among governance units will be gleaned from a review of government documents, websites and through interviews. More frequent and substantive collaboration among governance units indicates a higher overall complementarity among the governance units.

Both communication and collaboration levels will also be ranked ordinally as high, moderate, low or nil (non-existent) as detailed in Appendix I.

As an addendum to linkage complementarity, much time is spent detailing the ordinal levels of measurement in Appendix I. This is intentionally done to remove potential arbitrariness and to clearly explain how linkage complementarity is assessed through the tracing of the proceedings leading to legislative and regulatory changes, and, their implementation. To emphasize, it is not necessary to know the precise quantity of communication levels (e.g. 90 per cent), rather, we need to know if we have "more of" (e.g. high), "average" (e.g. moderate), "less of" (e.g. low) or "none of" (e.g. nil), in other words, their respective ranks, something which ordinal measurement is well suited.

To summarize, groundwater policy change is dependent on the character of nested institutional arrangements. Groundwater policy change is conceptualized in terms of actual changes in groundwater policy related to water takings, well driller regulations and wellhead protection plans. This is operationalized in terms of changes in the underlying property rights associated with each (access, withdrawal, management, exclusion, alienation). Nested institutional arrangements are conceptualized as the number of governance units (operationalized as the quantity of vertical and horizontal units), the nature of these linkages (operationalized as functional or strategic) and the complementarity of the linkages (operationalized as governance vision, communication level and collaboration). The expected result from this thesis is that the greater the number of governance units functionally and complementarily linked will be found in low uncertainty areas. The research design is shown schematically in Table 3.2.

3.5 Timelines

The assessment of policy change necessitates a longitudinal investigation and, as such, this study traces the evolution of groundwater management in one jurisdiction within the Ogallala Aquifer (Nebraska) and two jurisdictions within the Great Lakes Basin (Ontario, New York). The period of investigation is, however, limited to the time frame 1958 to 2006. Such a period ensures that sufficient time has passed for policy to have changed and provides multiple points of observation for comparison without having to trace the entire history of a policy. Indeed, all three groundwater policy areas have undergone significant changes over this time frame as shown in Table 3.3. To be clear, while the assessment of groundwater policy change, the dependent variable, is done longitudinally, the assessment of nested institutional arrangements, the independent variable, is done at points of specific policy change, that is, on a cross-sectional basis.

Table 3.2: Schematic Representation of Research Design

IV	Nested Institutional Arrangements						
	No. of Governance Units		Types of Linkages		Complementarity of Linkages		
DV	Vertical	Horizontal	Functional	Strategic	Governance Vision	Communication Level (No. Meetings, Proposals, Personal Comm.)	Collaboration (No. & Type)
Policy Change: *Water Takings* • access • withdrawal • management • exclusion • alienation • speed • magnitude *Well Driller Regs* • access • withdrawal • management • exclusion • alienation • speed • magnitude *WellheadPro-tection Plans* • access • withdrawal • management • exclusion • alienation • speed • magnitude							

Table 3.3: Time Frame / Dates of Significant Policy Changes

Jurisdiction	Groundwater Policy: Water Takings	Groundwater Policy: Well Driller Licensing	Groundwater Policy: Wellhead Protection
Ogallala Aquifer			
Nebraska	1980-87, 1991-99, 2000-05	1980-86, 1987-94, 1998-04	1986-94
Great Lakes Basin			
Ontario	1958-64, 1999-06	1966-70, 1980-84, 2000-04	2002-06
New York	1985-1991	1996-2006	1986-96

3.6 Data Sources

The main sources of information for this study will be from primary sources and semi-structured interviews; both of which will be supplemented with academic literature where possible. Primary data sources include material from leading court cases, legislation, meeting minutes, policy briefs, position papers, government documents, and annual reports. While some of this information will be found in libraries in books and journals, much more of it will be garnered from government departments, groundwater management districts, environmental groups and their related websites and will necessitate contact with various groups to access documents.

Undoubtedly, gaps in information will exist and clarification of the documents will be required. As such, information garnered from primary data sources will be supplemented with semi-structured interviews with individuals from relevant stakeholders such as governments, conservation authorities, groundwater conservation districts and groundwater users themselves for clarification and verification purposes. Interviewees will be asked open-ended questions in relation to the events surrounding changes in policy related to water takings, well driller regulations and wellhead protection plans. Interviewees will be initially selected from leading stakeholders as determined through the primary material and will be asked to recommend other relevant parties to the process who will be tracked down for subsequent interviews. Content analysis will not only uncover changes in groundwater policy but also the number, nature and complementarity of linkages. This will facilitate a determination of the effects of nested institutional arrangements on groundwater policy change under different conditions of uncertainty.

3.7 The Cases: Ogallala Aquifer and the Great Lakes Basin[15]

This dissertation is based on a comparative case study between the Great Lakes Basin and the Ogallala Aquifer. More specifically, it traces the evolution of groundwater management policy in two jurisdictions in the Great Lakes Basin (Ontario, New York) and one jurisdiction in the Ogallala Aquifer (Nebraska).

A number of reasons exist for the selection of this case study. In particular, the two aquifers are in different stages of management. The Ogallala Aquifer is in a period of advanced groundwater management with numerous groundwater management districts or groundwater conservation areas in existence. These districts have numerous powers including the ability to set well spacings, issue groundwater extraction permits and regulate withdrawals, though these vary from jurisdiction to jurisdiction. For instance, Roberts (1992) notes that Nebraska has local Groundwater Areas that have the authority to regulate well spacing, regulate withdrawals including metering of water usage and prohibit the construction of new wells.

In comparison, the Great Lakes Basin is in a less advanced groundwater

[15]Note that two jurisdictions (Pennsylvania in the Great Lakes Basin and Oklahoma in the Ogallala Aquifer) have been excluded from the original research design due to data collection concerns, that is, the magnitude of the data exceeds its marginal value.

management period, although significant differences exist between the composite jurisdictions. For instance, Ontario and New York require well permits for groundwater extractions over a set amount, although wide variation exists between the two regions. Groundwater takings of 50,000 L/day in Ontario requires a permit (OMOE, n.d.-a) while in New York, registration of groundwater takings is required for takings exceeding 100,000 gallons (US)/day (378,000 L/day) (NYSDEC, n.d.). In addition, specific groundwater management districts are rare in the Great Lakes Basin, well spacing regulations are generally not enacted nor are regulations pertaining to metering of water takings or groundwater use charges and/or for buying and selling groundwater (internally, that is, not across a jurisdiction's boundaries).

No doubt, differences in groundwater management regimes reflect the different pressures on the resource. The Ogallala Aquifer is considered to be a finite resource since water withdrawals significantly outpace aquifer recharge. In fact, withdrawals outpace the rate of natural recharge by a factor of fourteen (Jacques, 2004). Depending on the year in question, Opie (1993) notes that the Ogallala Aquifer can drop in some locations by as much as five feet in the Oklahoma-Texas Panhandle while Kromm and White (1992) note that recharge is only one fifth of an inch. Nebraska's situation is somewhat different with a larger recharge factor due to the geological composition of the state (a large amount of highly porous sand and gravel deposits). In contrast, published recharge data for the Great Lakes Basin does not exist for Ontario and is minimal in relation to the U.S. Great Lakes states due to the fact the aquifer is not well understood.

Little difference in management regimes exists between the cases when one considers where the main authority rests for each aquifer. No overall management authority exists for either the Great Lakes Basin or the Ogallala Aquifer and at the sub-unit level (province/state), little variation exists. For example, in the Ogallala aquifer, management authority is concentrated at the regional level (Natural Resource Districts) in Nebraska (Roberts, 1992), while in the Great Lakes Basin, management authority resides at the provincial/state level for Ontario (Percy, 1988) and New York (SLM Regional Water Supply Consortium, n.d.).

Similarities exist in governance regimes in that each aquifer is comprised of many sub-units with different legal and property rights regimes. The Great Lakes Basin is comprised of nine subnational units, all of which follow the common law tradition. Furthermore, Ontario and New York follow the reasonable use doctrine for groundwater management. In the Ogallala Aquifer, eight subnational units exist with all following the common law tradition with Nebraska following the reasonable use and correlative rights doctrines for groundwater management (Water Systems Council, 2003; Percy, 1988; Templer, 1992).

Other general similarities exist for the sub-national units in the two basins. The Ogallala Aquifer forms a significant part of Nebraska while the Great Lakes Basin forms a significant part of Ontario and New York (see Appendices II and III for comparison of the geographic locations). Moreover, all jurisdictions are experiencing increasing stress on the groundwater resource from a number of sources. For instance, agricultural expansion and intensification have led to increased water withdrawals and serious contamination problems from pesticides and nitrates (e.g. Opie, 2000; Hanson & Trout, 2001; Beaulieu, 2003; Renzetti, 2005; Citizen's Environmental Coalition, 2005). All jurisdictions also have populations concentrated in particular areas of their territory. New York and Nebraska have populations concentrated in the south and east portions of their territory while Ontario has a significant population concentrated in the southern portion of its territory.

3.8 Challenges

Two important challenges exist for this study. First, the case study comparison is between the Ogallala *Aquifer* and the Great Lakes *Basin*, that is, comparisons are made between subnational units in an aquifer and a drainage basin which are not necessarily the same. A drainage basin is the surface area of land drained by a river and its tributaries while an aquifer is the "saturated permeable geologic [underground] unit that can transmit significant quantities of water under ordinary hydraulic gradients" (Freeze & Cherry, 1979, p. 47). A drainage basin may or may not include an aquifer or only a part of an aquifer, hence, it can be said that the comparison is not a true one. Unfortunately, no solution exists for this problem. While scientific study delineated the parameters of the Ogallala Aquifer many years ago, aquifers in the Great Lakes Basin have not been as rigorously studied. For instance, while the United States Geological Survey (2004) has mapped geological materials that contain aquifers of different production capabilities, much less work has been done on delineating specific aquifers. In the Canadian context, even less work has been done on aquifer identification and mapping though recent model simulations by Ontario are a start in that direction (OMOE, n.d.-a). Of greater concern is the fact that it is not known whether the many small aquifers are connected or if one larger regional Great Lakes Basin aquifer exists. Research by Middleton (1988) suggests that connections between Canadian and American aquifers exist beneath connecting rivers such as the Detroit and St. Clair Rivers. In short, there is no getting around this problem and, for the purposes of this study, the boundaries of the Great Lakes Basin are taken to represent an aquifer on its own though it is explicitly acknowledged that this is unknown at this time.

The second challenge facing this study is the fact that an international border divides the Great Lakes Basin while no similar situation exists for the Ogallala Aquifer. This is an easier problem to handle though it increases the scope of the study. This problem is addressed by including one jurisdiction on the American side of the Great Lakes Basin (New York) to "control" for the international border thus facilitating a comparison between jurisdictions.[16]

3.9 Summary, Outcomes

This research proposal examines the effects of nested institutional arrangements on groundwater policy change in two aquifers in different periods of uncertainty. Uncertainty surrounds groundwater management. Groundwater also suffers from excludability and subtractability problems. CPR theory details the need for nested institutional arrangements for successful resource management, yet does

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[16]Of the eight Great Lake States (New York, Pennsylvania, Ohio, Indiana, Michigan, Illinois, Wisconsin and Minnesota), only New York, Pennsylvania and Illinois follow the reasonable use doctrine of groundwater use. New York was selected since a large part of the state falls within the Great Lakes Basin.

not relate their effects to the type, frequency and magnitude of policy change. This research will begin the process of unravelling nested institutional arrangements in this regard. In particular, the research addresses the following two areas of CPR theory:

(1) Nested Institutional Arrangements and Policy Change

The CPR literature does not address the effects of nested institutional arrangements on policy change nor their effect on policy change under different degrees of uncertainty. This is the crux of this study. It disaggregates nested institutional arrangements into the number of governance units, the nature and complementarity of linkages among governance units and layers and measures their effect on groundwater policy change. Moreover, it does this in repetitive interaction situations, something the CPR literature neglects. The frequency and magnitude of groundwater policy change is expected to be greater in the Ogallala Aquifer when compared to the Great Lakes Basin reflecting the present finite condition of the Ogallala Aquifer. This may reveal clues for how to address groundwater policy change in the Great Lakes Basin to avoid a similar fate. Furthermore, the frequency and degree of groundwater policy change is expected to be slower and less dramatic in those jurisdictions where groundwater policy management is concentrated at the provincial/state level (Ontario, New York in the Great Lakes Basin) largely reflecting difficulties in accessing and becoming institutionalized in the policy process. Such an assessment would complement Blomquist's (1992) investigation of groundwater policy adoption differences. The study also extends and complements work by Schlager and Blomquist (2005) and Ostrom (2005) in developing a method for relating nested institutional arrangements to the frequency and degree of policy change. In short, this research begins to unravel what is meant by nested institutional arrangements.

(2) Horizontal Linkages

The CPR literature is largely silent on horizontal linkages and their effect on policy change. This study reveals such linkages as being either functional and/or strategic and assesses their complementarity. Furthermore, it is expected that such linkages will be "denser" (more complex) in relation to the Ogallala Aquifer than in the Great Lakes Basin due to the low uncertainty involved, that is, the governance units in question are well aware of their position within the governance framework and how potential changes may alter their condition (become a "winner" or "loser"). As such, the research contributes to the further development of CPR theory.

At a practical level, this research describes the development of groundwater management policy in different institutional settings and in different periods of management. Examining groundwater management in a more developed aquifer such as the Ogallala may provide clues for the development and management of the Great Lakes Basin. It will identify cross-scale linkages and provide clues for where to place effort in order to achieve different types of policy change.

This chapter has laid the methodological foundation for the dissertation. The next three chapters (4, 5, and 6) present the data for each jurisdiction based on this framework while Chapter 7 analyzes the data for their effects on the type, frequency and magnitude of groundwater policy change.

Chapter Four

Ontario Groundwater Policy Change

"ebb and flow"

4.1 Context

Groundwater governance in Ontario has evolved over four distinct periods: pre-1956, 1956-1972, 1972-2000 and post-2000. Since 1935, well drillers needed to obtain a yearly license and, upon installation of a well, complete and submit a Water Well Record that detailed, among other things, the location of the well. No penalties existed for failure to have a license (O. Reg. 368/50) and water wells for domestic and/or farm purposes were exempt from the regulations (Well Driller's Act, 1937 c.50 and 1950 c. 423).

The post-World War II economic boom brought many challenges to Ontario. By the mid-1950s, the population had increased by one third and industrial growth had more than doubled since the end of the war (Ontario Water Resources Commission, 1969). This growth placed much pressure on the province's water resources and led to the creation of the Ontario Water Resources Commission (OWRC) in 1956 (Milner, 1957).

The OWRC is significant for groundwater governance in Ontario for many reasons since it was charged with assessing, securing, developing and protecting water resources in the province (OWRC, 1957). This necessitated knowledge of large water takings and, in 1961, Ontario introduced a Permit-To-Take-Water program for new water takings greater than 10,000 gal(IMP)/day though exemptions existed for domestic, farm (livestock) and firefighting purposes. A better understanding of groundwater dynamics including its availability was required and an aggressive research agenda was pursued (e.g. groundwater probability studies of most Southwestern Ontario counties; OWRC, 1965, 1969). Also, the 1960s were an active regulatory development period for well drilling regulations with many changes enacted including licensing fees and construction standards (e.g. O. Reg. 648/1970 (RRO 1970)). A high level of regulatory activity also existed for water protection; however, this flurry of activity surrounded "hard assets" in terms of the construction and management of sewage treatment plants. This is in contrast to the broad powers given to the OWRC enabling them to designate water protection areas which were largely unused (e.g. OWRC Annual Reports, 1957-72).

By the late 1960s and early 1970s, the importance of the environment as a public issue reached unprecedented levels. This was partly in response to Rachel Carson's book, *Silent Spring* (1962), which documented the discovery and impact of DDT on wildlife, and also to several large oil spills of that era (Harrison, 2000). This heightened environmental awareness, coupled with a comprehensive Ontario government reorganization, resulted in the formation of the Ministry of the Environment (MOE). All government environmental activities were combined into one Ministry, and by the spring of 1972, all OWRC activities were amalgamated into the MOE (OMOE, 1971-1973). Note that, in this process, water activities, and especially groundwater, became only one of many focuses within the ministry, which included such diverse policy areas as air, land, waste and pesticides.

The 1970s and early 1980s saw little change in groundwater policy direction as originally set out by the OWRC. The active groundwater research agenda continued[17] and few minor regulatory changes occurred in this time frame (e.g. metric conversion) except for the establishment of the Environmental Appeal Board (EAB) in 1974. The EAB is an administrative tribunal set up to allow individuals and corporations alike the opportunity to appeal Ministry orders and decisions such as license and/or permit amendments and cancellations (OMOE, 1976). Many regulatory changes for well drilling occurred in the mid-1980s including detailed license classifications/requirements and many construction changes (See Appendix IV). The PTTW program was left unchanged and little was done to further groundwater protection.

A change in provincial government in 1995 complicated matters. With a focus on spending reductions, tax cuts and the elimination of "red tape", the government drastically reduced operating expenditures (Woolstencroft, 1997). The MOE budget was reduced by thirty-nine per cent between 1994-1995 and 2000-2001 effectively reducing its expenditures to mid-1970s' levels (McKenzie, 2002). As a result, MOE groundwater research was non-existent and enforcement activities

[17]A cursory count reveals thirty-eight MOE studies from 1972-82 (e.g. Goff & Brown, 1981).

largely disappeared as the system became complaints driven.

In May 2000, everything changed. Seven people in Walkerton, Ontario died and several hundred others became ill after consuming contaminated groundwater. The Walkerton Inquiry was subsequently established to investigate what went wrong and to make recommendations to address the problems. It identified, among other things, problems associated with water well approvals, chlorination, inspections and enforcement. Overshadowing everything were the aforementioned budget cuts when approximately thirty per cent of the MOE staff were terminated. Less enforcement activity ensued while prosecutions were "less likely" to occur. In fact, at the time of the Walkerton tragedy, a voluntary abatement culture was the dominant MOE mindset (O'Connor, 2002).

The Walkerton tragedy renewed focus on groundwater. In particular, an aggressive research agenda was re-established with the launch of regional groundwater studies in 2001-2002 to better understand groundwater-surface water dynamics, contamination threats and to delineate and assess municipal wellhead protection areas (OMOE, Land Use Policy Branch, 2001). By 2003, many regulatory changes had occurred including those related to well licensing and construction (see Appendix IV) and those related to the PTTW program (see Appendix V).

Inspection and enforcement issues, however, persist. For instance, while municipal water plants (groundwater and/or surface water) have faced a zero tolerance policy towards infractions since Walkerton, non-municipal wells have been ignored. Source protection planning, recently developed, does not address private water wells and no new well inspectors have been hired. Ontario has one water well inspector for the province *as a whole*, which is the same number since the mid-1990s and a far cry from the 2-3 water well inspectors *per region* they had in the 1960s and 1970s. In its defence, the MOE notes that there is little need for active inspection and enforcement activity for private wells since a 2006 inspection "sweep" found a regulatory compliance rate of eighty-seven per cent though the results have been criticized as not being representative of field conditions (OMOE, Sector Compliance Branch, 2006; Ontario Office of Auditor General, 2004).[18] The regulations are now under review by the MOE.

Over time, two groups have come to influence regulatory changes the most. First, the Ontario Ground Water Association (OGWA)[19] has worked to aid "the delivery of safe and clean water supplies throughout the Province" through improved water well construction standards and eliminating unjust and unlawful extractions (OGWA, n.d., 1967). The OGWA, an industry association formed in 1952 and comprised of water well drilling contractors, pump installers, groundwater scientists and engineers, and manufacturers and suppliers, has over time become recognized as the industry's representative and its input is sought on an ongoing basis by the MOE.

Recently, Conservation Authorities (CAs) have been heavily involved in Source Protection Planning. CAs were created in 1946 and are "local, watershed management agencies that deliver services and programs that protect and manage

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[18]Fifty-four of 785 contractors and 136 of over 500,000 wells were examined. Data provided by MOE Water Well Business Unit, e-mail to author, 19 February 2007.

[19]The OGWA has undergone various name changes over the years including the Ontario Water Well Association, the Canadian Water Well Contractor's Association and the Ontario Ground Water Association (OGWA). The OGWA is used in this thesis and is inclusive of previous names.

water and other natural resources in partnership with government, landowners and other organizations" (Conservation Ontario, n.d.). These services include flood and erosion control with the operation of recreational services, an important byproduct of their central mandate. CAs also suffered major budgetary cutbacks in the mid-1990s losing forty-two per cent of their budget (McKenzie, 2002) and the Walkerton tragedy provided CAs with an opportunity to re-establish themselves given the fact the *O'Connor Report* (2002) recommended a watershed based approach to protect Ontario's drinking water supply. Currently, CAs are in the process of facilitating the development of SWPPs (e.g. Advisory Committee, 2003; UTLTSCRCA, 2007).

The above overview provides the framework for assessing the effect of nested institutional arrangements on the type, frequency and magnitude of groundwater policy change. The next three sections examine actual groundwater policy changes (dependent variable) operationalized as changes in well driller regulations, permit-to-take-water and wellhead protection plans in relation to our independent variables (number of governance units, linkage types and complementarity of linkages). To emphasize, taking stock of the number of governance units serves as an indication of the complexity of nested institutional arrangements; linkage types reveal the nature of the relationship between governance units; and the assessment of the complementarity of linkages is an indicator of the likelihood of positive groundwater policy change. Preliminary findings are summarized at the end of each *main* section (not time frame) and a chapter summary provides generalizations about the patterns for the independent variables across our three dependent variables.

4.2 Well Driller Regulations Independent Variable Summary

Changes in well driller regulations are interpreted as changes in licensing, well construction (e.g. location, chlorination, abandonment), and enforcement procedures (e.g. inspections, enforcement). The effects of nested institutional arrangements on such regulations are examined over three time periods: 1966-70, 1980-84 and 2000-04.

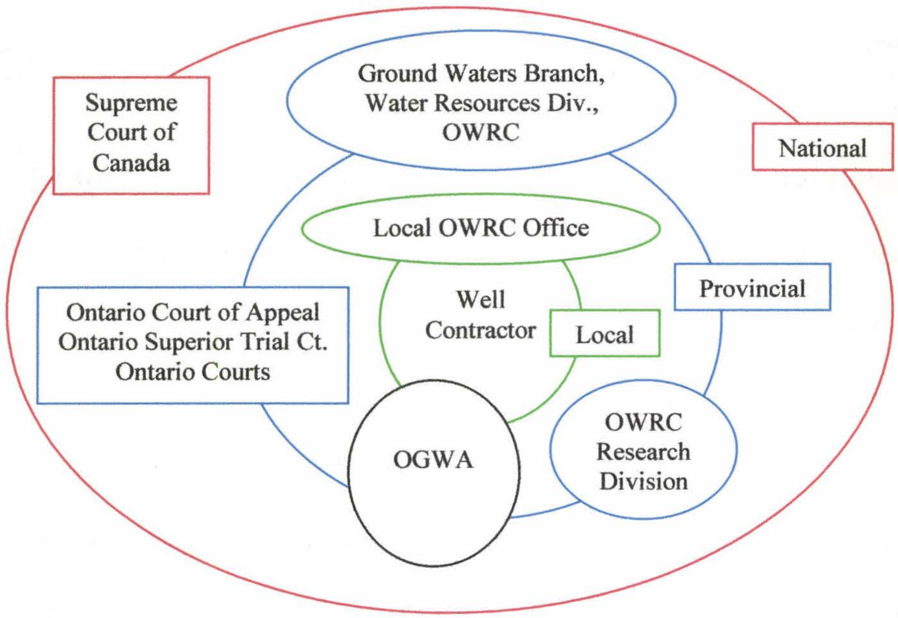
4.2.1a 1966-1970: Number of Governance Units

Eight overall governance units were active at this time as shown in Figure 4.1. This included three vertical governance units (local, provincial, national) and two local, six provincial and one national level horizontal governance units.

4.2.1b 1966-1970: Types of Linkages

Linkage types are summarized in Table 4.1. Local OWRC Offices, where Ontario's three water well inspectors (one for each region) who were primary contacts for drillers through field inspections were situated, played a crucial role in the process (OGWA, 1967; OWRC official (retired), interview, 13 October 2006). Insights into better well construction techniques, such as improved pump installation techniques, were developed and communicated to the OWRC Ground Waters Branch (GWB) in Toronto, and regulatory issues were clarified and usually overcome. As a former inspector noted, "if I could convince the contractor of what to do, then I was their "friend" and behaviour would change easier in the future and the relationship would develop" (OWRC official (retired), 13 October, 2006). Local OWRC Offices also accepted drilling license applications and forwarded them to Toronto for processing and, on occasion, were called upon to answer questions in regards to an application. In essence, there was a two way flow of information between contractors and inspectors and between inspectors and the OWRC GWB. Water well records were also kept in the regional offices and available for viewing at no charge.

Figure 4.1: Well Driller Governance Units, 1966-70, ON



The OWRC GWB was responsible for developing and administering Ontario's water well regulatory framework. They accomplished this with input from the local Offices, contractors, the OGWA and with information from the OWRC Research Division. In short, the OWRC GWB had final say in the issuance of licenses and were the "lead" for regulatory investigations and changes yet consulted widely with all parties throughout the process (OWRC, 1970; OWRC Annual Reports, 1966-1970; OWRC official (retired) & OGWA, interviews, 13 October 2006, 25 September and 11 October 2006). Educational activities also formed a prominent part of the OWRC GWB with staff presenting papers and manning a booth at the yearly OGWA convention and hosting two conferences for water well contractors (1968, 1971) to present research on such topics as well construction (OWRC, 1968, 1972).

The OGWA's core activities were primarily in lobbying, educating and socializing/networking with involvement at both the local and provincial levels. Locally, the OGWA assisted drillers with licensing applications and with mediation services when problems arose (OGWA official, interview, 11 October 2006). Provincially, the association represented members to the OWRC and worked with the OWRC to educate their membership through seminars held at their Annual Conventions with summaries printed in the Convention's "Souvenir Programme". Opportunities to network and socialize were plentiful either at local district meetings (nine/yr) and/or at the Annual Convention which incorporated dinners, dances and tours of the local area (see, for instance, any OGWA Annual Convention "Souvenir Programme[s]"). The OGWA also worked to obtain a groundwater regulatory framework that both protected the public's interests and was feasible for implementation. For instance, much effort was directed at ensuring well contractors would continue to perform all installation functions related to water wells without having to bring in other licensed trades such as electricians which, it was argued, would unduly increase the complexity of a well's installation and place a financial burden on contractors (McLaughlin, 1968). The last thing they wanted was "poorly informed legislators [who could] very easily pass laws which [were] useless" (McLean, 1965).

Issues that could not be resolved locally between inspectors and contractors (and at times OGWA) would upon a summary offence proceed through the provincial court system.[20] Note that these cases were few and far between and "as long as one had a good relationship with all parties involved, when problems did arise, most people worked to fix the problems" (OWRC official (retired), interview, 13 October 2006). In fact, drillers fixed problems "as soon as possible" since they "were for the most part a conscientious group that took pride in their work" (OWRC official, interview, 11 October 2006). While few cases ever went to court; less than one per year per inspector according to two former water well inspectors (OWRC officials, interviews, 11, 13 October, 2006), those that did ended up in Provincial Court, a court that hears less serious offences. Appeals of decisions to higher courts were possible as shown in Figure 4.2.

Figure 4.2: Ontario's Court System

Supreme Court of Canada	• Hears appeals on questions of constitutional law.
↑ ↑ ↑	
Ontario Court of Appeal	• Hears appeals on questions of law.
↑ ↑ ↑	
Ontario Superior Trial Court	• Hears appeals on questions of facts or law.
↑ ↑ ↑	
Provincial Courts	• Summary offences start here.

Throughout this time frame, as previously discussed, the OWRC Research Division was concerned with a wide range of research activities related to water quality and quantity. For instance, several studies related to groundwater availability were undertaken and the Division was "continually review[ing] literature and keep[ing] informed of general engineering and scientific progress" (OWRC, 1969).

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[20] A summary offense is a minor criminal offense (e.g. license revocation) tried by a judge or magistrate without a jury or preliminary hearing.

Note the emphasis was on the physical aspects of groundwater and not the governance aspects.

Table 4.1: Linkage Types, Well Driller Regulations, 1966-1970, ON .

	OGWA	Local Off., OWRC	GW Br., OWRC	Res. Div. OWRC	Courts
OGWA	-----	F+/-, S	F+/-, S	F +	F+/-
Local Off. OWRC	F+/-, S	-----	F +, S	F +	S
GW Br., OWRC	F+/-, S	F +, S	-----	F +	S
Res. Div., OWRC	F +	F +	F +	-----	F neu
Courts	F+/-	S	S	F neu	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

Given the above discussions, the OGWA was functionally and strategically linked to the local OWRC Offices and the OWRC GWB while being functionally linked to the OWRC Research Division, as well as, the courts. This functional interdependency existed by the very nature of what each party did: OGWA represented its members, well drillers, to others; water well inspectors were located in local OWRC offices and inspected the work of well drillers, provided regulatory information and relayed driller concerns to "head office"; and the OWRC GWB processed licenses and developed legislation and associated regulations.

These functional interdependencies were negative or positive in nature depending on the success inspectors had in terms of finding deficiencies during inspections and the type of regulations developed. Yet, the good overall rapport inspectors had with contractors, the few regulatory charges laid, and the good reception of the regulations devised by the OWRC GWB by contractors indicated a positive relationship.[21]

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[21] The next few pages question the positiveness of the relationship, specifically, whether it was regulatory capture. While possible, the charge is dismissed due to outstanding enforcement issues (i.e.

Note that the relationship between OGWA and local OWRC Offices was also strategic in nature since OGWA acted on behalf of its members to highlight regulatory problems such as drilling wells to collect and dispose of storm water runoff and/or connecting agricultural tile drains to sinkholes to achieve the same purpose (e.g. Waterloo Hydrogeologic, 2004; OWRC official (retired), interview, 13 October 2006). In turn, local Offices expanded on this information and communicated it to the OWRC GWB. The OGWA and the OWRC GWB also shared a strategic relationship in that both worked together to develop a regulatory framework that protected the groundwater resource yet did not negatively impact well contractors which was highlighted in their collaboration to continue to allow well contractors to perform all installation functions without requiring the aid of other licensed trades.

Functional and positive interdependencies also existed between the OGWA and the Research Division and the courts. Simply put, OGWA represented well drillers while the Research Division conducted water availability studies throughout the province which aided well contractors in the location of potential water wells. Similarly, the courts adjudicated disputes that could not be settled by other means. Whether this functional interdependency was positive or negative depended on the outcome of the case at hand.

The linkage between local OWRC Offices and the OWRC GWB was functionally positive and strategic in nature since collectively they delivered the

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consistency) between the parties and the lack of contradictory evidence otherwise (e.g. from well owners).

OWRC's mandate in relation to groundwater. Functionally positive interdependencies existed between local OWRC Offices, the OWRC GWB and the Research Division. Both OWRC branches had a mandate to develop and deliver its groundwater program while the Research Division investigated groundwater availability in the province, information which increased the body of knowledge available from which to base future decisions. In addition, strategic links existed between local OWRC Offices, the OWRC GWB and the courts to ensure legislative and regulatory compliance.

4.2.1c 1966-1970: Complementarity of Linkages

governance visions (goals)

The goals of each governance unit are shown in Table 4.2 and goal similarities in Table 4.3. Most of the OGWA's goals were directly member oriented, such as promoting the welfare of its members. As such, the OGWA had a low similarity in governance goals with local OWRC Offices, the OWRC GWB and the courts. A low similarity in goals also existed between the OGWA and the OWRC Research Division since the OGWA did have a minor research component among its many goals.

Local OWRC Offices and the OWRC GWB had a high similarity in governance goals with the courts and with each other. Both units relied on the courts for aid in the enforcement of the regulations with local OWRC Offices directly inspecting and issuing summary offences while the OWRC GWB prosecuted non-compliers as required. Local OWRC Offices also had a low similarity in goals with the OWRC Research Division while the OWRC GWB had a medium similarity. Local OWRC Offices had little say in what research was done though they were occasionally called upon to help in the process (OGWA official, interview, 11 October 2006; Well Contractor, personal communication, 06 June 2007). As for the OWRC GWB, the OWRC Research Division complemented their regulatory revision and development aspects. No similarity in governance goals existed between the OWRC Research Division and the courts since each body simply performed different functions.

Table 4.2: Goals of Governance Units, 1966-1970, ON

Ontario Ground Water Association
• Foster, promote interests/welfare of members; • Promote simplification, standardization, interchangeability of drilling equipment; • Foster scientific education, research to improve water well construction; • Elimination unfair economic practices, and freedom from unjust/unlawful extractions; • Assist in maintaining/establishing uniformity and equity in customs, commercial usage of the water well contracting business; • Acquire, preserve, disseminate valuable business information; • Promote greater and friendly intercourse among industry and with other industries.
Local OWRC Office
• Field work for water well inspections, and all regulatory investigations and complaints.
Ground Waters Branch, OWRC
• Policy development; • Aid delivery of a) Well Management Program (licensing, well inspections, investigate regulatory complaints); and b) Water Management Program (processing PTTW applications; investigate water interference complaints; enforce legislative/permit rqts.)
Research Division, OWRC
• Conduct applied research on water quality; assess water supplies; • Review literature, keep informed of general engineering and scientific progress.
Courts
• Adjudicate disputes.

***communication level** (meeting frequency, proposals, personal communication)*

Communication levels between governance units were mixed. For instance, and of note, communication levels between the OGWA, local OWRC Offices and the OWRC GWB were high. Meetings were continually held during this time frame to discuss legislative and regulatory changes that largely occurred in 1969 (e.g. OWRC

Annual Reports, 1966, 1967; McClenaghan, 1974). Furthermore, the OWRC had half page ads in the "Official Program" of the OGWA Annual Convention from 1968-1970 thanking well contractors and the OGWA for their continued "close cooperation" enabling both to better serve Ontarians through "good well construction and resource planning" and noting the "favourable acceptance" of the new regulations (e.g. OGWA, *Souvenir Programme,* 1968, 1969). This close cooperation is also noted in the favourable legislation developed (e.g. no other licensed trades required in well construction).

Table 4.3: Linkage Complementarity Summary, 1966-1970, Well Driller Regulatory Change, ON

	OGWA	Local Off., OWRC	GW Br., OWRC	Res. Div. OWRC	Courts
Governance Vision (Goals)					
OGWA	-----	Low	Low	Low	Low
Local Off., OWRC	Low	-----	High	Low	High
GW Br., OWRC	Low	High	-----	Moderate	High
Res. Div., OWRC	Mod.	Low	Moderate	-----	-nil-
Courts	Low	High	High	Low	-----
Communication Level (Meetings, Proposals, Personal Communication)					
OGWA	-----	High	High	Moderate	Low
Local Off., OWRC	High	-----	Moderate	Moderate	Low
GW Br., OWRC	High	Moderate	-----	Moderate	Low
Res. Div., OWRC	Mod.	Moderate	Moderate	-----	Low
Courts	Low	Low	Low	Low	-----
Frequency and Type of Collaboration					
OGWA	-----	High	High	Low	Low
Local Off., OWRC	High	-----	Mod./High	Low	Low
GW Br., OWRC	High	Mod/High	-----	Low	Low
Res. Div., OWRC	Low	Low	Low	-----	Low
Courts	Low	Low	Low	Low	-----

For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

High communication levels are also seen in the number of OWRC speakers at OGWA Annual Conventions, the articles by OWRC officials in the Convention's *Souvenir Programme*, the manning of a OWRC display booth at such conventions and in the OWRC conferences previously noted (OGWA Annual Convention *Souvenir Programmes*, 1966-1970). The OWRC not only wanted to disseminate information to OGWA and its members but also learn from them through open and frank discussions (OWRC official (retired), interview, 13 October 2006).

The relationship between the OGWA, its members and local OWRC Offices was one characterized by high communication levels due to the nature of the work each party performed. Building long term relationships and avoiding adversarial prosecution processes were important as a former OWRC Inspector noted, "a court settles nothing except who pays for what...[they are] too adversarial and do not make friends and build relationships" (OWRC official (retired), interview, 13 October 2006). Numerous members of all units attended the conventions and conferences that were held which increased the opportunity to exchange ideas and work towards a more comprehensive regulatory framework though one former inspector noted that the social element, that is, the "schmoozing" between officials and contractors was, at times, perhaps "in bad taste" (OWRC official, interview, 13 October 2006). This high communication level between the OGWA members and especially inspectors was likely the cause of low communication levels between all parties and the courts.

Communication levels between local OWRC offices and the OWRC GWB were moderate in that the local Offices largely carried out their tasks and routinely submitted reports to the OWRC GWB. Regulatory investigations and prosecutions necessitated more frequent communication between the two yet, as previously noted, few prosecutions occurred largely due to field staff that worked out a local solution to the problem which the OWRC GWB typically approved (OWRC officials (retired), interviews, 11, 13 October 2006; Well Contractor, personal communication, 06 June 2007).

frequency and type of collaboration

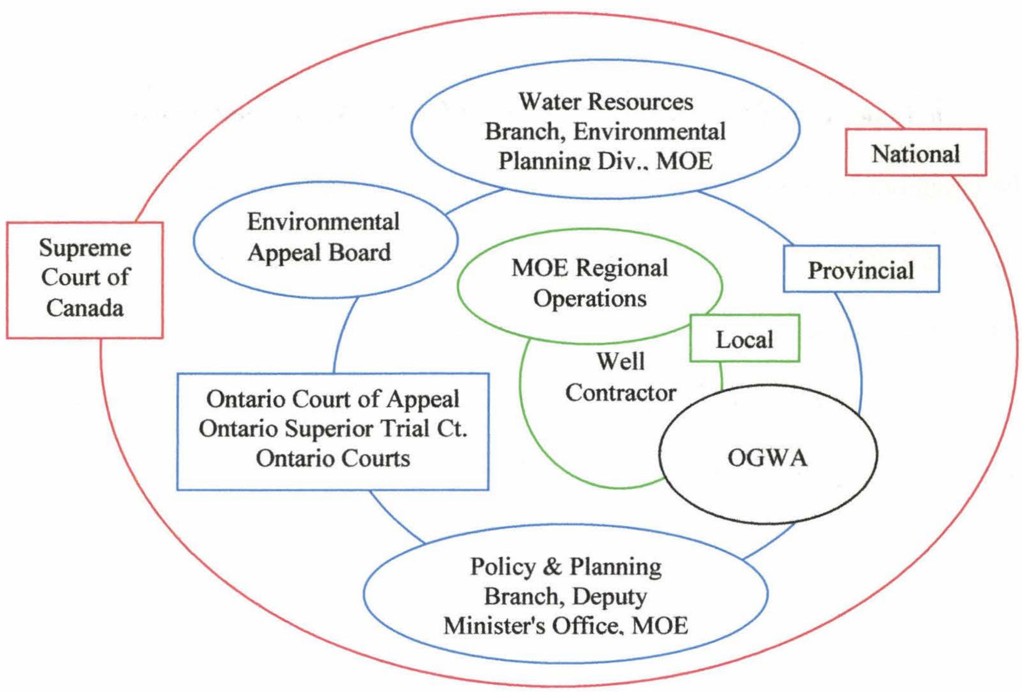
The preceding discussion reveals collaboration levels. First, low levels of collaboration existed between the courts and all other governance units due to the few number of cases that made it to court each year. Second, low collaboration levels also existed between the OWRC Research Division and all other governance units. While communication levels were moderate through the dissemination of information, the actual collaborations in projects were few.

In contrast, a high collaboration level existed between the OGWA and local OWRC Offices and the OWRC GWB as evidenced in the planning of the educational portions (e.g. seminars) of the conventions, work done to allow contractors to continue to perform all water well installation functions, as previously discussed, and the collaboration involved in mediating regulatory infractions at the local level. These activities consumed a large portion of time for all parties involved. Finally, collaboration levels were moderate to high between local OWRC Offices and the OWRC GWB which largely reflected a much smaller role in planning annual education events by the local OWRC Offices.

4.2.2a 1980-1984: Number of Governance Units

Nine overall governance units were active at this time as noted in Figure 4.3. Three vertical governance units (local, provincial, national) were present while there were two local, seven provincial and one national level horizontal governance units. Note the change from the OWRC to the Ontario Ministry of the Environment (MOE) which occurred in 1972. Local regional offices, renamed Regional Operations Division[22], remained and largely carried out the same functions as the old local OWRC Offices. The Water Resources Branch (WRB) of the Environmental Planning Division assumed the functions formerly delivered by the OWRC GWB along with the groundwater research component.

Figure 4.3: Well Driller Governance Units, 1980-1984, ON



[22]By 1984 there were six Regional Offices and nineteen smaller District/sub-District offices (OMOE, 1985).

A new governance unit, the MOE Policy and Planning Branch (PPB) of the Deputy Minister's Office, identified broad program and resource needs of the Ministry and had a large co-ordination role in terms of policy development, planning, and research needs (OMOE Annual Reports, 1980-1984).

No changes occurred with the OGWA and with existing adjudication bodies, however, one additional adjudication body was added in 1974, the MOE Environmental Appeal Board (EAB). Any Director's decision (e.g. refusal to issue a license) could be first appealed (on questions of fact) to the EAB then to the Minister of the Environment, a political appointment, for a final decision. Appeals on questions of law were appealed through the court system and then referred to the EAB (OEPA, RSO 1980).

4.2.2b 1980-1984: Types of Linkages

Linkage types are summarized in Table 4.4. The OGWA's core activities remained in lobbying, educating and networking. Lobbying efforts were directed at instituting a certification-based licensing program to address driller competency. Voluntary well driller certification began in 1978 and became mandatory in 1984 after the Minister became personally involved (OGWA, Souvenir Program, 1978).[23] The OGWA's educational activities remained unchanged and included the co-facilitation of written MOE Certification Exams at their Annual Conventions.

Regional Offices continued the work of the former local OWRC Offices in

[23] The Minister, Harry Parrott, became involved accidentally, after well problems were experienced by his daughter. As a retired inspector noted, upon inspection, with the Minister present, and being informed of pending changes that addressed the deficiencies, the Minister ordered the regulatory changes, which were "with the lawyers the past few years", to be completed and on his desk within days after which legislative progress was "swift" (OMOE official, interview, 13 October 2006).

relation to receiving licensing applications, water well inspections and regulatory investigations. Tensions arose in relation to the transfer of water well records to the MOE WRB in Toronto due to their lack of understanding of the records' significance and operation and to reduced access for contractors. This lack of understanding was also evident in inspection and enforcement issues with "head office people...ha[ving] no knowledge of what was out there...not want[ing] to learn what was out there and...not respect[ing] the fact they needed this knowledge" (OMOE official (retired), interview, 13 October 2006). Furthermore, inspectors had to continually justify "why [they] were there" and noted being asked "why do we need you...why do we have you" (OMOE official (retired), interview, 13 October 2006). Essentially there was "no interest" in wells from the central offices. This is also seen in prosecutory activity with prosecutors lacking knowledge on the subject matter, having their own agendas, omitting inspectors from testifying and often not informing inspectors of court dates and progress on cases. Inevitably, inspectors felt this lost them cases (OMOE officials (retired), interviews, 11, 13 October 2006).

Table 4.4: Linkage Types, Well Driller Regulations, 1980-1984, ON

	OG-WA	MOE Reg. Op.	MOE Water Res. Br.	MOE Pol/ Plan. Br.	En. App. Bd.	Courts
OGWA	-----	F+/-, S	F -	F -	F +	F+/-
MOE Reg. Op.	F+/-, S	-----	F -	F -	F +	F+/-
MOE Water Res. Br.	F -	F -	-----	F -	F +	F+/-
MOE Pol/Plan Br.	F -	F -	F -	-----	F +	F+/-
Env. App. Bd.	F+/-	F +	F +	F +	-----	Fn
Courts	F+/-	F+/-	F+/-	F+/-	Fn	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

The MOE WRB performed the core water and well management functions though less emphasis was placed on these functions as attention was diverted to larger projects such as upgrading drinking water quality objectives and contaminants in sport fish. Policy development was a prime responsibility for the MOE WRB with the MOE PPB assuming a coordination role (OMOE Annual Reports, 1980-1984).

The OGWA and MOE Regional Operations were linked functionally due to the nature of their work; one represented members who constructed water wells while the other inspected such wells for regulatory conformance. This relationship could either be positive or negative depending on deficiencies found. Furthermore, the two were strategically linked in that they worked closely together in developing a certification program that included pump installers where each felt the majority of problems occurred (e.g. OGWA Annual Convention *Souvenir Program*, 1980-1984; OMOE official (retired), interview, 13 October 2006). This close relationship did not transfer over to the MOE WRB nor to the MOE PPB where the OGWA was functionally linked to each in a negative manner, which is demonstrated by the fact that regulatory development was stalled for over ten years at the provincial level between the two MOE Branches. As previously noted, the Minister's involvement was needed to overcome delays. The MOE Regional Operations were functionally linked in a negative way to both MOE central office branches for the same reasons as were the two provincial MOE Branches.

All governance units, except the formal court system, were linked to the Environmental Appeal Board in a positive and functional way. The linkage was functional due to the adjudication services the body performed on the area in question and the relationship was positive due to the fact that the EAB was a less costly, more timely and accessible forum for all parties. The EAB and the courts were functionally linked but that relationship was neutral in nature.

4.2.2c 1980-1984: Complementarity of Linkages

governance visions (goals)

The goals of each governance unit are shown in Table 4.5 and similarities are summarized in Table 4.6. The OGWA had a low similarity in goals with all other governance units noted by the fact that any similarity that occurred in terms of licensing and policy development was eroded by the much broader and diffuse goals of the other units which minimized the importance of water well regulatory issues.

Table 4.5: Goals of Governance Units, 1980-1984, ON

Ontario Ground Water Association
• Foster, promote interests/welfare of members; • Promote simplification, standardization, interchangeability of drilling equipment; • Foster scientific education, research to improve water well construction; • Elimination unfair economic practices, and freedom from unjust/unlawful extractions; • Assist in maintaining/establishing uniformity and equity in customs, commercial usage of the water well contracting business; • Acquire, preserve, disseminate valuable business information; • Promote greater and friendly intercourse among industry and with other industries.
MOE Regional Operations
• Regulate pollution sources; construction and operation of wells; storage/use pesticides; • Oversee development, operation, closure of waste management sites; • Manage, operate Ministry water & sewage systems; • Monitor quality of natural environment; control major noise sources; • Regulate water use; respond to public complaints, environmental emergencies; • Evaluate projects and monitor environmental assessment recommendations.
MOE Water Resources Branch, Environmental Planning Division
• Water Management including a) Develop Water Quality Objectives, b) Well Mgt. Program (licensing, inspections, investigate regulatory complaints, develop regulations), c) Water Mgt. Program (process PTTW applications, investigate water interference complaints, enforce legislative/permit rqts.); • Water Resource Inventories; Engineering, Scientific Data Service; • Larger environmental studies such as Sudbury Environmental Study, Grand River Study; pollutant inventory in Sport Fish; Great Lakes Program (surveillance, investigation, assessment program re data and information aquatic conditions nearshore areas).
MOE Policy & Planning Branch, Deputy Minister's Office
• Analyze policies/programs; co-ordinate policy development; central agency liaison; • Develop, maintain planning system, management processes; • Socio-economic analysis of proposed policies, undertakings; • Co-ordinate, evaluate research priorities/performance, allocates research resources.
Environmental Appeal Board & Courts
• Adjudicate disputes.

A low similarity also existed between the MOE Regional Operations and the MOE WRB based on the fact that activities related to water wells were "lost" in the broader mandate of the MOE WRB. Likewise, a low similarity existed between the MOE Regional Operations and the MOE PPB, which had different goals. Note that these units could have complemented each other, yet the delays introduced in legislative and regulatory development, previously discussed, proved otherwise.

The MOE Regional Operations and the MOE WRB both had moderate similarities in relation to the EAB and the courts due to their similar regulatory enforcement and adjudication roles. A moderate similarity in goals also existed between the two central office branches based on the fact both had a regulatory development function. The EAB and the courts, to state the obvious, had a high similarity in goals with both concerned with the adjudication of decisions.

***communication level** (meeting frequency, proposals, personal communication)*

No major changes in communication levels occurred during this time frame. This was largely due to the fact that work on the major issue of contractor certification had been ongoing since 1969 with agreement reached in 1976 (OGWA Annual Convention Program, 1976). In fact, by 1979 the OGWA and the MOE WRB were experiencing "a lull in negotiations" due to the pending passing of legislative and regulatory revisions which were continually delayed for reasons noted above (OGWA Annual Convention Program, 1979).[24] However, meetings with the MOE WRB were held "from time to time...[to]...keep the lines of communication open"

[24]This included delays due to elections held 09 June 1977 and 19 March 1981.

(OGWA Annual Convention Program, 1979) and the MOE WRB attended seven OGWA district meetings in 1981 and five in 1982 to keep everyone updated on the status of the proposed changes (OGWA Annual Convention Program, 1981, 1982). In addition, the WRB attended at least one OGWA Board meeting every year and the OGWA President was asked to speak to a "closed shop seminar" of MOE personnel in Belleville in 1981. Moreover, staff from the WRB and Regional Operations attended and presented papers at the OGWA Annual Conferences. The OGWA and the MOE WRB also co-sponsored a one day seminar in 1982 to resolve inconsistencies in well completion techniques. Note, however, that the MOE terminated their advertisements in the OGWA's Convention *Souvenir Program* in 1982 (OGWA Annual Convention Programs, 1979-1982).

Table 4.6: Linkage Complementarity Summary, 1980-84, Well Driller Regs., ON

	OG-WA	MOE Reg. Op.	MOE Water Res. Br.	MOE Pol/ Plan Br.	En. App. Bd.	Courts
			Governance Vision (Goals)			
OGWA	-----	Low	Low	Low	Low	Low
MOE Reg. Op.	Low	-----	Low	Low	Mod.	Mod.
MOE Water Res. Br.	Low	Low	-----	Mod.	Mod.	Mod.
MOE Pol/Plan Br.	Low	Low	Mod.	-----	Low	Low
Env. App. Bd.	Low	Mod.	Mod.	Low	-----	High
Courts	Low	Mod.	Mod.	Low	High	-----
			Communication Level (Meetings, Proposals, Personal Communication)			
OGWA	-----	High	Mod.	Low	Low	Low
MOE Reg. Op.	Low	-----	Mod.	Low	Low	Low
MOE Water Res. Br.	Mod.	Mod.	-----	Mod.	Low	Low
MOE Pol/Plan Br.	Low	Low	Mod.	-----	Low	Low
Env. App. Bd.	Low	Low	Low	Low	-----	Low
Courts	Low	Low	Low	Low	Low	-----
			Frequency and Type of Collaboration			
OGWA	-----	High	High	Low	Low	Low
MOE Reg. Op.	High	-----	Mod.	Low	Low	Low
MOE Water Res. Br.	High	Mod.	-----	Mod.	Low	Low
MOE Pol/Plan Br.	Low	Low	Mod.	-----	Low	Low
Env. App. Bd.	Low	Low	Low	Low	-----	Low
Courts	Low	Low	Low	Low	Low	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

High communication levels between the OGWA and MOE Regional Operations continued due to frequent interactions with members in regards to inspections, enforcement, regulatory investigations and activities held at Conventions and Seminars. In contrast, the OGWA had low communication levels with the MOE PPB based on the lack of correspondence found in archival documents and the lack of MOE PPB personnel attendance at the OGWA Conventions and the MOE/OGWA seminar (OGWA, Annual Convention *Souvenir Programs*, 1979-1984; OMOE official (retired), interview, 13 October 2006).

Communication between MOE Regional Operations and the MOE WRB was moderate and task based. In other words, information and reports, such as inspection data and commenting on policy papers, were forwarded to the MOE WRB by MOE Regional Operations while MOE Regional Operations were not necessarily kept up to date on regulatory prosecutions, as previously noted (MOE Annual Reports, 1979-1984). Regional Operations' requisitions were also "routinely lost" in the bureaucracy for months (OMOE Official (retired), interview, 13 October 2006). In essence, communication was there, though largely one way from Regional Operations to the WRB. Little to no communication existed between the PPB and Regional Operations with a former Regional Operations Official noting that PPB felt they knew everything while a current Official stated the "old way of doing things where policy was *dictated* from the top down created much animosity and conflict" (emphasis added; OMOE officials (retired and current), 13 October 2006 and 09 March 2007 respectively).

Communication levels between the MOE WRB and the MOE PPB were mixed. Prior to 1981, little communication existed based on the fact that the legislative changes had been "buried" for years. The "swiftness" with which regulatory change occurred, after the Minister's involvement, necessitated much communication between the two units which is assessed as moderate reflecting both the relative inactive earlier period and the flurry of activity that followed (see MOE Annual Reports before and after 1981).

All governance units had low levels of communication with both the EAB and the courts, which was reflected in the few cases that reached these governance units. This, again, reflected the high level of communication that occurred between the OGWA, its members and inspectors located in MOE Regional Operations.

frequency and type of collaboration

Collaboration levels closely resembled communication levels (see Table 4.6). A high degree of collaboration was found between the OGWA, MOE Regional Operations and the MOE WRB. This was seen in the work done in mediating regulatory infractions and in responding to groundwater investigations. In addition, the OGWA and the MOE WRB co-sponsored a seminar in 1982 and collaborated in bringing MOE staff to speak at OGWA district meetings and Annual Conventions previously noted. Much work was also done between them to initiate the voluntary contractor certification requirements including examinations held at the OGWA Annual Conventions starting in 1978.[25]

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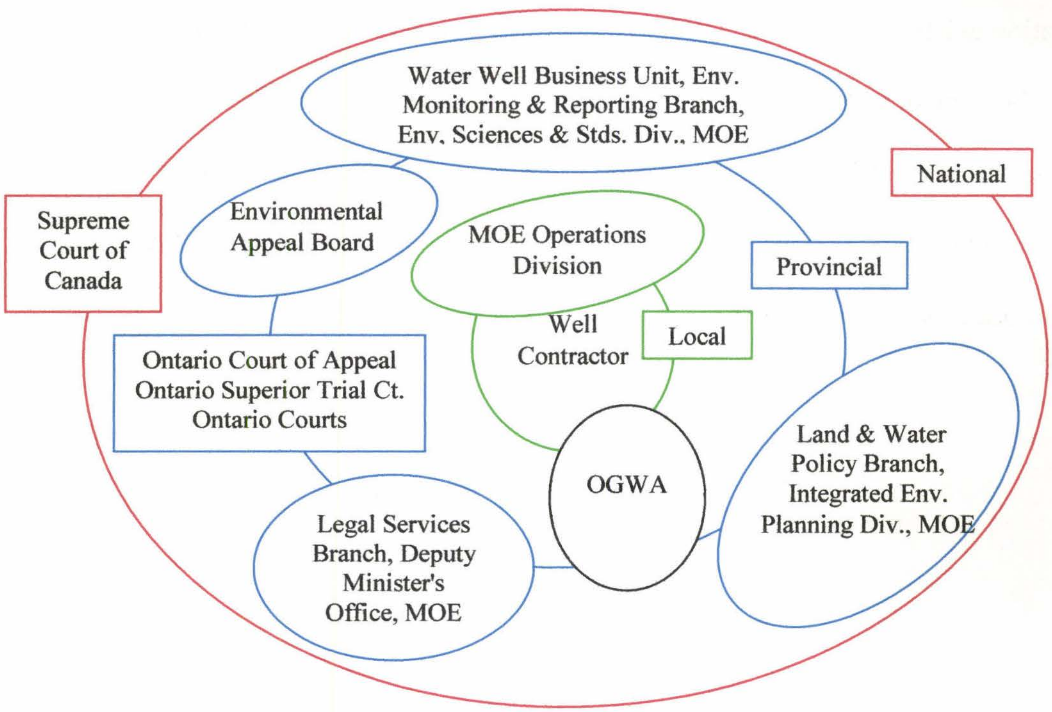
[25]Progress can be tracked via OGWA Annual Conventions *Souvenir Programs*, 1972-1984.

Collaboration between the OGWA and the MOE PPB was low to non-existent with the OGWA historical records revealing little communication and no collaborative efforts. A similar situation existed between the MOE Regional Operations and the MOE PPB while a moderate amount of collaboration existed with the MOE WRB, as noted above, in terms of regulatory infraction and other groundwater investigations (OMOE Annual Reports, 1980-1984; OMOE officials (retired), interviews, 11, 13 October 2006). Note that a moderate amount of collaboration existed between the MOE WRB and the MOE PPB based on the work needed to be done once legislative and regulatory changes were prioritized by the MOE PPB due to the minister's involvement. Low levels of collaboration existed between the adjudicative bodies and the other governance units, again, due to the infrequent use of such procedures.

4.2.3a 2000-2004: Number of Governance Units

This period was marked by ten governance units overall, as shown in Figure 4.4 including three vertical governance units (local, provincial, national) and two local, eight provincial and one national horizontal governance units. Governance changes in this period were more cosmetic than anything with no changes occurring in the adjudication procedures or with the OGWA.

Figure 4.4: Governance Units, Well Driller Regs., 2000-2004, ON



Little change occurred within the MOE Operations Division though an Investigations and Enforcement Branch (IEB) and a Sector Compliance Branch (SCB) were formally developed within the Division. The IEB simply reflected the consolidation and recognition of the functions that were already being performed by the Operations Division while the SCB performed regulatory "sweeps" on continuing problem sectors to improve compliance (MOE Business Plans, 1999-2003; MOE, Undated; Interviews with MOE officials 21 February and 09 March 2007). Note that water well inspections no longer existed, having been terminated in the mid-1990s (OMOE official, interview, 21 February 2007).

Similarly, the MOE PPB was reorganized into the Land and Water Policy Branch (LWPB) of the Integrated Environmental Planning Division. In the process, it assumed most of the planning functions that were formerly done by the MOE WRB, as well as, its own existing policy and planning functions such as coordination. Also, the Water Well Business Unit (WWBU; Environmental Monitoring and Reporting Branch, Environmental Sciences and Standards Division) was created to process licenses and to manage the water well database (OGWA & OMOE officials, interviews, 25 September 2006 and 21 February 2007).

4.2.3b 2000-2004: Types of Linkages

The core governance unit activities did not change significantly though much reorganization took place. The events that occurred in Walkerton, Ontario may have placed groundwater and wells high on the government's agenda, yet this occurred within the upper echelon of government at the expense of the more local governance units. Table 4.7 shows the linkage types for the period 2000-2004.

The OGWA's core activities of lobbying, educating and networking did not change. For instance, they continued to pursue licensing changes to align well drilling along apprenticeship training programs (minimum classroom instruction, work hours and continuing education hours per year) with the goal of eventually having well drilling officially recognized as a licensed trade (OGWA Annual Reports 1997-1999; Marquardt, 2002; OMOE official, interview, 26 March 2007). They also pursued well construction and abandonment changes (OGWA, 2001). No changes in linkage type occurred between the OGWA and any of the adjudication bodies including the Legal Services Branch, of which the relationship had largely become irrelevant since no mandatory inspections and few prosecutions occurred. A similar situation existed with the other governance units and the adjudication bodies.

Table 4.7: Linkage Types, 2000-2004, Well Driller Regs., ON

	OG-WA	MOE Op. Div.	Water Well B. U.	Land/Water Pol. Br.	Legal Ser. Br.	En. App. Bd.	Courts
OGWA	-----	F neu	F neu	F -, S	F -	F +	F+/-
MOE Op. Div.	Fneu	-----	F neu	F -	F -	F +	F+/-
Water Well B. U.	Fneu	F neu	-----	F +	F neu	F +	F+/-
Land/Water Pol. Br.	F-,S	F -	F +	-----	F+/-, S	F +	F+/-
Legal Ser. Br.	F -	F -	F neu	F+/-, S	-----	F neu	F neu
En. App. Bd.	F +	F +	F +	F +	F neu	-----	F neu
Courts	F+/-	F+/-	F+/-	F+/-	F neu	F neu	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative;
Fn, F neu = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

The linkage between the OGWA and the MOE Operations Division was functional and neutral in nature due to their respective functions. Functionality is shown by the fact that the OGWA worked closely with its members on the ground to investigate regulatory issues as required (OGWA officials, interviews, 25 September and 11 October 2006). However, the fact that there were few investigations during the time frame and the fact that regular well inspections were no longer part of the MOE Operations mandate made the overall relationship neutral reflecting much less interaction between the two.

A similar relationship existed between the OGWA and the MOE WWBU. On the whole, few license applications were rejected, yet the water well record information system remained unmanageable and unreliable since few updates had been done since the 1980s (OGWA, Annual Report 1996; OMOE & OGWA officials, interviews, 21 February, 2007, 13, 11 October 2006 respectively; OMOE WWBU, personal communication, 17 November 2006).

At the same time, a strategic and a functionally negative relationship existed between the OGWA and the MOE LWPB. The relationship was strategic in that the two units worked together to address issues such as licensing and well abandonment though the co-operative effort was not achieved until the OGWA sent the LWPB a "strong letter" expressing their "disappointment" with earlier drafts (Wilson, 1998). The OGWA was "basically pleased" with the final product in 1999 though they were frustrated by delays in its implementation (Wilson, 1999; OGWA, 2001). This frustration quickly deepened when training and interpretation materials were not available for at least six months after the new regulations took effect and some materials, such as specified well caps were not produced nor available in Ontario ("Regulation 903 Questions", 2003). Evidence also suggests that the LWPB did not itself know how to interpret the new regulations since it was written "by lawyers, for lawyers" while informing at least one contractor "[w]e can't interpret it ourselves, talk to your lawyer" (McCarten, 2003). Further attempts at regulatory clarification also proved fruitless since when directly asked what parts of the legislation were enforceable, an LWPB Official responded that "[t]he answers may come at a later date" ("Discover 903 Meetings", 2003). Combined, these illustrate the negative functional relationship that existed.

The MOE Operations Division had a functionally neutral relationship with the MOE WWBU since it responded to regulatory investigations reported to the MOE WWBU. Furthermore, the above discussion highlights a functionally negative relationship between the MOE Operations Division and the MOE LWPB reflecting the MOE Operations Division's lack of participation in regulatory development, non-enforceable regulations and the lack of staff to enforce them ("Discover 903 Meetings", 2003; McCarten, 2003; OMOE official, interview, 09 March 2007).

The MOE WWBU had a functionally positive relationship with the MOE LWPB since it delivered the program to meet the goals set out by the LWPB. The MOE WWBU also played a significant role in educating the industry about the regulatory changes through many regional meetings after the regulations were introduced (seven such meetings were held in 2003-2004; see *The Source*, 2003-2004 for details).

4.2.3c 2000-2004: Complementarity of Linkages

***governance visions** (goals)*

The goals of each governance unit are shown in Table 4.8 and similarities summarized in Table 4.9. The OGWA had a low similarity in goals with MOE Operations Division based on the fact that Operations had little impact on water well construction having lost their inspections function, with little to no enforcement activity, and by having a more diverse set of goals. Goals were moderately similar between the OGWA, the MOE WWBU and the MOE LWPB recognizing the specific functions of the former and increased awareness placed on both since the Walkerton water tragedy. A low similarity in goals existed between OGWA and the MOE Legal Services Branch and the other adjudication bodies which reflects the lack of emphasis placed on enforcement overall ("OGWA Regional Meetings", 2003; Morwood, 2003).

<u>Table 4.8: Goals of Governance Units, 2000-2004, Well Driller Regs., ON .</u>

Ontario Ground Water Association
• Foster, promote interests/welfare of members; • Promote simplification, standardization, interchangeability of drilling equipment; • Foster scientific education, research to improve water well construction; • Elimination unfair economic practices, and freedom from unjust/unlawful extractions; • Assist in maintaining/establishing uniformity and equity in customs, commercial usage of the water well contracting business; • Acquire, preserve, disseminate valuable business information; • Promote greater and friendly intercourse among industry and with other industries.
MOE Operations Divisions
• Responsible for program delivery in relation to: -protecting air quality; surface and ground water quality and quantity; -ensure appropriate management of wastes; control use of pesticides; -administer approvals, licensing programs, investigative and enforcement program; -responsible for environmental assessment and approvals.
MOE Water Well Business Unit
• Deliver Water Well Programs including: -Water Well Help Desk, contractor, technician licensing, manage water well records.
MOE Land & Water Policy Branch
• Policy, program development to protect/restore the quality/quantity of Ontario's water; • Collaborate with other jurisdictions/governance units in policy, program development; • Analyze/co-ordinate policies and programs, policy development; • Liaison with central agencies.
Legal Services Branch, Deputy Minister's Office
• General counsel on interpretation of statutes and regulations, preparation and review of proposed legislation, regulations and other legal documents; • Conduct prosecutions, act as counsel at environmental hearings, represent the ministry and instruct, support, and counsel on civil claims against the ministry and the province.
Environmental Appeal Board & Courts
• Adjudicate disputes.

The similarity in goals between the MOE Operations Division and all other governance units was low. This was due to the fact that regular inspections were no longer done, that they had different aspects of the mandate to deliver and, in particular, they had little to no role in regulatory development (OMOE officials, interviews, 09 and 26 March 2007). A similar situation existed in relation to the

MOE WWBU and the MOE LWPB and all adjudication services. The MOE WWBU had a narrow administrative mandate that could provide basic information to the other units when required. The MOE LWPB had a moderate similarity in goals with all adjudication services since it largely crafted the legislation and regulations that the other units interpreted and enforced. All adjudication services had highly similar goals.

communication level ***(meeting frequency, proposals, personal communication)***

Communication patterns were low throughout this period except for a couple of notable exceptions. One exception to this trend was in communications between the LWPB and the Legal Services Branch where communication levels were moderate. This can be seen by the fact that the regulatory changes that occurred were drafted from a legal perspective and resulted in the inability of OGWA and MOE staff to decipher their specific intent, as noted above. Drafts of the changes were also exchanged between the units on a regular yet infrequent basis (MOE officials, interviews, 09, 26 March 2007).

Second, communication levels between the OGWA and the MOE WWBU and the MOE LWPB was high. Much communication centred on unlicensed contractors doing pump installations with the OGWA and its members continually reporting such activities to the Operations Division and the MOE WWBU ("Put Those Complaints In Writing", 1999; "OGWA Regional Meetings", 2003; Morwood, 2003). By 2003, the Operations Division admitted that it lacked the staff to enforce regulations on unlicensed contractors, that current staff were "mostly unfamiliar with wells", and that it was "*not* the job of people in the ministry to deal with unlicensed contractors and technicians" (emphasis added; "OGWA Regional Meetings", 2003). Evidence of high communication levels was also found in the fact that MOE officials attended several OGWA Regional Meetings (twelve between Fall 2002-Winter 2004) and the OGWA Annual Convention to discuss the new regulation that came into effect (see *The Source*, OGWA's quarterly newsletter for an in depth review). Communication levels were even higher when one considers the educational activities these governance units collaborated in including print, video and open public forums on well protection (sixty one forums in 2003-2005), and certification exams held at the OGWA Annual Conventions (*Well Aware: A Well Owner's Video*, 2002; OGWA and Green Communities Association, 2003; Agriculture and Agri-Food Canada & OMAFRA, 2003). The planning and delivery of these types of activities provided ample opportunity to discuss ongoing concerns. Overall, the OGWA felt they had a "strong working relationship" with the MOE LWPB and the MOE WWBU despite the ambiguous wording in the new regulation (OGWA, 2004).

Communications between the Operations Division and all other governance units were low given the lack of inspections, the "top-down" policy development process and "need to know" information basis that existed at the time ("OGWA Regional Meetings", 2003; Interview with MOE Official, 09 March 2007). In contrast, communication levels between the MOE WWBU and the MOE LWPB was high given the collaboration required to explain regulatory changes to the OGWA and its members and work on other projects previously discussed.

Table 4.9: Linkage Complementarity Summary, 2000-04, Well Driller Regs., ON

	OG WA	MOE Op. Div.	Water Well B. U.	Land/Water Pol. Br.	Legal Ser. Br.	En. App. Bd.	Courts
Governance Vision (Goals)							
OGWA	-----	Low	Mod	Mod	Low	Low	Low
MOE Op. Div.	Low	-----	Low	Low	Low	Low	Low
Water Well B. U.	Mod	Low	-----	Low	Low	Low	Low
Land/Water Pol. Br.	Mod	Low	Low	-----	Mod	Mod	Mod
Legal Ser. Br.	Low	Low	Low	Mod	-----	High	High
Env. App. Bd.	Low	Low	Low	Mod	High	-----	High
Courts	Low	Low	Low	Mod	High	High	-----
Communication Level (Meetings, Proposals, Personal Communication)							
OGWA	-----	Low	High	High	Low	Low	Low
MOE Op. Div.	Low	-----	Low	Low	Low	Low	Low
Water Well B. U.	High	Low	-----	High	Low	Low	Low
Land/Water Pol. Br.	High	Low	Mod/High	-----	Mod	Low	Low
Legal Ser. Br.	Low	Low	Low	Mod	-----	Low	Low
Env. App. Bd.	Low	Low	Low	Low	Low	-----	Low
Courts	Low	Low	Low	Low	Low	Low	-----
Frequency and Type of Collaboration							
OGWA	-----	Low	High	High	Low	Low	Low
MOE Op. Div.	Low	-----	Low	Low	Low	Low	Low
Water Well B. U.	High	Low	-----	High	Low	Low	Low
Land/Water Pol. Br.	High	Low	High	-----	Mod	Low	Low
Legal Ser. Br.	Low	Low	Low	Mod	-----	Low	Low
Env. App. Bd.	Low	Low	Low	Low	Low	-----	Low
Courts	Low	Low	Low	Low	Low	Low	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

frequency and type of collaboration

Collaboration levels mirrored communication levels and largely involved the OGWA, the MOE WWBU and the MOE LWPB. Ample evidence of this is found in information and educational activities, including twelve "Discover 903 Regional Meetings" over a two year term to review changes to the regulatory framework, as previously discussed. However, collaborative efforts went beyond the meetings to include the continuation of certification exams held at the Annual Conventions, the development of a new industry training program delivered through Sir Sandford Fleming College in Peterborough (2002), frequent meetings (at least four) with

Minister Dombrowsky during 2004 (and another three in the Spring of 2005) and her key address at the OGWA Annual Convention in 2005, and the appointment of the OGWA Executive Director to the Expert Source Water Protection Implementation Committee in 2004 (See *The Source* 2002-2005 for specifics). These were in addition to the print, video and open public forums previously noted on well protection (*Well Aware: A Well Owner's Video*, 2002; OGWA & Green Communities Association, 2003; Agriculture and Agri-Food Canada & OMAFRA, 2003).

4.2.4 Preliminary Findings: Well Drilling Regulations and Organizational Environment

This section (4.2) has traced the organizational environment surrounding the evolution of well drilling regulations in Ontario from 1966 to 2004. In terms of policy changes, we note the increased specificity in licensing requirements. For instance, two categories of licenses were introduced in 1966-1970 which was later divided into three categories and four classes in the 1980-1984 period. At the same time, qualifications for licenses went from experienced based (two years, 1966-1970) to a combination of academic work, experience and exams (1980-1984) which was expanded in 2000-2004 to include a continuing education component. Similarly, well construction standards became increasingly more detailed over the period (e.g. pumps, abandonment) though some of the "rigidity" was loosened in the latter time frame (e.g. chlorination, pumps) (see Appendix IV). Enforcement procedures also became more elaborate with the introduction of the Environmental Appeal Board. The important point to note is the fact that changes in the legislative and regulatory framework represent changes in policy instrument settings and not in policy goals and/or the policy instruments themselves.

In terms of the organizational environment, a close working relationship existed between the governance units in the 1966-1970 period. This is in contrast to the next two time frames when the relationship became increasingly divisive or caustic as the organizational environment became more complex with groundwater issues more and more marginalized in the broader institutional mandates.

The next section examines the organizational environment surrounding water takings in Ontario.

4.3 Water Takings Independent Variable Summary

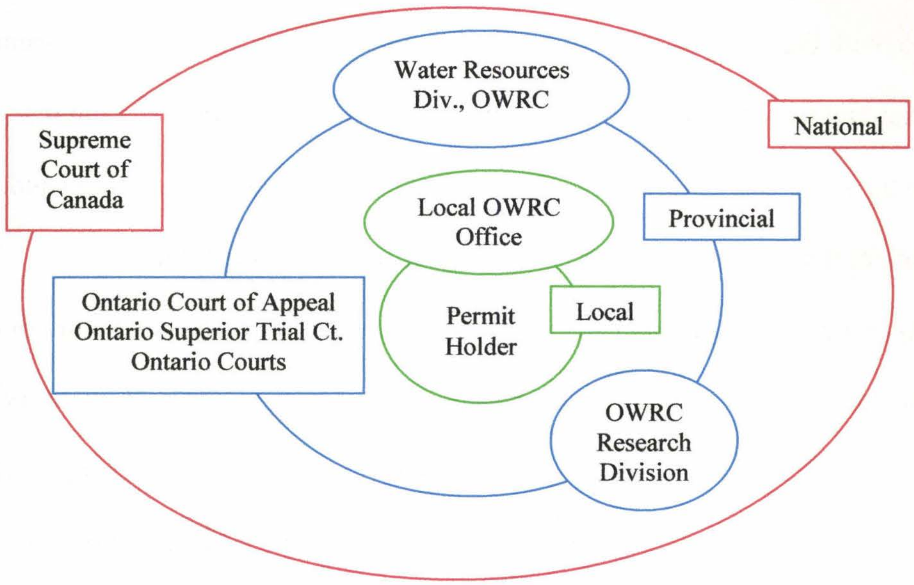
The effects of nested institutional arrangements on water takings, specifically permits-to-take-water (PTTWs) are examined over two time frames, 1958-1964 and 1999-2006, with the associated legislative and regulatory changes shown in Appendix V. The examination of water takings, our second dependent variable, is done in relation to the same independent variables as for well driller regulations. Restated, taking stock of the number of governance units serves as an indication of the complexity of nested institutional arrangements; linkage types reveal the nature of the relationship between governance units; and the assessment of the complementarity of linkages is an indicator of the likelihood of positive groundwater policy change. The time frames selected for study, as noted above, reflect the two periods when water takings legislative and regulatory changes occurred in Ontario.

4.3.1a 1958-1964: Number of Governance Units

Seven governance units affected PTTWs during this time frame as shown in Figure 4.5. This included three vertical governance units (local, provincial, national) and one local, five provincial and one national horizontal governance units. Note that these governance units are largely identical to those for well driller regulations except for two notable exceptions. First, there was no one industry group, such as the OGWA, that was responsible for water permit holders. Rather, the situation was characterized by direct interactions between permit holders and the governance units. Second, PTTWs were administered through the Water Management Program of the

OWRC Water Resources Division and not specifically the groundwater or surface water branch.

Figure 4.5: Water Takings Governance Units, 1958-1964, ON



4.3.1b 1958-1964: Types of Linkages

Linkage types are summarized in Table 4.10. Staff at local OWRC Offices largely played an intermediary role accepting PTTW applications and forwarding them to the WRD in Toronto. Application clarifications, when required, were investigated by the local OWRC Offices which also housed water permit inspectors (in addition to water well inspectors). These inspectors ensured compliance with the regulations, water permit conditions, and investigated any water taking interference complaints (e.g. OWRC Annual Reports, 1961-1967; OWRC official (retired), interview, 13 October 2006).

The OWRC WRD's core activities were much broader than the local Offices and included the administration (e.g. processing PTTW applications) and policy development functions of the Water Management Program (OWRC Annual Reports, 1961-1967). The Research Division of the OWRC, as previously discussed, performed research related to water quantity and quality and adjudication functions were identical to that found for well driller regulations during 1966-1970.

Within this framework, local OWRC Offices had functionally positive linkages with all governance units. This resulted from the basic functions it performed in that they had a large role in delivering the Water Management Program on the ground while the OWRC WRD formally reviewed permit applications. At the same time, the relationship was also strategic in that they acted together to achieve a particular end. The relationship with the courts while functional was positive or negative depending on the decisions reached by the courts.

Table 4.10: Linkage Types, Water Takings Governance Units, 1958-64, ON .

	Local OWRC Offices	OWRC Water Resources Div.	OWRC Research Div.	Courts
Local OWRC Offices	-----	F +, S	F +	F + or -
OWRC Water Res. Div.	F +, S	-----	F +	S
OWRC Research Div.	F +	F +	-----	F neu
Courts	F + or -	S	F neu	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

The OWRC Research Division had a functionally positive relationship with the main governance units. This was due to the function it performed which complemented the other units by increasing the body of knowledge available from which to base decisions. The OWRC Research Division's relationship with the courts was functionally neutral; the former increased the body of knowledge available while the latter adjudicated disputes. The OWRC WRD and the courts were strategically linked, that is, they were linked together to pursue their goals of legislative and regulatory enforcement.

4.3.1c 1958-1964: Complementarity of Linkages

***governance vision** (goals)*

The goals of each governance unit are shown in Table 4.11 and linkage similarities are summarized in Table 4.12. A high similarity in goals existed between local OWRC Offices, the OWRC WRD and the courts. The two OWRC governance units acted together to ensure program delivery and compliance while each participated in prosecutorial processes when required through the courts to ensure legislative and regulatory compliance (OWRC Annual Reports, 1961-1967; OWRC official (retired), interview, 13 October 2006). A low similarity in governance goals existed between the OWRC Research Division and the local OWRC Offices since each unit simply performed different functions. The local OWRC Offices dealt with then current conditions and regulations while the OWRC Research Division's work was taken into consideration in legislative and regulatory changes. Similarly, the OWRC WRD and the OWRC Research Division had moderately similar goals. The OWRC WRD policy development was based, to an extent, on the results of the OWRC Research Division's work while the OWRC WRD commanded specific research needed, such as water availability studies previously discussed under the well driller regulations. No similarity in goals existed between the OWRC Research Division and the adjudication units.

***communication level** (meeting frequency, proposals, personal communication)*

Table 4.11: Goals of Governance Units, Water Takings Regs., 1958-1964, ON

Local OWRC Offices
• Field work for PTTW and water well inspections; • Field work for all regulatory investigations and complaints.
Water Resources Division, OWRC
• Assesses, develops, controls surface and groundwater resources: a) Well Management Program (Groundwater Branch): • water well contractor licensing; • inspections; • investigating regulatory complaints; • revising, developing regulations. b) Water Management Program (largely Surface Water Branch): • processing PTTW applications; • enforcing legislative/permit rqts.; • investigating water interference complaints.
Research Division, OWRC
• Conduct applied research on water quality; assess water supplies; • Review literature, keep informed of general engineering and scientific progress.
Courts
• Adjudicate disputes.

Table 4.12: Complementarity Summary, Water Takings, 1958-1964, ON

	Local OWRC Offices	OWRC Water Resources Div.	OWRC Research Div.	Courts
	Governance Vision (Goals)			
Local OWRC Offices	-----	High	Low	High
OWRC Water Res. Div.	High	-----	Moderate	High
OWRC Research Div.	Low	Moderate	-----	-nil-
Courts	High	High	-nil-	-----
	Communication Level (Meetings, Proposals, Personal Communication)			
Local OWRC Offices	-----	Moderate	Low	Low
OWRC Water Res. Div.	Moderate	-----	Moderate	Low
OWRC Research Div.	Low	Moderate	-----	Low
Courts	Low	Low	Low	-----
	Frequency and Type of Collaboration			
Local OWRC Offices	-----	Moderate	Low	Low
OWRC Water Res. Div.	Moderate	-----	Low	Low
OWRC Research Div.	Low	Low	-----	Low
Courts	Low	Low	Low	-----

For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

A moderate level of communication between the main OWRC governance units existed during this time frame. The local OWRC Offices were given their roles and functions to fulfill and left to "do the job" with infrequent meetings (1-2/yr) with the OWRC WRD. Note that these meetings were productive in that serious consideration was given to input provided by those working directly in the field (OWRC official (retired), interview, 13 October 2007). This same moderate level of communication existed between the OWRC WRD and the OWRC Research Division though not between the OWRC Research Division and the local OWRC Offices. A broad and intensive research agenda was elaborated in the OWRC's early years with the Research Division left to carry it out while providing regular updates to the OWRC WRD (OWRC *Annual Reports*, 1956-1964). Local OWRC Offices had little to do with the OWRC Research Division unless their services were required to carry out the research (OWRC official (retired), interview, 13 October 2006). Low communication levels characterized the relationship between the OWRC governance units and the courts reflecting the few cases that were prosecuted for having no water permits (OWRC *Annual Reports*, 1956-1964; OWRC official (retired), interview, 13 October 2006).

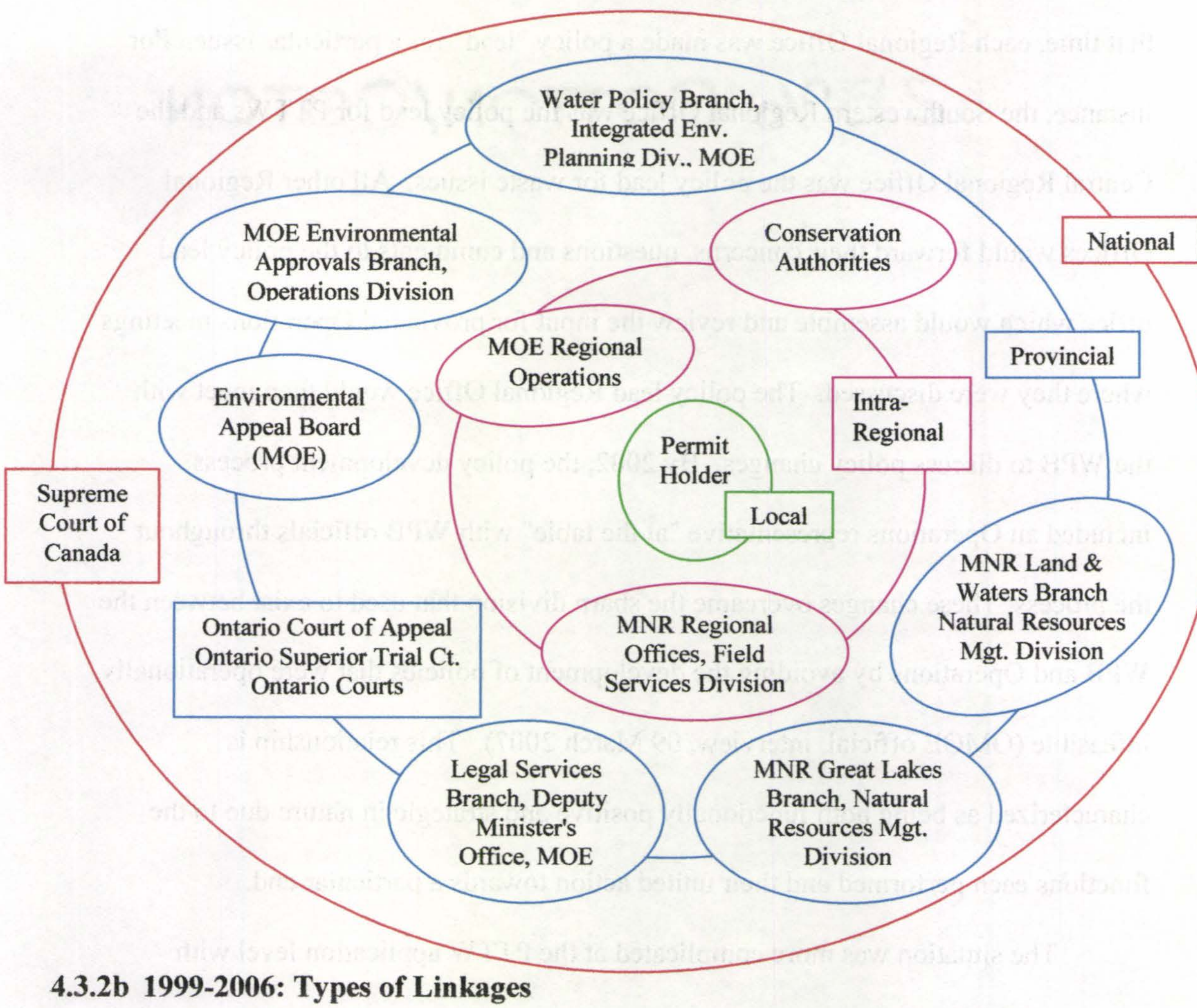
frequency and type of collaboration

Collaboration levels were mixed during the period. Collaboration between local OWRC Offices and the OWRC WRD largely surrounded water interference investigations and the processing of permit applications (OWRC *Annual Reports,* 1958-1964). Local Offices would typically investigate concerns and report and discuss their findings with the OWRC WRD who would then have the latitude to issue a final decision (OWRC official (retired), interview, 13 October 2006). Low collaboration levels existed between the OWRC Research Division and both other OWRC units, noting the fact that the OWRC Research Division had much autonomy in carrying out its research, as previously noted. Collaboration with the courts was low to non-existent due to the lack of prosecutions during the time frame.

4.3.2a 1999-2006: Number of Governance Units

Thirteen governance units affected PTTWs during this time frame as shown in Figure 4.6. There were three vertical governance units (intra-regional, provincial, national) and three intra-regional, nine provincial and one national horizontal governance units. Of note was the introduction of another vertical governance unit (regional) and ministry (Ministry of Natural Resources).

Figure 4.6: Water Takings Governance Units, 1999-2006, ON



4.3.2b 1999-2006: Types of Linkages

A number of processes were at work simultaneously in the permitting process and linkage types are summarized in Table 4.13. First, policy development over the time frame was very much a collaborative effort between MOE Regional Operations and the MOE Water Policy Branch (WPB). Having witnessed the difficulties between policy development and implementation related to well drilling regulations (e.g. O. Reg. 903) which followed a top down approach, input from Regional Operations into legislative and regulatory changes was incorporated from the beginning and blended with changes that occurred in the MOE in the mid-1990s. At that time, each Regional Office was made a policy "lead" for a particular issue. For instance, the Southwestern Regional Office was the policy lead for PTTWs and the Central Regional Office was the policy lead for waste issues. All other Regional Offices would forward their concerns, questions and comments to the policy lead office which would assemble and review the input for provincial Operations meetings where they were discussed. The policy lead Regional Office would then meet with the WPB to discuss policy changes. By 2002, the policy development process included an Operations representative "at the table" with WPB officials throughout the process. These changes overcame the sharp division that used to exist between the WPB and Operations by avoiding the development of policies that were operationally infeasible (OMOE official, interview, 09 March 2007). This relationship is characterized as being both functionally positive and strategic in nature due to the functions each performed and their united action towards a particular end.

The situation was more complicated at the PTTW application level with several governance units having a role in the process. All environmental approvals were handled by the MOE Environmental Approvals Branch (EAB), a separate branch of the MOE Operations Division, except for two including PTTWs. For PTTWs, the EAB received the application and screened it for completeness, and collected associated fees.[26] The EAB then forwarded the application to the appropriate Regional Office for regulatory screening, technical review and scientific input. Each Regional Office had a Technical Support Section that included hydrogeologists and environmental planners to evaluate the application. Based on their input, the permit was either approved or denied by the Regional Director (Water Supervisor). As such, the linkage between the units was functionally positive.

However, other governance bodies could affect the process before permit approval was given. The permit application could have been referred to the Ministry of Natural Resources (MNR) Great Lakes Branch (GLB) if the withdrawal or diversion was greater than specified thresholds in the Great Lakes Charter (1985), its Annex (2001) and the implementation agreements (2005) (OMOE, April 2005). These bi-national agreements, between the eight Great Lake States, Ontario and Quebec, established a framework for surface and groundwater management in the Great Lakes Basin including limiting water diversions within the basin, establishing basin wide environmental standards for water use, focusing on enhanced water conservation measures and providing a larger role for scientific input in decision-making (OMNR, 2005). In such referrals, the MNR GLB reviewed the PTTW application to ensure compliance with the agreements and consulted with the MOE

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[26] A standard permit application fee exists for all applications except for agricultural permits which is exempt from the fee structure (OMOE, 2005).

Regional Office in question in making its recommendations (OMOE, April 2005). The MNR GLB could also have called upon its own Regional Offices to examine the application (OMOE official, interview, 09 March 2007). This referral procedure reveals a functionally positive and strategic relationship between the MNR GLB and the MOE Regional Operations. It also reveals a functionally positive relationship between the MNR GLB and MNR Regional Offices and MOE Regional Operations.

Table 4.13: Linkage Types, Water Takings Governance Units, 1999-2006, ON

	MOE Reg. Op.	**MNR Reg. Off.**	**Cons. Auth.**	**MOE Env. App. Br.**	**MOE Water Pol. Br.**	**MOE Legal Ser. Br.**	**MNR G.L. Br.**	**MNR Land/Wat Pol. Br.**	**MOE En. App. Bd.**	**Co ur ts**
MOE Reg. Op.	-----	F +	F +	F +	F +, S	F +/-	F +,S	F +/-, S	F +, S	F+/ -
MNR Reg. Off.	F +	-----	F +	F neu	F +	F neu	F +	F +	F neu	Fneu
Cons. Auth.	F +	F +	-----	F neu	F +	F +/-	F neu	F +, S	F +, S	F +/-
MOE Env. App. Br.	F +	F neu	F neu	-----	F +	F neu	F neu	F neu	F neu	F neu
MOE Water Pol. Br.	F +, S	F +	F +	F +	-----	F +/-, S	F +, S	F +, S	F +	F +/-
MOE Legal Ser. Br.	F +/-	F neu	F +/-	F neu	F +/-, S	-----	F +, S	F +, S	F +	F neu
MNR G.L. Br.	F +, S	F +	F neu	F neu	F +, S	F +, S	-----	F +	F +	F +/-
MNR Land/ Wat. Pol. Br	F +/-, S	F +	F +, S	F neu	F +, S	F +, S	F +	-----	F +	F +/-
MOEEn.AppBd.	F + S	F neu	F + S	F neu	F +	F +	F +	F +	-----	Fn
Courts	F +/-	F neu	F +/-	F neu	F +/-	F neu	F +/-	F +/-	F neu	----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative;
Fn, Fneu = Functionally Neutral; S = Strategic For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

Permit applications faced further scrutiny if the application occurred in a "high-use watershed". Applications that removed water from the tertiary watershed, that is, excluding the Great Lakes and its connecting channels, and that removed water from the watershed including water takings for beverage manufacturing, food processing, ready-mix concrete manufacturing and large manufacturing processes were denied (OMOE, April 2005).[27] High-use watersheds were designated as such based on scientific investigation by the MNR Land and Waters Branch (LWB),

[27]Decisions could be, and at times were, appealed to the Minister of the Environment, a political position, who could override the regulations for a final decision (e.g. Pond, 2004, pp. 8-12).

Natural Resources Management Division though the MNR Regional Offices and Conservation Authorities (CAs) were consulted in the process (OMOE, April 2005). This reveals functionally positive relationships between the three governance units and a functionally negative relationship between the MNR LWB and the MOE Reg. Operations.

Drought conditions could also seriously impact current and new water takings. In 1999, Ontario's Low Water Response (OLWR) was established largely due to droughts at the time and lowered Great Lakes water levels. The OLWR ensured that the province was prepared to address a drought situation through an increasingly aggressive water conservation program. The OLWR system was administered by the MNR LWB and implemented through MNR Regional Offices and CAs. The MNR LWB obtained hydrological, meteorological and environmental data from many sources including CAs and Environment Canada to classify drought conditions as Level I, II, or III (Level III being the most severe) (OMNR, 2003). Of note in this process was CAs who reviewed the data to confirm the conditions and thus provided feedback to the MNR. Once confirmed, CAs could establish Water Response Teams comprised of major water users and stakeholders in the watershed to coordinate a response to the situation which could vary according to the severity of the situation (OMNR, 2003). Drought conditions were taken into consideration when reviewing a PTTW application by MOE Regional Operations with Directors able to place conditions on the permit, such as requiring the documentation of water efficiency measures and emergency conservation measures (OMOE, April 2005). Note that

Directors had discretion to also modify permit conditions in response to continuing drought conditions.

Ontario's Low Water Response system reveals an intricate web of relationships. The linkage between the MOE Regional Operations and the MNR LWB was functional and positive in nature, as well as, strategic. Each unit wanted to manage water resources effectively and perform independent functions to that end, yet they also strategically acted together towards their goals. Functionally positive relationships existed between the MNR LWB, the MNR Field Offices and CAs. Each had a part in the implementation process. Moreover, a strategic relationship existed between CAs and MNR LWB due to their concerted action in addressing drought conditions; one concerned with largely ecological watershed issues (CAs) and the other with broader environmental and socio-economic issues (MNR LWB).

The core activities of the adjudication bodies were identical to that found for well driller regulations for the similar time frame and are not repeated here though the linkage types are shown in Table 4.13. Of note are the functionally positive relationships between the MOE Environmental Appeal Board and most governance units and the functional relationship between the courts and the core governance units (positive/negative depending on court decision).

4.3.2c 1999-2006: Complementarity of Linkages

governance visions ***(goals)***

Governance goals for each unit are shown in Table 4.14 and similarities are summarized in Table 4.15. A number of points are noteworthy. In relation to MOE Regional Operations, a high similarity in goals existed between them, CAs and the

MOE Environmental Approvals Branch reflecting, in large part, their direct function in processing and reviewing PTTW applications. Note, for instance, the CA's involvement in LWR teams and that PTTWs were to be considered on a watershed basis which CAs were intimately involved in managing and protecting. Similarities in goals were moderate between the MOE Regional Operations and the MOE WPB and the MOE Legal Services Branch. This reflected their respective functions in that the mandate for the Legal Services Branch was particularly narrow. Note that similarities between MOE Regional Operations and the MNR GLB and the MNR LWB were low which reflected the MNR departments' much wider focus.

The MNR's Regional Offices, GLB and the LWB had a moderate similarity in goals as did CAs, the MOE WPB and the MNR LWB. As previously discussed in terms of linkages, these units were not only involved in the permitting process but approached it from a similar perspective. A moderate similarity in goals also existed in relation to CAs and the MNR GLB in that both were heavily involved in protecting and managing water resources with CAs working at the watershed level and the GLB working at the basin level.

The MOE WPB also had a moderate similarity in goals with the MNR GLB and the MNR LWB which largely reflected their policy development functions. Goal similarities between all adjudication units and the other governance units were low while similarities in goals between adjudication units were high.

communication level** **(meeting frequency, proposals, personal communication)

Communication levels reflected the interconnectedness of related activities

Table 4.14: Goals of Governance Units, Water Takings, 1999-2006, ON

MOE Regional Offices, Operations Divisions
• Responsible for program delivery in relation to: -protecting air quality; surface and groundwater quality and quantity; -ensure appropriate management of wastes; control use of pesticides; -administer approvals and licensing programs, and investigative and enforcement program; -responsible for environmental assessment and approvals including those for permits-to-take-water.
MNR Regional Offices, Field Services Division
• Responsible for program delivery in relation to: -enforcement of Fish and Wildlife Conservation Act (e.g. hunting licenses); -wildlife rehabilitation and nuisance wildlife management; support other divisions in field work as req'd.
Conservation Authorities
• Establish, implement various conservation, restoration, development and management programs related to natural resources (not including gas, oil, coal and minerals) on a watershed basis: -flood control/warning, erosion control; recreational areas; protect, restore, manage natural habitat.
MOE Environmental Approvals Branch, Operations Division
• Regulatory environmental approvals including environmental assessment; technical approvals under the Ontario Water Resources Act, Environmental Protection Act re waste, sewage, noise, air; soil and groundwater remediation under Brownfields Act; Pesticides Act.
MOE Water Policy Branch, Integrated Environmental Planning Division
• Policy, program development to protect and restore the quality and quantity of Ontario's water; • Collaborate with other jurisdictions/governance units in policy, program development; • Analyze policies and programs; co-ordinate policy development and liaison with Central Agencies.
MOE Legal Services Branch, Deputy Minister's Office
• General Counsel on interpretation of statutes/regulations, preparation/review of proposed legislation, regulations and other legal documents; • Conduct prosecutions, act as counsel at environmental hearings, represent the ministry and instruct, support and counsel on civil claims against ministry and the province.
MNR Great Lakes Branch, Natural Resources Management Division
• Represent Ontario government for Great Lakes inter-jurisdictional water issues (oversee boundary water levels/flows; balance interests of major water users/ stakeholders); • Protect Great Lakes through implementation of G. L. Charter, Annex and implementation agreements.
MNR Land & Waters Branch, Natural Resources Management Division
• Manage Ontario's natural resources related to aggregates, oil, gas, salt and other minerals; • Land Use and Environmental Planning (including Crown land and a Land Information System); • Manage water resources (forecasting, warning of drought, flood, erosion hazards; water power generation, integrated management of water resources through water budgets, watershed planning, river mgt).
MOE Environmental Appeal Board & Courts
• Adjudicate disputes.

performed in the permitting process. The MOE Regional Operations, where permits were reviewed and scientifically evaluated, had either moderate or high communication levels with most main governance units outside of the adjudication units. Simply put, communication with other governance units was required to evaluate a permit depending on whether a permit application triggered the Great Lakes Charter and associated agreements, and whether the permit was from a high use watershed. Furthermore, much work was done in establishing and following joint review procedures, such as between MOE Regional Operations and MNR GLB for permit reviews and for policy development (OMOE, April 2005). A similar situation applied to communication levels with CAs and the MNR LWB in relation to Low Water Responses and in delineating high use watersheds. Likewise, the MOE WPB was closely tied to the MNR GLB and the MNR LWB through policy development and implementation which demanded moderate communication levels with proposals, drafts and reviews being exchanged on a regular basis (>3x/yr). Low communication levels existed with and among the adjudication units reflecting few prosecutions for regulatory infractions (OMOE officials, interviews, 09, 26 March 2007).

frequency and type of collaboration

Collaboration levels mirrored communication levels with one notable exception. CAs and MNR Regional Office's collaboration levels were characterized as low due to the fact neither were actively involved together in policy development and each submitted data to the MNR LWB to determine low water conditions with CAs assuming the lead in Water Response Teams (which could include an MNR representative). Also of note is the fact that while collaboration levels between the MOE Regional Operations and the MOE WPB was high in terms of policy development, as previously discussed, collaboration was low when it came to permit issuance. The MOE Regional Operations largely assumed full control of the process and had final authority in granting a water permit (though decisions could be appealed to the adjudicative bodies). As such, their relationship is characterized as having a moderate level of collaboration.

Table 4.15: Complementarity Summary, Water Takings, 1999-2006, ON

	MOE Reg. Off.	MNR Reg. Off.	Cons. Auth.	MOE En. App. Br.	MOE Water Pol. Br.	MOE Leg. Ser.	MNR GL Branch	MNR Land/ Wat. Pol. Br.	MOE En. App. Bd.	Courts
Governance Vision (Goals)										
MOE Reg. Off.	-----	Low	High	High	Mod	Mod	Low	Low	Low	Low
MNR Reg. Off.	Low	-----	Low	Low	Low	Low	Mod	Mod	Low	Low
Cons. Auth.	High	Low	-----	Low	Mod	Low	Mod	Mod	Low	Low
MOE En. App. Br.	High	Low	Low	-----	Low	Low	Low	Low	Low	Low
MOE Water Pol. Br.	Mod	Low	Mod	Low	-----	Mod	Mod	Mod	Low	Low
MOE Legal Ser. Br.	Mod	Low	Low	Low	Mod	-----	Mod	Low	High	High
MNR G.L. Branch	Low	Mod	Mod	Low	Mod	Mod	-----	High	Low	Low
MNR Land/Wat. Pol. Br.	Low	Mod	Mod	Low	Mod	Low	High	-----	Low	Low
MOE En. App. Bd.	Low	Low	Low	Low	Low	High	Low	Low	-----	High
Courts	Low	Low	Low	Low	Low	High	Low	Low	High	----
Communication Level (Meetings, Proposals, Personal Communication)										
MOE Reg. Off.	-----	Low	Mod	Mod.	Mod.	Low	Mod	Mod	Low	Low
MNR Reg. Off.	Low	-----	Mod	Low	Low	-nil-	Mod	High	Low	-nil-
Cons. Auth.	Mod	Mod	-----	Low	Low	-nil-	Low	High	Low	-nil-
MOE En. App. Br.	Mod	Low	Low	-----	Low	Low	-nil-	-nil-	Low	-nil-
MOE Water Pol. Br.	Mod	Low	Low	Low	-----	Mod	Mod	Mod	Low	Low
MOE Legal Ser. Br.	Low	-nil-	-nil-	Low	Mod	-----	Low	Low	Low	Low
MNR G.L. Branch	Mod	Mod	Low	-nil-	Mod	Low	-----	Mod	Low	Low
MNR Land/Wat. Pol. Br.	Mod	High	High	-nil-	Mod	Low	Mod	-----	Low	-nil-
MOE En. App. Bd.	Low	Low	Low	Low	Low	Low	Low	Low	-----	Low
Courts	Low	-nil-	-nil-	-nil-	Low	Low	Low	-nil-	Low	----
Frequency and Type of Collaboration										
MOE Reg. Off.	-----	Low	Mod	Mod.	Mod.	Low	Mod	Mod	Low	Low
MNR Reg. Off.	Low	-----	Low	Low	Low	-nil-	Mod	High	Low	-nil-
Cons. Auth.	Mod	Mod	-----	Low	Low	-nil-	Low	High	Low	-nil-
MOE En. App. Br.	Mod	Low	Low	-----	Low	Low	-nil-	-nil-	Low	-nil-
MOE Water Pol. Br.	Mod	Low	Low	Low	-----	Mod	Mod	Mod	Low	Low
MOE Legal Ser. Br.	Low	-nil-	-nil-	Low	Mod	-----	Low	Low	Low	Low
MNR G.L. Branch	Mod	Mod	Low	-nil-	Mod	Low	-----	Mod	Low	Low
MNR Land/Wat. Pol. Br.	Mod	High	High	-nil-	Mod	Low	Mod	-----	Low	-nil-
MOE En. App. Bd.	Low	Low	Low	Low	Low	Low	Low	Low	-----	Low
Courts	Low	-nil-	-nil-	-nil-	Low	Low	Low	-nil-	Low	----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

4.3.3 Preliminary Findings: Water Takings and Organizational Environment

The organizational environment surrounding the evolution of Ontario water takings legislative and regulatory changes over the two available time frames was examined in this section (4.3). Ontario instituted a Permit-To-Take-Water Program in the early 1960s for takings greater than 10,000 gal(IMP) which has remained unchanged until recently. Note that permit fees are now required as are environmental considerations in permit applications.

In terms of the organizational environment, note the lack of complexity (e.g. few governance units; process) for the 1958-1964 time frame. This is in contrast to the second period (1999-2006) where many more governance units are involved in a more intricate process. Note should also be made of the lack of conflict due in part to the lack of a unifying voice (e.g. interest group) for permit applicants. In other words, changes to the regulatory framework were largely achieved internally among various government departments who themselves saw the process as mainly non-controversial.

4.4 Source Protection Planning Independent Variable Summary

The effects of nested institutional arrangements on source water protection, our third dependent variable, are examined over the only available time frame, 2002-2006. Again, the same independent variables (number of governance units, linkage types and complementarity of linkages) are used in the analysis to reveal the complexity, nature and complementarity of the linkages in the relationships.

4.4.1a 2002-2006: Number of Governance Units

Nine governance units were active at this time as shown in Figure 4.7 (and associated membership in the Technical Experts Committee in Figure 4.8). Three of these governance units were advisory in nature and are included here since their impact was significant. Legislative changes in regards to SWP were largely an "in-house" affair for the MOE that extended out to the broader governance community and the public through the use of the advisory committees. Overall, two vertical governance layers (intra-regional, provincial) and one intra-regional and eight provincial horizontal governance units were present.

4.4.1b 2002-2006: Types of Linkages

Legislative change surrounded passage of the Clean Water Act, development of associated regulations and the Act's implementation structure. Linkage types are summarized in Table 4.16. Note that the majority of the linkages were functionally positive and strategic in nature. The MOE Land and Water Policy Branch's (LWPB) linkage with all other governance units, except the MNR Land and Waters Branch (LWB), is a prime example. The MOE LWPB core activities were in relation to policy development and coordination within and outside the Branch. This necessitated coordination with the MOE Drinking Water Program Branch (DWPB) which also had a policy development function in relation to drinking water sources and related compliance activities. Policy development necessarily required the counsel of the MOE Legal Services Branch (LSB). A positive functionality and strategic linkage between the MOE LWPB and Conservation Ontario (CO) was seen in the fact that CO's mandate was the promotion of watershed based environmental protection and management, and the fact that the two units in conjunction with the MOE DWPB developed an implementation strategy for source water protection in Ontario (e.g. CO, 2007). The functional positive and strategic linkage with the Advisory Committees was highlighted in the functions each performed: the Advisory Committees were to provide advice to the MOE LWPB which had policy development as its main function. The strategic nature was shown in the establishment of these Advisory Committees by the MOE LWPB in the first place.

Similar linkages existed for the MOE DWPB and will not be repeated here. Both the MOE DWPB and the MOE LWPB had functionally positive linkages with the MNR LWB. This was due to the functions each performed with the MNR LWB responsible for the integrated management of water resources through water budgets and watershed planning. Similar linkages existed for the MOE LSB except in reference to the MNR LWB, CO and CAs where linkages were functional in nature yet their positiveness or negativeness depended on the actual legislation and regulations established.

Figure 4.7: Source Protection Planning Governance Units, 1999-2006, ON

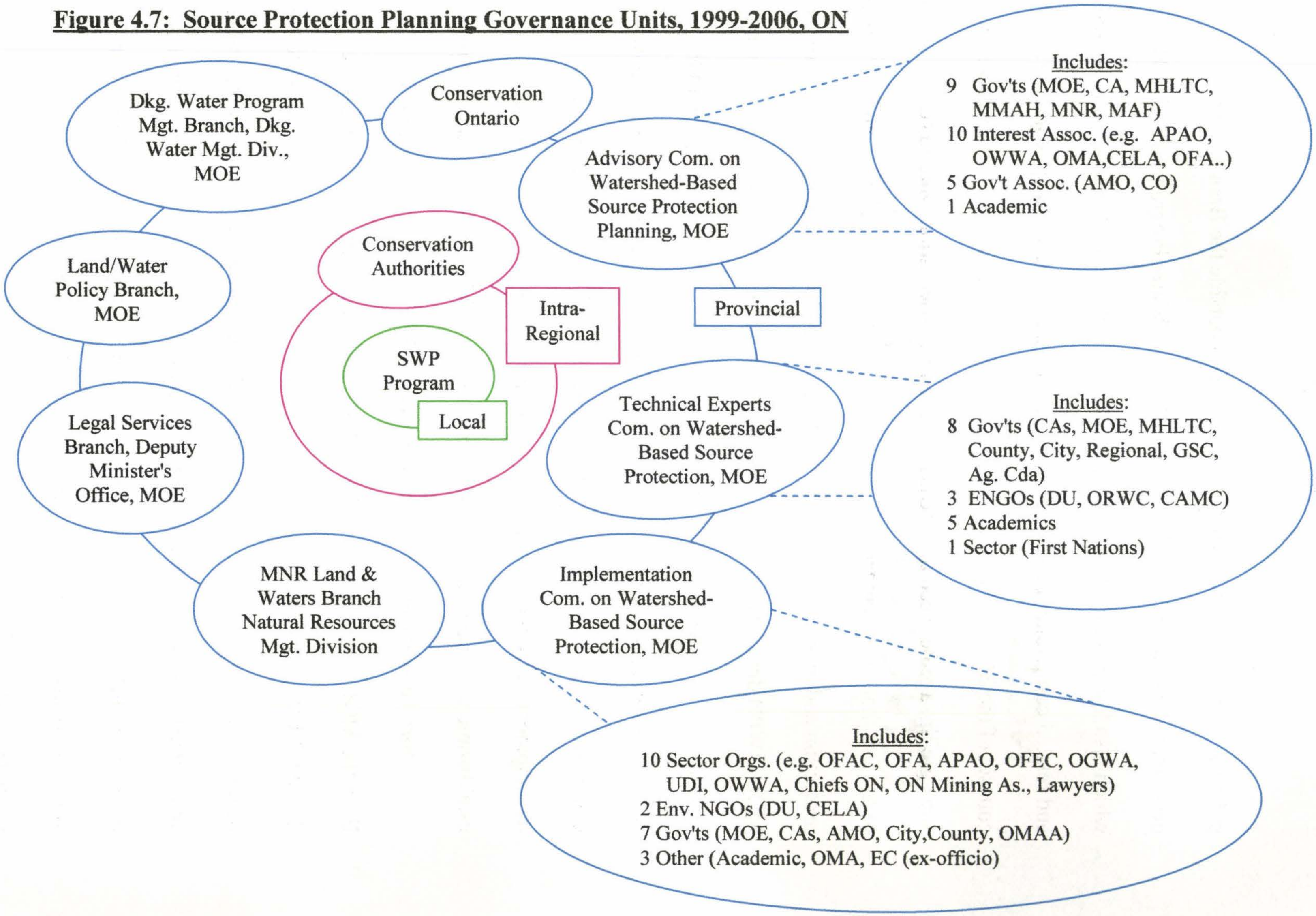
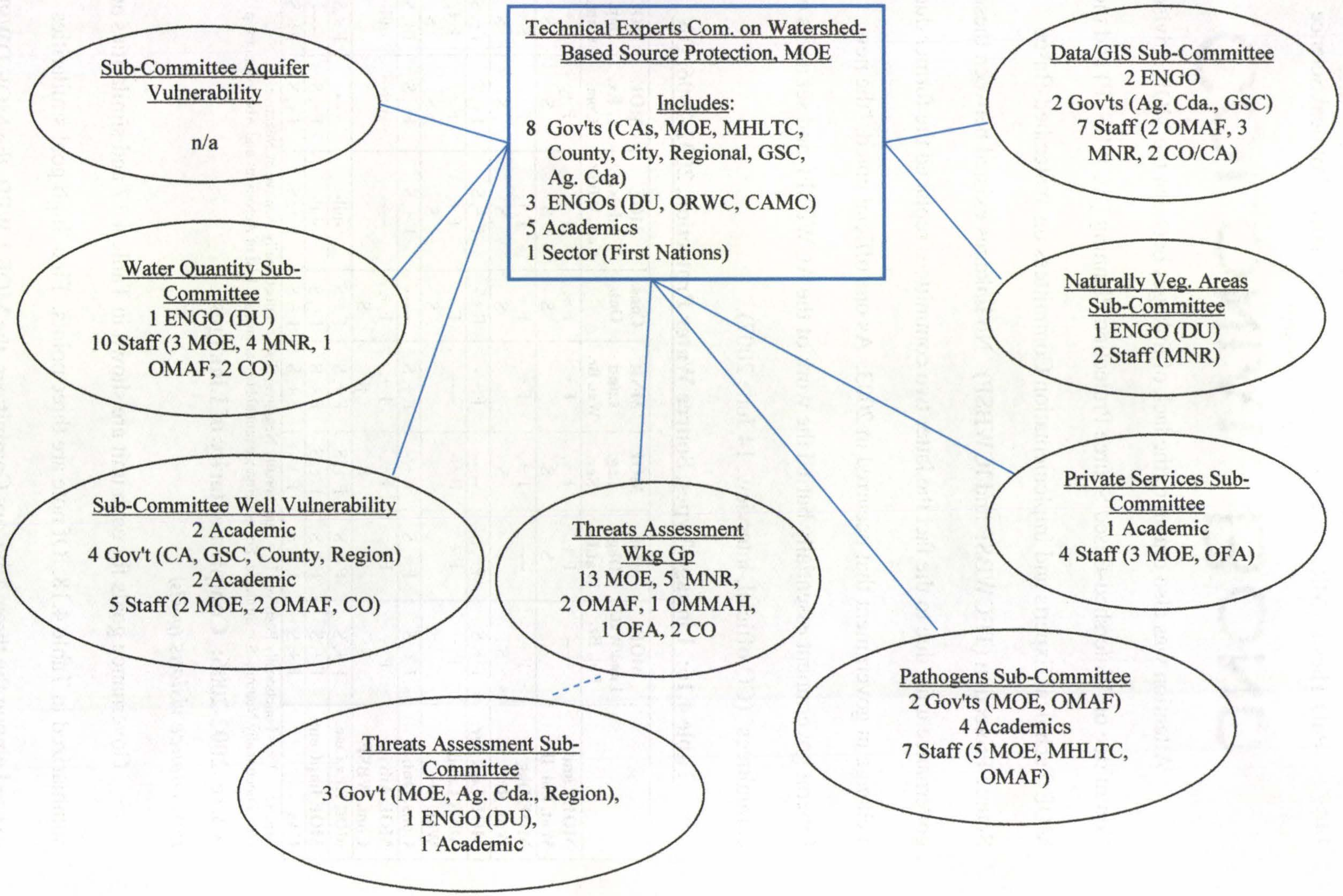


Figure 4.8: Technical Experts Committee and Sub-Committee Membership



Attention was also drawn to the lack of linkages between the MOE Advisory Committee on Watershed-Based Source Protection Planning (ACWBSPP) and the MOE Technical Experts and Implementation Committees on Watershed-Based Source Protection (TECWBSP and ICWBSP). No linkages existed between these governance units due to the fact the latter two committees replaced the former due to a change in government that occurred in 2003. As one official noted, "the new Liberal government essentially buried the work of the ACWBSPP and set up its own committees" (CO official, interview, 14 June 2007).

Table 4.16: Linkage Types, Source Water Protection, 2002-2006, ON

	MOE Land/Wat. Pol. Br.	MOE Dkg Wat.Br.	MOE Leg. Ser.	MNR Land Wat. Br.	Cons. Ont.	MOE Advis. Com. WBSP	MOE T. Ex. Com.	MOE Imp. Com.	CAs
MOE Land/ Wat. Pol. Br.	-----	F +, S	F +, S	F +	F +, S	F +, S	F +, S	F +, S	F +, S
MOE Dkg Wat. Br.	F +, S	-----	F +, S	F +	F +, S	F +, S	F +, S	F +, S	F +, S
MOE Leg. Ser.	F +, S	F+, S	-----	F +/-	F +/-	F +, S	F+, S	F+, S	F+/-
MNR Land Wat. Br.	F +	F +	F +/-	-----	F +, S	F +, S	F +, S	F +, S	F +, S
Cons. Ont.	F +, S	F +, S	F +/-	F +, S	-----	F +, S	F+, S	F+, S	F+S
MOE Advis. Com. WBSP	F +, S	F +, S	F +, S	F +, S	F +, S	-----	-nil-	-nil-	F +, S
MOE T.Ex.Com.	F +, S	F +, S	F +, S	F +, S	F +,S	-nil-	-----	F +,S	F +S
MOE ImpCom.	F +, S	F +, S	F +, S	F +, S	F+, S	-nil-	F+, S	-----	F+S
CAs	F +, S	F +, S	F +/-	F +, S	F+, S	F +, S	F+, S	F+, S	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative;
Fn = Functionally Neutral; S = Strategic; For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

4.4.1c 2002-2006: Complementarity of Linkages

***governance visions** (goals)*

Governance goals for each unit are shown in Table 4.17 and similarities are summarized in Table 4.18. Of note are three points. First, high goal similarities existed among the three Advisory Committees, the MOE LWPB, the MOE DWPB, CO and the CAs. The Advisory Committee's goals were to provide advice to the MOE in how to design and implement source water protection planning in Ontario (see the Terms of Reference for each: MOE ACWSPP, 2003; MOE WBSPIC, 2004; MOE WBSPTEC, 2004). Conservation Ontario (CO) was the provincial liaison to the MOE for CAs and promoted and developed watershed based environmental programs implemented through the individual CAs. Both aforementioned MOE branches had a significant policy development role in relation to water policy either generally (MOE LWPB) or specifically related to drinking water (MOE DWPB), for which source water protection was devised.

Second, the MOE LWPB and the MOE LSB had moderate similarities in goals. This was due to the fact the MOE LWPB had a significant policy development function in relation to water while the MOE LSB provided aid and general counsel for the preparation and review of legislation (e.g. the Clean Water Act). Overlap and similarities existed yet from different perspectives; one from a water background and the other from a legal background, revealing emphasis on different aspects.

Third, the MOE LSB had moderate similarities in goals with all MOE governance units and low similarities in goals with the others. In relation to the MOE governance units, similarities existed in relation to legislative and regulatory development functions yet each unit has a slightly different mandate and focus. For instance, the MOE LSB was primarily concerned with the legal aspects of any policy and program that was developed while the Advisory Committees were also concerned with this aspect in that they desired legislation and regulations that would be enforceable. Moreover, the Advisory Committees were concerned with developing policy that addressed the relevant aspects of source water protection and that would be feasible from an implementation point of view. In relation to the low similarities in goals between the MOE LSB and the other governance units, the other governance units had *interests* in the legislative and regulatory developments that occurred since they would have impacted their own activities but note that these interests were largely different than the formal legalistic approach of the MOE LSB. The only exception could have been in relation the MNR LWB if the MOE had overstepped its jurisdiction. However, source water protection was assigned to the MOE due to its impacts on drinking water *quality* while the majority of the MNR's activities concerned water quantity (e.g. Low Water Response). Also note the high similarities in goals between the MNR LWB and CO which were intimately related since funding for CAs was funneled through the MNR previously discussed under Water Takings.

***communication level** (meeting frequency, proposals, personal communication)*

Communication levels were, for the most part, high as shown in Table 4.18. This assessment is based on membership in the three Advisory Committees over the time frame and the fact that the governance units participated in related education activities such as being part of the Organizing Committee and/or giving talks at the A.D. Latornell Conservation Symposium which attracted over 700-1200 people over a three day period (A.D. Latornell, n.d.-a, n.d.-b). For instance, the MNR was a major sponsor of the event, consistently had over five speakers at the event in addition to numerous other attendees and two display booths (A.D. Latornell, n.d.-b; CO official, interview, 14 June 2007). Furthermore, the Minister of the Environment had often addressed the event and MOE staff had given presentations as had CAs

(Credit Valley Conservation, 2004; MOE, 2002, 2004; A.D. Latornell, n.d.-b; CO & UTRCA officials, interviews, 14, 11, June 2007).

Table 4.17: Goals of Governance Units, Source Water Protection, 2002-06, ON .

MOE Land & Water Policy Branch
Note: only water policy activities listed. • Policy, program development to protect and restore the quality and quantity of Ontario's water; • Collaborate with other jurisdictions/governance units in policy, program development; • Analyze policies and programs; co-ordinate policy development and liaison with Central Agencies.
MOE Drinking Water Program Management Branch
• Lead for program design/management; • Support policy development and enforcement program through program analysis.
MOE Legal Services Branch, Deputy Minister's Office
• General Counsel on interpretation of statutes and regulations, preparation and review of proposed legislation, regulations and other legal documents; • Conduct prosecutions, act as counsel at environmental hearings, represent the ministry and instruct, support and counsel on civil claims against ministry and the province.
MNR Land & Waters Branch, Natural Resources Management Division
• Manage Ontario's natural resources related to aggregates, oil, gas, salt and other minerals; • Land Use and Environmental Planning (including Crown land and a Land Information System); • Manage water resources (forecasting, warning of drought, flood, erosion hazards; water power generation, integrated mgt. water resources through water budgets, watershed planning, river mgt).
Conservation Ontario
• Ensure conservation, restoration and responsible management of Ontario's water, land and natural habitats through programs that balance human, environmental and economic needs.
MOE Advisory Committee Watershed-Based Source Protection Planning
• Provide advice to government on a framework for watershed-based source protection planning, consistent with the Walkerton Inquiry's O'Connor Report (22 recs. on source protection planning).
MOE Technical Experts Committee Watershed-Based Source Protection
• Provide technical advice to guide how plans to be developed, data rqts., what standards might be required, and how threats and risks to drinking water to be managed.
MOE Implementation Committee Watershed-Based Source Protection
• Provide Ontario government with advice re tools/approaches to implement watershed-based source protection through: 1. Review existing, new, expanding roles/respons. for all participants in a SWP system; 2. Review innovative funding mechanisms.
Conservation Authorities
• Establish, implement various conservation, restoration, development and management programs related to natural resources (not including gas, oil, coal and minerals) on a watershed basis: -flood control/warning, erosion control; recreational areas; protect, restore, manage natural habitat.

Membership in the Advisory Committee also contributed to the high communication levels. For instance, the MOE ACWBSPP met approximately ten times from its inception in November 2002 to its final report release in April 2003 and included members from the most governance units as shown in Figure 4.7 (MOE, 2003; CO official, interview, 14 June 2007). A similar situation existed with the other two Advisory Committees. Note the membership in these two Advisory Committees and related working groups and sub-committees in Figures 4.7 and 4.8. Both of these Advisory Committees were formed in December of 2003 and met independently yet simultaneously over the next ten months on a frequent basis either in the full committee, working group and/or subcommittees. Most people sat on more than one Committee (e.g. one CO official sat on the two main committees, three sub-committees and one working group, while MOE and MNR representatives sat on most committees, working groups and sub-committees) leading one official to note that it was "pretty intense" and that one needed to "keep in mind that the members already had full time jobs to tend to let alone all of this source water protection work" (OWSPPIC, 2004; OWSPPTEC, 2004, CO official, interview, 14 June 2007). In addition, both MOE governance units worked with CO and CAs on a frequent basis to develop Source Protection Boards and Source Protection Committees beginning in 2005 (OMOE, 2005, 2007; CO official, interview, 14 June 2007).

Three exceptions to the high communication levels noted above existed. The first was in relation to communication levels between the MOE DWPB and the MOE LSB and the MNR LWB. This was largely due to the fact that the MOE DWPB was a "late comer" to the process, that is, it was just being established during the first third of this time frame, hence the moderate level of communication assessed. The second was in relation to the lack of communication (i.e. nil) between the MOE ACWBSP and the other two Advisory Committees (Technical Experts, Implementation). This was due to the fact that the latter two Advisory Committees were formed *after* a new government "buried" the report of the MOE ACWBSP Committee and formed two new committees of its own to guide the process (CO official, interview, 14 June 2007; for mandates and length of terms see OWSPPIC, 2004; OWSPPTEC, 2004; and

Table 4.18: Complementarity Summary, Source Water Protection, 2002-06, ON

	MOE Land/Wat Pol. Br.	MOE Dkg Wat.Br.	MOE Leg. Ser.	MNR Land Wat. Br.	Cons. Ont.	MOE Advis. Com.WBSP	MOE T. Ex. Com.	MOE Imp. Com.	CAs
Governance Vision (Goals)									
MOE Land/Wat. Pol. Br.	-----	High	Mod	Mod	High	High	High	High	Mod
MOE Dkg Wat Br.	High	-----	Mod	Mod	High	High	High	High	High
MOE Leg. Ser.	Mod	Mod	-----	Low	Low	Mod	Mod	Mod	Low
MNR Land/ Wat. Br.	Mod	Mod	Low	-----	High	Mod	Mod	Mod	Mod
Cons. Ont.	High	High	Low	High	-----	High	High	High	High
MOE Advis. Com. WBSP	High	High	Mod	Mod	High	-----	High	High	High
MOE T. Ex.Com.	High	High	Mod	Mod	High	High	-----	High	High
MOE Imp. Com.	High	High	Mod	Mod	High	High	High	-----	High
CAs	Mod	High	Low	Mod	High	High	High	High	-----
Communication Level (Meetings, Proposals, Personal Communication)									
MOE Land/Wat. Pol. Br.	-----	High	High	High	High	High	High	High	High
MOE Dkg WatBr.	High	-----	Mod	Mod	High	Low	High	High	High
MOE Leg. Ser.	High	High	-----	Low	Low	Low	Low	Low	Low
MNR Land/ Wat. Br.	High	Mod	Low	-----	High	High	High	High	Mod
Cons. Ont.	High	High	Low	High	-----	High	High	High	High
MOE Advis. Com. WBSP	High	Low	Low	High	High	-----	-nil-	-nil-	High
MOE T. Ex. Com.	High	High	Low	High	High	-nil-	-----	Low	High
MOE Imp. Com.	High	High	Low	High	High	-nil-	Low	-----	High
CAs	High	High	Low	Mod	High	High	High	High	-----
Frequency and Type of Collaboration									
MOE Land/Wat. Pol. Br.	-----	High	High	High	High	High	High	High	High
MOE Dkg WatBr.	High	-----	Mod	Mod	High	Low	High	High	High
MOE Leg. Ser.	High	High	-----	Low	Low	Low	Low	Low	Low
MNR Land/ Wat. Br.	High	Mod	Low	-----	High	High	High	High	Mod
Cons. Ont.	High	High	Low	High	-----	High	High	High	High
MOE Advis. Com. WBSP	High	Low	Low	High	High	-----	-nil-	-nil-	High
MOE T. Ex. Com.	High	High	Low	High	High	-nil-	-----	Low	High
MOE Imp. Com.	High	High	Low	High	High	-nil-	Low	-----	High
CAs	High	High	Low	Mod	High	High	High	High	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

OMOE, 2003). Lastly, note the low communication levels between the Technical

Experts and the Implementation Committees. This was due to different mandates assigned to each and tight timelines as previously discussed and evidenced in their separate reports. There was communication, but it was low and done through individuals who were members of both committees as noted above.

frequency and type of collaboration

The preceding discussion reveals the frequency and type of collaboration that occurred where collaboration levels mirrored communication levels and will not be repeated in depth here (see above). Briefly, high levels of collaboration are noted in participation in the three Advisory Committees, input into the MOE's White Paper on Source Water Protection released in 2004, and participation in organizing the yearly A.D. Latornell Conservation Symposium. Collaboration levels reflected timeline issues, and function differences noted under communication levels.

4.4.2 Preliminary Findings: Source Protection Planning and Organizational Environment

Source protection planning (SPP) was examined in this section (4.4) for the period 2002-2006, the time of its introduction. SPP is for municipal wellheads (not private wells) and for surface water intakes and, while mandated by the provincial government, that is, the development of a source protection plan is required, acting on such plans is *voluntary* and no funds have, to date, been earmarked for such activities by the provincial government.

In terms of the organizational environment, note the centrality of Conservation Ontario and Conservation Authorities. Both had large and significant roles throughout the process. In fact, SPP provided both with the opportunity to re-establish themselves as the prime watershed protection entities in the province. However, this re-establishment was achieved through the provincial government's multilateral approach via the use of several advisory and technical committees. In short, the process was driven by the provincial government largely in response to the Walkerton water tragedy and the recommendations that came out of the *O'Connor Report* (2002).

4.5 Summary

This chapter has presented data in regards to legislative and regulatory changes to Ontario groundwater policy related to well drilling, water takings and source water protection. The changes have been evaluated in terms of our nested institutional framework (independent variables), that is, in terms of the number of governance units, the nature of the linkages (functional, strategic) and in the complementarity of the linkages (similarities in goals, communication and collaboration levels). Some generalizations about the patterns for the independent variables are offered here to briefly summarize the chapter's findings.

In relation to well drilling, the number of governance units held steady at eight to ten across all three time frames. The locus of activity was also centred at the provincial level. Strategic linkages were also plentiful in the first time frame yet were practically non-existent in the last two time periods. This coincided with the existence of many functionally negative linkages in the latter two time frames to the point that they eroded benefits derived from the functionally positive linkages that existed and coincided with the emergence of the OMOE which consolidated several environmentally related functions for the government. As such, groundwater became increasingly marginalized in this larger and broader organizational environment.

This pattern of erosion in relationships between governance units does not appear when examining water takings, though the potential was there. This can be seen in the lack of functionally negative relationships over both time frames and in the high level of functional linkages that were labelled as both positive and negative and depended on the outcome. The process was largely internally driven by the OMOE with a high number of strategic linkages present in both time frames. This suggests the governance units were largely "on the same page" in regards to legislative and regulatory changes despite the marginally lower level of linkage complementarity in the second time frame when the additional vertical governance layer was present and when the number of governance units almost doubled.

It appears source protection activities were a different matter altogether. By its very nature, many governance units are potentially affected given the fact municipalities may supply water to other jurisdictions, municipal water sources may be outside of one's jurisdiction and given broader watershed planning activities. Note the multilateral approach to SPP and the high number of functionally positive and strategic linkages that existed. The lack of functionally negative linkages is significant given SPP's potential to negatively affect certain stakeholders yet any negativeness was subsumed within the broader multilateral forums that existed.

These generalizations and preliminary results are further analyzed individually and in relation to the type, frequency and magnitude of groundwater policy change in Chapter 7. The next chapter presents data for New York, our second data chapter.

Chapter Five

New York Groundwater Policy Change

"springs everywhere"

5.1 Context

New York is a home rule state. That alone is a principal reason for the existing fragmented groundwater governance regulatory framework. Home rule allows a local government to "design and amend its own charter, subject to the laws and constitution of the state and also subject to veto by the state" (Patterson, 2008, p. 539). This greatly increases local control over affairs with many local governments enacting rules and regulations (and assume primacy) as long as they are as stringent as those put forth by the State. This has allowed many groundwater programs to evolve over three main time frames (pre-1970, 1970-1995, post-1995) among three principal governance units: New York Department of Environmental Conservation (DEC), New York Department of Health (DOH) and the United States Environmental Protection Agency (EPA).

Well driller regulations have a mixed history in New York. For instance, Long Island counties (Nassau, Suffolk) have been subject to regulations for contractor registration and well construction standards since 1935.[28] Yet, the rest of the state, including the Great Lakes Basin, has been exempt from the regulations though the DEC, DOH and the well drillers themselves have long desired them. In the mid to late 1990s, three issues coalesced and led to regulatory changes in 1999. The DEC lacked comprehensive hydrological information and required well driller logs to assess aquifers in the state. At the same time, the DOH wanted binding well construction regulations while drillers desired the regulatory changes as a way to "professionalize" the industry. Officially, as all interviewees noted, it "was the drillers' idea for [the] regulatory changes" due to the political climate of the day (DEC, DOH & Empire State Water Well Drillers' Association (ESWWDA) officials, interviews, 13, 20, 25, 09 July 2007 respectively).[29]

The 1999 regulatory changes, shown in Appendix VI, mandated statewide driller and pump installer registration, as well as, certification via National Ground Water Association exams. Furthermore, DOH well construction regulations (for location, construction, decommissioning) were enacted in late 2005 after much stakeholder consultation and replaced DOH *guidelines* first issued in 1966 (see NYSDOH, 1966).

Enforcement issues also reflect the dichotomy present between driller registration and well construction standards. The DEC is responsible for

[28]Pesticide issues related to potato farming, the unique hydrogeology of Long Island and salt water intrusion were all major reasons for the initial regulatory development (Wick, 1998; Long Island Farm Bureau, 2007; Gianessi & Marcelli, 2000; DEC & DOH officials, interviews, 13, 25 July 2007).

[29]As one ESWWDA official noted, the Republican Governor, George Pataki (1995-2006), "was very business sensitive" and desired to keep the Republican base of support, the business community, "happy". As such, if well drillers did not like the changes there "would be no chance politically" of them succeeding.

registration and certification[30] of well drillers which is enforced through a graduated system. This involves letters (2), a phone call, visits by DEC Conservation Officers to "fact-check" (e.g. did you get letter, aware of need to register), the issuance of tickets, formal hearings before a DEC Administrative Law Judge, and asking the Attorney General to "put them out of business" (DEC official, interview, 13 July 2007). The compliance rate is high with only a handful of tickets issued each year though, on at least two occasions, drilling rigs have been confiscated until the individuals registered and paid their fines (ESWWDA official, interview, 09 July 2007).

Enforcement of well construction standards is largely unresolved and complex. The regulations are the DOH's responsibility though as one DOH Official stated, "neither we nor the DEC need any more litigation....we are both strapped for legal help...[and] are overloaded" (DOH official, interview, 25 July 2007). Furthermore, the DOH admits that proper well construction is "largely dependent on the well drillers" and likely a civil matter between the homeowner and the driller though that is far from clear. Some County Health Departments[31], for example, have a well permitting system that affords some oversight (DOH official, interview, 25 July 2007). Other County Health Departments have indirect oversight functions through water quality testing but no permitting system. Yet still, enforcement actions can be pursued through the Department of State Code Enforcement Officers (CEO) who have oversight for the building code which stipulates DOH well construction

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[30]Interestingly, while the DEC mandates certification, they do not track it (DEC official, interview, 13 July 2007).

[31]Not all Counties have formed health departments. Of the 28 counties that lie, totally or partially, in the Great Lakes Basin, 9 (Wayne, Ontario, Yates, Steuben, Tompkins, Jefferson, Lewis, Hamilton, Herkimer) are part of 5 multi-county District Health Departments (NYSDOH, 2007).

regulations are to be followed. However, note that CEOs offer limited enforcement since the building code and related permits are triggered for new home construction and not for drilling a new well associated with an existing home. In these cases, it is largely by chance and at the whim of CEOs to locate and investigate such an installation (DOH & Town of Gorham, Ontario County officials, interviews, 25, 17 July 2007).

Water takings in the NY Great Lakes Basin are addressed through the Great Lakes Water Withdrawal Registration Program (GLWWRP) established in 1988. Water withdrawals greater than 100,000 gal(US)/day averaged over a consecutive thirty day period need to be registered with the DEC Division of Water. The program also mandates registration for any water diversions and proposed consumptive uses greater than five million gal(US)/day (NYSDEC, n.d.-a).

Water well registration information is used by the State to meet its obligations for reporting water use to the Great Lakes Commission under the 1985 Great Lakes Charter, to which Ontario is also subject. The GLWWRP is a registration process and not a permitting process. No judgment or decision-making is involved in the process and DEC staff only contact registrants if deficiencies in their reports exist and clarification is required. Data is entered into the Water Use Management Database to produce a com-prehensive report on water use. Enforcement provisions for the GLWWRP mirror those for well driller licensing previously discussed (DEC official, interview, 30 July 2007).

Note that statewide water withdrawal legislation does not exist.

Rather, legislation covering the state is sporadic and largely depends on whether or not one falls within a river basin commission which attempts to bring a unified approach to managing a river system. For instance, New York is party to two such commissions: The Delaware River Basin Commission (DRBC) and the Susquehanna River Basin Commission (SRBC) [32] and each one has similar withdrawal regulations (e.g. project review and withdrawal registration triggered >100,000, project review (consumptive uses) triggered >20,000; All figures in gal(US)/day-avg 30dy; DRBC, 1961, 2001, 2006; SRBC, 1972; National Archives and Records Administration, 2006). Note that neither jurisdiction falls within the Great Lakes Basin. Also, a public supply permitting program exists in New York that potentially impacts water takings though it is not included in this study. The fact is the program is based on permanence, water potability and the number of service connections (min. 5) and not on water quantity issues per se (NYSDEC, n.d.-b).

Regulatory changes in relation to source water protection mimic changes in well driller and water takings regulations, that is, they are fragmented and interspersed among many governance units. Some long established aspects, such as Watershed Rules and Regulations (WRRs), established at the turn of the 20th century by local governments, focus on water pollution control to minimize disease outbreaks related to water supplies such as typhoid deaths. They established, for instance, minimum separation distances for such items as privies, stables and cemeteries, as

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[32] The DRBC (est. 1961) is a compact between the federal government, New York, New Jersey, Delaware and Pennsylvania. The SRBC (est. 1970) is a compact between the federal government, New York, Pennsylvania and Maryland (see DRBC, n.d.-a and SRBC, 2001 for their scope and jurisdiction).

well as, provided local authorities with enforcement powers (e.g. WRRs for Village of Akron, Erie County, NYCRR 10, Part 113, s. 113.1). Later amendments to WRRs have addressed newer threats to water supplies such as salt storage and radioactive materials (e.g. Houghton Water District, Alleghany County, NYCRR 10, Part 101, s. 101.4). Note that not all local governments such as cities and towns in the Great Lakes Basin have established WRRs (e.g. Herkimer County municipalities) and many of the WRRs are idiosyncratic and persisted until recently due to local and technological peculiarities.[33]

Groundwater protection has received renewed focus since the 1980s due to the discovery of several major cancer clusters based on groundwater contamination.[34] The renewed focus was federally driven by the EPA via amendments to the Safe Drinking Water Act in 1986 and in 1996. The 1986 amendments encouraged the voluntary development of Wellhead Protection Plans (WHPP) by states as an inexpensive way of protecting groundwater supplies. Similarly, the 1996 amendments extended the program to include surface water supplies through the mandated development of Source Water Assessment Programs (SWAPs). Both

[33]The City of Syracuse's "pail service" is a prime example. Instituted in 1908 to protect the City's main source of drinking water, Skaneateles Lake, two full time and two part time city employees were responsible for collecting and emptying from homes and cottages located along the lake up to 250 five gallon pails of raw human sewage from specially built privies into approved treatment facilities. Unable to install septic systems or other alternatives for various reasons (e.g. lot sizes, geology), the pail service continued until 1998 when the remaining 100 homes were ordered to install composting toilets by 2000. The City now collects pails of finished compost once a year -54 in 2003 as compared to 3,402 pails of raw sewage in 1998 (Abbott, 2004).

[34]Cancer clusters are the occurrence of significantly higher than expected number of cases of the same or related cancer among a group of people, a geographic area or period of time (see National Cancer Institute, 2006). Three of these occurred in East Woburn, Massachusetts in the 1970s, Niagara Falls, New York (Love Canal) in 1979, and, in Hinkley, California (Pacific Gas and Electric) from the 1960-1980s.

programs attempted to delineate protection areas for water sources and identify potential contamination sources and develop groundwater management approaches to protect the resource (USEPA, n.d.-a; NYSDOH, 1999).

However, few "on the ground" protection activities occurred. For instance, while NY was one of the first states to develop a WHPP (1990), which officials admitted was a "large effort" and a "good idea", it mainly clarified concepts related to work "largely done under other programs", and, as such, "never really took off" (EPA, DOH & DEC officials, interviews, 27, 20, 06 July, 2007). The same officials also all noted the fact that the program was not funded ensured little protection activity ensued. The 1996 changes partly addressed this deficiency by providing some funding.

In addition to local WRRs, WHPPs and SWAPs, many other State programs address groundwater protection. For instance, amendments to the federal Clean Water Act in 1987 necessitated development of plans to address toxics, non-point source pollution, coastal pollution and watershed protection. New York has responded by developing and enhancing many programs such as the State Pollutant Discharge Elimination System (SPDES) (NYSDEC, n.d.-g). At the same time, the watershed protection concept has taken root and emphasizes sound scientific principles and widespread stakeholder participation. Watershed protection was further advanced through Unified Watershed Assessments mandated by the USEPA Clean Water Action Plan in 1998. New York's plan for all fifty-four watersheds identified priority areas for additional efforts and funding for water quality issues

(NYSDEC, 1998). It is from this plan that each watershed developed Watershed Restoration Action Strategies to address priority areas (e.g. Genesee/Finger Lakes Regional Planning Council, 2004).

As the above discussion highlights, a dense spider web of regulations in policy and planning has evolved in relation to groundwater in New York. Three agencies have been crucial throughout the process: the DEC, the DOH, and the EPA. The DEC is principally involved in water quantity management such as water takings and well driller registration and, at a broad scale, watershed protection activities. However, the DEC has only been involved in such activities since its formation in 1970 when it assumed staff from the DOH for classification and water standards leaving the DOH with laboratories and few technical staff (DEC Official, interview, 06 July 2007). Local entities should also not be overlooked since many have assumed significant regulatory functions.

Water and administrative enactments continue to be shared between the DEC and the DOH. Note that WHPP was initially the DEC's responsibility but was transferred to the DOH in 1998 along with associated staff when SWAP came online in 1998 (NYS Executive Chamber, 1998). This consolidated drinking water related activities in one department, the DOH, something the DOH has been involved in since the turn of the 20th century in terms of water quality standards (NYSDOH, 2002).

Many of the above activities by the DEC and DOH have been federally driven with the EPA playing a significant role in the process. Prior to 1970, the federal government largely dealt with interstate commerce issues in relation to water, something individual states could not address due to constitutional limitations. This was achieved through various statutes including the Rivers and Harbors Act of 1899 and the Federal Water Pollution Control Act of 1956 (treatment plant construction grants). The need to eliminate lax state enforcement activity due to inter-state competition for businesses led, in part, to the EPA's establishment in 1970. Since then, both the Clean Water Act (1987; and its predecessor, the Water Pollution Control Act; 1948 as amended), addressing point source discharges, and the Safe Drinking Water Act (1974 as amended), addressing the public drinking water systems, water quality and groundwater, have figured prominently in groundwater activities (USEPA, 2002). It is in response to these various acts that many of New York's programs related to SWP have developed.

5.2 Well Driller Regulations Independent Variable Summary

New York well driller regulatory changes are interpreted as changes in registration/certification, well construction (e.g. location, yield testing) and enforcement procedures (e.g. inspections, enforcement). Only one time period is available to study the effects of nested institutional arrangements on such changes: 1996-2006.

5.2.1a 1996-2006: Number of Governance Units

Sixteen governance units were active at this time as noted in Figure 5.1 dispersed over four vertical governance levels (local, intra-regional, state, national). This included two local, two intra-regional, nine state and three national level horizontal governance units.

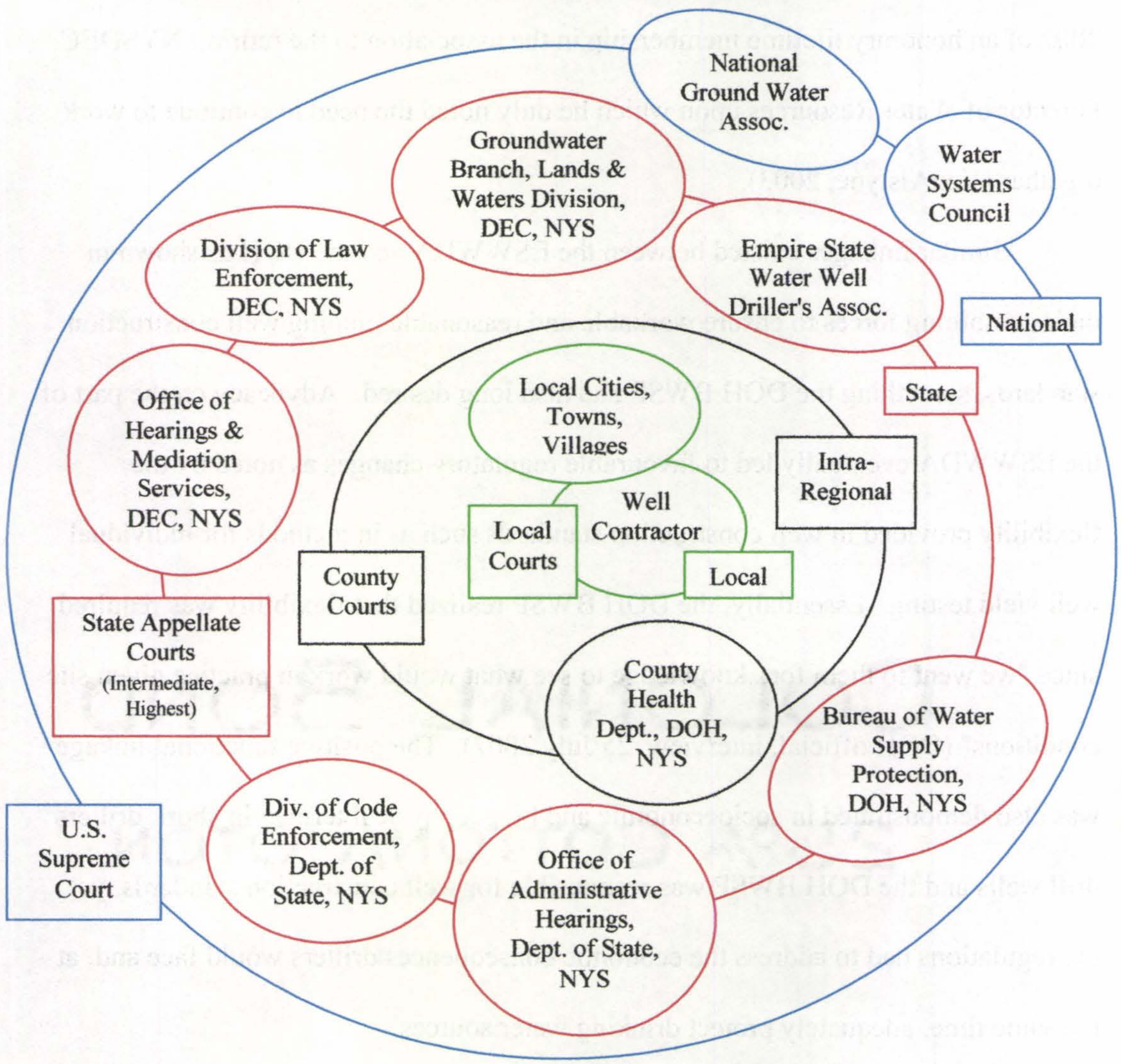
5.2.1b 1996-2006: Types of Linkages

Linkage types are summarized in Table 5.1. Two processes were intertwined and at work simultaneously; the first for registration and certification of well drillers and the second for the development of well construction standards.

Regulatory changes primarily involved three main governance units, the DEC, the DOH and the ESWWDA. The linkage between the ESWWDA and the DEC GWB was functionally positive and strategic in nature. The strategic nature is shown by the fact both desired regulatory change, albeit for different purposes. The ESWWDA wanted regulatory change to clean up the industry from unscrupulous contractors and "fly-by-nighters" while the DEC GWB wanted driller logs since it was "the best source of hydrogeological information" for the assessment of aquifers

(ESWWDA & DEC officials, interviews, 09, 13 July 2007). A positive functionality was indicated in their activities with the ESWWDA involved in advocacy, education

Figure 5.1: Well Driller Governance Units, 1996-2006, NY



and networking to ensure the protection and promotion of groundwater and its use ("Mission", 2007). The DEC GWB is also involved in the protection of groundwater resources with added assessment activities (NYSDEC, n.d.-c). The two also worked together to meet their goals in addressing several ongoing examination issues and ensuring regulatory changes were both feasible with quick uptake by the industry as noted by the numerous meetings and information sessions detailed in the next section. This positive functionality was underscored in the presentation by the ESWWDA in 2002 of an honorary lifetime membership in the association to the retiring NYSDEC Director of Water Resources upon which he duly noted the need to continue to work together (VanAlstyne, 2003).

Similar linkages existed between the ESWWDA and the DOH as shown in their combining forces to ensure workable and reasonable binding well construction standards, something the DOH BWSP had also long desired. Advocacy on the part of the ESWWDA eventually led to favourable regulatory changes as noted by the flexibility provided in well construction standards such as in methods for individual well yield testing. Essentially, the DOH BWSP realized that flexibility was required since "we went to them for...knowledge to see what would work in practice given site conditions" (DOH official, interview, 25 July 2007). The positive functional linkage was also demonstrated in socioeconomic and biogeophysical terms. In short, drillers drill wells and the DOH BWSP was responsible for well construction standards, yet the regulations had to address the economic consequences drillers would face and, at the same time, adequately protect drinking water sources.

A strategic and functionally neutral linkage existed between the ESWWDA and the National Ground Water Association (NGWA), a non-profit organization of groundwater professionals focused on groundwater related research, education and advocacy work worldwide including certification of contractors, scientists, engineers and manufacturers (NGWA, Undated-a). The strategic nature was highlighted in the joint administration of certification exams and review classes at ESWWDA quarterly meetings (see any issue of *Holetalk*), as well as, in the development of a separate certification exam for pump installers in 2001 and 2002 ("Now Available!," 2002).[35] Functionality was indicated in the need for certification of drillers with the NGWA possessing one of the few available certification processes that was "well established and reputable" (DEC official, interview, 13 July 2007). The neutrality of the linkage arose since any positiveness built up through their strategic interactions and the basic activities performed by each were seriously eroded by the numerous certification exam changes imposed, often on short notice, by the NGWA and much to the dismay of both the ESWWDA and the DEC.[36] As noted by an ESWWDA Official, the association was "too tired to fight [this] any more" with another stating that while the "NGWA was founded by drillers ...[it has]...the last few years forgot where they came from" (T. Bates, 2007-a; and, Boyd, 2005 respectively). The frustration in dealing with the constant changes eventually led the ESWWDA and the DEC to seek out and develop alternative exams with the Water Systems Council (WSC), a national organization which focused on the education of the public, industry and government alike to protect groundwater resources with a particular emphasis on individual water

[35]The exam was known as the NY Modified Exam, later renamed the NGWA General Pump Exam and offered nationwide. Prior to the exam's development, pump installers had to write the driller's exam, much of which did not apply to their work (ESWWDA & NGWA officials, interviews, 09, 06 July 2007).

[36]Since 2002, exam changes have included a fivefold increase in exam fees, the reporting of exam results on plain paper (no NGWA letterhead), the non-reporting of test scores to the DEC GWB for confidentiality reasons, the termination of paper-based exams, exam walk-ins, and the exam proctor of over ten years due to conflict of interest reasons though no changes in the proctor's situation occurred (NGWA, ESWWDA & DEC officials, interviews, 06, 09, 13 July 2007; *Holetalk*, 2002-present).

wells and small water systems (Water Systems Council, n.d.). Linkages between the ESWWDA, the DEC GWB and the WSC were functionally positive and strategic.

Linkages between the NGWA and other governance units were functionally neutral given the mandates of each entity. The same is true in regards to linkages between enforcement and adjudication entities (see Table 5.1). Meanwhile, the adjudication units were functionally linked to the other governance units such as local governments due to the functions they performed. They adjudicated disputes that arose from the rules and regulations the other governance units divided and applied. Note that the linkage was either positive or negative depending on the outcome of a case at hand.

Table 5.1: Linkage Types, Well Driller Regulatory Changes, 1996-2006, NY

	ES WW DA	**DEC GW Br.**	**N G W A**	**Local Gov't**	**DOH Cty. Hth. Dept.**	**DEC Div. Law En.**	**DEC Off. of Hear.**	**Co urts**	**DOH Bur. Wat. Sup.**	**DOS Div. Code En.**	**DOS Off. Ad. Hear.**	**Wat Sys. C.**
ESWWDA	-----	F+, S	Fn,S	F+/-	Fn	F+/-	F+/-	F+/-	F+/-, S	F +	F +	F+,S
DEC GW Br.	F+,S	-----	Fn	Fn	Fn	F+/-	F+/-	F+/-	F+	F+/-	F+/-	F+,S
NGWA	Fn,S	Fn	---	Fn	Fn	Fn	Fn	Fn	Fn	Fn	Fn	Fn
Local Gov't	F+/-	Fn	Fn	-----	Fn	Fn	Fn	F+/-	F+	F+	F+	Fn
DOH Cty Hth. Dept.	F neu	F neu	F+	F neu	-----	F neu	F neu	F+/-	F+	F+/-	F+/-	F neu
DEC Div. Law En.	F+/-	F+/-	F neu	F neu	F neu	-----	F neu	Fn	F+/-	F neu	F neu	F neu
DEC Off. of Hear.	F+/-	F+/-	F neu	F neu	F neu	F neu	-----	Fn	F+/-	F neu	F neu	F neu
Courts	F+/-	F +/-	Fn	F +/-	F+/-	Fn	Fn	---	F+/-	Fn	Fn	Fn
DOH Bur Wat. Sup.	F+/- S	F+	F neu	F+	F+	F+/-	F+/-	F+/-	-----	F+/-	F+/-	F neu
DOS Div. Code En.	F+	F+/-	F neu	F+	F+/-	F neu	F neu	F neu	F+/-	-----	F neu	F neu
DOS Off. Ad. Hear.	F+	F+/-	F neu	F+	F+/-	F neu	F neu	F neu	F+/-	F neu	-----	F neu
Wat. Sys. C	F+, S	F+, S	Fn	Fn	Fn	Fn	Fn	Fn	Fn	Fn	Fn	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative;
Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

A functionally positive relationship existed between the DEC GWB and the

DOH BWSP with their activities socioeconomically and biogeophysically intertwined. The DEC GWB core activities surrounded aquifer mapping, groundwater quality monitoring, public water supply permitting and the management of registration and certification of well drillers (NYSDEC, n.d.-d). Well construction standards were, by comparison, the responsibility of the DOH BWSP as were source protection plans. In essence, the DEC GWB affected aspects related to water quantity management while the DOH BWSP had responsibility for water quality management.

Enforcement linkages were multi-faceted. Those between the ESWWDA and the DEC Division of Law Enforcement, which oversaw the DEC Conservation Officers who enforce DEC rules and regulations, and the DEC Office of Hearings, which offered both mediation services and formal hearings, decisions which could be appealed to the DEC Commissioner and the state court system, were functional in nature (NYSDEC, n.d.-e, f). Whether they were positive or negative depended on the level of enforcement activity and on final decisions reached. A similar linkage existed with the DOS Division of Code Enforcement, which oversaw Code Enforcement Officers (e.g. building code) and the DOS Office of Hearings; both are charged with the responsibility of enforcing well construction standards (NYSDOS, n.d.). Likewise, functional linkages existed between both enforcement and hearings branches with the DEC GWB and the DOH BWSP. Again, whether the linkages were positive or negative largely depended on the level of enforcement activity and on final decisions reached. Note that a similar situation existed in relation to enforcement activities and local governments and County Health Departments since each had some regulatory oversight depending on whether they had assumed primacy (ESWWDA, DOH & Town of Gorham officials, interviews, 09, 20, 25, 17 July 2007).

5.2.1c 1996-2006: Complementarity of Linkages

***governance visions** (goals)*

The goals of each governance unit are shown in Table 5.2 and similarities in goals are summarized in Table 5.3. A moderate similarity in governance goals existed between the ESWWDA, the DEC GWB, the NGWA, the DOH BWSP and the WSC. This reflected the activities of each unit and, moreover, their overlap in environmental and health protection, each of which contributed a key part of the regulatory puzzle. For instance, the DEC GWB was responsible for water quantity issues while the DOH BWSP administered water quality issues via well construction standards; both of which impacted water well drillers and their association, the ESWWDA. The NGWA and WSC entered the process through their certification exams mandated by the DEC GWB which directly related to well construction standards.

In addition, the DEC GWB had a high similarity in goals with the DEC Division of Law Enforcement and the DEC Office of Hearings. It is, after all, these latter two bodies that enforced and adjudicated the DEC GWB regulations. A similar situation existed between the DOH BWSP and the DOS Division of Code Enforcement and the DOS Office of Administrative Hearings though the goal similarity is classified as moderate in nature largely due to the fact that enforcement activity related to DOH responsibilities remained "unresolved" (DOH official, interview, 25 July 2007). At the same time, note the high similarity in goals between the DOH BWSP and the County Health Departments who either aided or assumed the delivery functions for the DOH.

Table 5.2: Goals of Governance Units, Well Driller Regs., 1996-2006, NY .

Empire State Water Well Driller's Association
• Take leadership role in protecting natural resources via promotion of groundwater industry; • Supports spirit of cooperation, communication, education within industry and with consumers and regulatory agencies.
NYS DEC Groundwater Branch
• Contribute to Div. of Water's Mission re protect and conserve waters of New York State; • Achieved through many programs including water quantity mgt via well driller registration.
National Ground Water Association
• Advance expertise of all groundwater professionals; • Increase groundwater awareness and protection through education and outreach; • To be leading community of groundwater professionals that promotes responsible development, use, and management of groundwater resources.
Local Governments
• To promote, enhance, and foster a community's social and economic well-being.
NYS DOH County Health Departments
• Aids in delivery of protecting and promoting the health of New Yorkers through prevention, science and the assurance of quality health care delivery; • Includes delivery of safe drinking water via many programs like water quality standards.
NYS DEC Division of Law Enforcement
• To protect the environment, natural resources and people of New York through law enforcement, education and public outreach.
NYS DEC Office of Hearings
• Independent office; conducts hearings related to DEC's permitting/enforcement activities; • May employ less formal means such as mediation.
Courts
• Adjudicate disputes.
NYS DOH Bureau of Water Supply Protection
• Aids in delivery of protecting and promoting the health of New Yorkers through prevention, science and the assurance of quality health care delivery; • Activities related to delivery of safe drinking water including regulation of public water supplies, well construction standards and SWP.
NYS DOS Division of Code Enforcement
• Provide variety of services related to New York's Uniform Fire Prevention and Building Code and State Energy Conservation Construction Code; • Includes code enforcement activity, technical assistance/training for local enforcement.
NYS DOS Office of Administrative Hearings
• Conducts hearings related to DOS activities.
Water Systems Council
• Protect well water users, the capital investment in existing wells, groundwater resources; • Ensure safe drinking water supply; • Promote wells as affordable, common-sense drinking water systems.

Similarities in regards to the other governance units were straightforward. For instance, a low similarity in goals existed between most of the other governance units which either reflected significantly different or broader mandates. The exceptions exist with the NGWA and all adjudication units which had no similarity in goals, and in governance goals between adjudication units which were highly similar given their functions though they applied to different aspects of the regulatory framework. The DEC adjudication units, for example, applied to DEC registration issues while the DOS adjudication units applied to well construction standards, a DOH responsibility. The courts applied to all facets.

communication level** **(meeting frequency, proposals, personal communication)

Communication levels were polarized during this time frame (see Table 5.3). Of note, communication levels were high between the ESWWDA and the DEC GWB, the NGWA, and the DOH BWSP. Meetings were continually held with officials from each unit attending many of the ESWWDA quarterly meetings. For instance, at the time of the regulatory changes in 1999/2000 multiple DEC officials attended the ESWWDA quarterly meetings detailing the changes and, since then, have attended at least one of the meetings every year. A similar pattern held true for the other governance units. These meetings were in addition to the two to four meetings per year the ESWWDA had with each of the parties to discuss the ongoing regulatory changes. For instance, many meetings and discussions were held between the DEC GWB, the ESWWDA and the NGWA over the initial implementation of the certification testing requirement. Communications also increased due to the development of the NY Modified Exam for pump installers to meet the certification requirements (see *Holetalk* 1998-2002). A similar high frequency of communication existed between the WSC, the ESWWDA and the DEC GWB due to certification exam development and related educational activities (DEC GWB & ESWWDA officials, interviews, 13, 09 July 2007).

Other avenues of communication also existed between the DEC GWB and the ESWWDA and the NGWA. These included the joint administration of certification exams and review classes held since 1992-1993 at ESWWDA quarterly meetings (e.g. "Meeting Agenda," 2000), the advertisement, until 2004, of NGWA scholarships in the ESWWDA newsletter *Holetalk* (e.g. "NGWA Auxiliary Scholarship," 2003), the ESWWDA's membership in the NGWA and related member participation in committee work (T. Bates, 2007-a), and attendance at the NGWA's annual conventions, as well as, participation in NGWA's yearly "Washington Fly-ins" to address various groundwater legislation at the national level (Smith, 2002). However, the nature of the communication was not all positive especially in relation to certification exams previously discussed and that the DOH BWSP was kept informed of developments and participated when needed in relation to well construction standards.

High communication levels were both the result of and necessitated the elaboration of various positions by the parties. This included the desire by the ESWWDA to make the DEC GWB pump installer certification requirements apply equally to all drillers and non-drillers alike working on wells (Smith, 1999) and, the ESWWDA's strong opposition to the DEC GWB's fee structure changes in 2006 (T. Bates, 2007-b). A similar situation applied to the DOH BWSP in relation to the ESWWDA which had continually argued for feasible and flexible construction standards (e.g. yield testing) to ensure compliance and related health protection (e.g. Boyd, 2005; Moravec, 2005).

The relationship between the ESWWDA, the DEC GWB and the Water Systems Council (WSC) was characterized by moderate levels of communication. The difficult relationship with the NGWA led to the ongoing development of alternate certification exams with the WSC beginning in 2006. These parties had met infrequently (two to four times per year) yet had more frequent communication via other means (e.g. telephone, e-mail) to facilitate the exam's development. In addition, the parties had also met infrequently in conjunction with the DOH BWSP to discuss training workshops (Well Care Workshops) for Code Enforcement officials and DEC Conservation Officers since 2004 (e.g. Hawk-Baldwin, 2004) which were held beginning in the Spring of 2007 (DOH BWSP & ESWWDA officials, interviews, 25, 09 July 2007). Communication levels between the DOH BWSP and the WSC is classified as low. The NGWA was also party to these regulatory changes through its membership in the WSC and its communication level with the WSC was classified as low. In short, the NGWA was not directly involved in these developments though it was kept abreast of its progress (NGWA official, interview, 06 July 2007).

Communication levels between the DEC GWB and the DEC Division of Law Enforcement, as well as, between the DOH BWSP and the DOS Code Enforcement officials, and between these units was moderate in nature. This reflected the limited enforcement activity that did occur beginning in late 2000 with DEC Conservation Officers instructed to begin asking drillers for proof of registration and certification

(Hawk-Baldwin, 2000) and with DOS Code Enforcement Officers being asked to do the same ("Legislation Update," 2003). Since then, enforcement activities increased with fines handed out in some cases, a court appearance by one driller for non-compliance (S. Bates, 2004), and equipment seizure by the DEC in two other cases (ESWWDA official, interview, 09 July 2007). Note, however, that enforcement activities were still generally limited, much to the ESWWDA's dismay (Hawk-Baldwin, 2007) largely due to the lack of funds for the additional enforcement (S. Bates, 2005), jurisdictional confusion ("Legislative Update," 2004; NYSDOH BWSP officials, interviews, 20 July 2007), and the lack of training for enforcement officials which the parties addressed by developing a training program, as previously discussed.

Other communication levels between governance units were low to non-existent (i.e. nil) generally reflecting a governance unit's narrow role in the process. For instance, both Hearing's Offices (DEC, DOS) had little communication with any of the other governance units due to the low levels of enforcement overall and the time required before a case would be subject to their administration. Similarly, the NGWA's mandate for registration and certification was very different than a County Health Department's mandate, the courts or the Hearings Offices. One exception did exist however. The DOH BWSP and County Health Departments had moderate communication levels given their interconnectedness. Both were involved in delivering their health responsibilities with the DOH BWSP establishing the framework within which the County departments largely operated.

Table 5.3: Linkage Complementarity Summary, 1996-2006, Well Driller Regs, NY

	ES W W DA	DEC GW Br.	N G W A	Local Gov't	DOH Cty. Hth. Dept.	DEC Div. Law En.	DEC Off. of Hear.	Co urts	DOH Bur. Wat. Sup.	DOS Div. Code En.	DOS Off. Ad. Hear.	Wat Sys. C.
Governance Vision (Goals)												
ESWWDA	-----	Mod	Mod	Low	Low	Low	Low	Low	Mod	Low	Low	Mod
DEC GW Br.	Mod	-----	Mod	Low	Low	High	High	Low	Mod	Low	Low	Mod
NGWA	Mod	Mod	---	Low	Low	-nil-	-nil-	nil	Mod	-nil-	-nil-	Mod
Local Gov't.	Low	Low	Low	-----	Mod	Low	Low	Low	Mod	Low	Low	Low
DOH Cty. Hth. Dept.	Low	Low	Low	Mod	-----	Low	Low	Low	High	Low	Low	Low
DEC Div. Law En.	Low	High	nil	Low	Low	-----	High	High	Low	Mod	Mod	-nil-
DEC Off. of Hear.	Low	High	nil	Low	Low	High	-----	High	Low	Mod	Mod	-nil-
Courts	Low	Low	nil	Low	Low	High	High	---	Low	High	High	-nil-
DOH Bur. Wat. Sup.	Mod	Mod	Mod	Mod	High	Low	Low	Low	-----	Mod	Mod	Mod
DOS Div. Code En.	Low	Low	nil	Low	Low	Mod	Mod	High	Mod	-----	High	-nil-
DOS Off. Ad. Hear.	Low	Low	nil	Low	Low	Mod	Mod	High	Mod	High	-----	-nil-
Wat. Sys. C.	Mod	Mod	Mod	Low	Low	-nil-	-nil-	nil	Mod	-nil-	-nil-	-----
Communication Level (Meetings, Proposals, Personal Communication)												
ESWWDA	-----	High	High	Low	Low	Low	-nil-	nil	High	Low	-nil-	Mod
DEC GW Br.	High	-----	High	Low	Low	Mod	-nil-	nil	High	Mod	-nil-	Mod
NGWA	High	Mod	---	-nil-	-nil-	-nil-	-nil-	nil	Low	-nil-	-nil-	Low
Local Gov't.	Low	Low	nil	-----	Low	Low	-nil-	nil	Low	Low	-nil-	-nil-
DOH Cty. Hth. Dept.	Low	Low	nil	Low	-----	Low	-nil-	nil	High	Low	-nil-	-nil-
DEC Div. Law En.	Low	Mod	nil	Low	Low	-----	Low	Low	Low	Low	-nil-	-nil
DEC Off. of Hear.	-nil-	-nil-	nil	-nil-	-nil-	Low	-----	nil	Low	-nil-	-nil-	-nil-
Courts	-nil-	-nil-	nil	-nil-	-nil-	Low	-nil-	---	-nil-	Low	-nil-	-nil-
DOH Bur. Wat. Sup.	High	High	Low	Low	High	Low	Low	nil	-----	Mod	Low	Low
DOS Div. Code En.	Low	Mod	nil	Low	Low	Low	-nil-	Low	Mod	-----	Low	-nil-
DOS Off. Ad. Hear.	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	nil	Low	Low	-----	-nil-
Wat. Sys. C.	Mod	Mod	Low	-nil-	-nil-	-nil-	-nil-	nil	Low	-nil-	-nil-	-----
Frequency and Type of Collaboration												
ESWWDA	-----	High	High	Low	Low	Low	-nil-	nil	Mod	Low	-nil-	Mod
DEC GW Br.	High	-----	Low	Low	Low	Low	-nil-	nil	Low	Low	-nil-	Mod
NGWA	High	Low	---	-nil-	-nil-	-nil-	-nil-	nil	-nil-	-nil-	-nil-	Low
Local Gov.	Low	Low	nil	-----	Low	Low	-nil-	nil	Low	Low	-nil-	-nil-
DOH Cty Hth. Dept.	Low	Low	nil	Low	-----	Low	-nil-	nil	Mod	Low	-nil-	-nil-
DEC Div. Law En.	Low	Low	nil	Low	Low	-----	Low	nil	Low	Low	-nil-	-nil-
DEC Off. of Hear.	-nil-	-nil-	nil	-nil-	-nil-	Low	-----	nil	-nil-	-nil-	-nil-	-nil-
Courts	-nil-	-nil-	nil	-nil-	-nil-	-nil-	-nil-	---	-nil-	-nil-	-nil-	-nil-

Table 5.3: (cont'd)
Linkage Complementarity Summary, 1996-2006, Well Driller Regs, NY.

	ES W W DA	DEC GW Br.	N G W A	Local Gov't	DOH Cty. Hth. Dept.	DEC Div. Law En.	DEC Off. of Hear.	Co urts	DOH Bur. Wat. Sup.	DOS Div. Code En.	DOS Off. Ad. Hear.	Wat Sys. C.
Frequency and Type of Collaboration (cont'd)												
DOH Bur. Wat. Sup.	Mod	Low	nil	Low	Mod	Low	-nil-	nil	-----	Low	-nil-	Low
DOS Div. Code En.	Low	Low	nil	Low	Low	Low	-nil-	nil	Mod	-----	-nil-	-nil-
DOS Off. Ad. Hear.	-nil-	-nil-	nil	-nil-	-nil-	-nil-	-nil-	nil	-nil-	-nil-	-----	-nil-
Wat. Sys. Council	Mod	Mod	Low	-nil-	-nil-	-nil-	-nil-	nil	Low	-nil-	-nil-	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

frequency and type of collaboration

Collaboration levels, summarized in Table 5.3, largely mirrored communication levels. Of note are the high collaboration levels between the ESWWDA, the DEC GWB and the NGWA. This was due to their mutual involvement in the initial registration and certification exams, the development of the New York Modified Exam for pump installers, and their involvement in administering the exams at either ESWWDA quarterly meetings and at DEC regional offices once a year since 2004, as previously discussed. In addition, the ESWWDA and the NGWA collaborated to establish certification review classes held at ESWWDA quarterly meetings and collaborated to influence the federal government through the yearly NGWA "Washington Fly-ins", as previously discussed. Similarly, the ESWWDA and the DEC GWB collaborated to educate well drillers in the proper completion of well logs in 2002 and 2003 (Moravec, 2002) and worked with the Water Systems Council to develop new certification exams (developments can be traced via updates in *Holetalk* from 2004-2007). Care must also be taken not to dismiss numerous collaborative efforts between the two to address frequent changes to the NGWA certification exams though the efforts were largely unsuccessful.

Low levels of collaboration existed between the WSC and the DOH BWSP with efforts directed at the development of the training program for code enforcement officials only (see updates in *Holetalk*, 2004-2007). Note the high level of collaboration between the ESWWDA and the DOH BWSP in the training program's development and sessions since the program was jointly delivered by the two, as well as, the ESWWDA's participation in the Technical Advisory Committee for well construction standards development (DOH BWSP official, interview, 25 July 2007). In addition, the DOH BWSP worked with the ESWWDA in the development of well construction "Fact Sheets" to ensure feasible implementation "on the ground" (DOH BWSP & ESWWDA officials, interviews, 25, 09 July 2007).

Collaborative efforts between the other governance units were low to non-existent (nil). In short, they had little involvement with each other given their mandates. The court's collaboration levels with other governance units, for example, was non-existent. There were essentially no pressing issues or items to address. The NGWA also did not collaborate with the other units (and vice versa), outside of the previously mentioned ones above, largely due to different mandates. They performed different functions and their paths did not cross to the point where collaboration was necessary. Similar patterns hold for the other governance units with the exception of the DOH BWSP and the County Health Departments in which, again due to overlap in the delivery of the department's mandate, a moderate level of collaboration occurred through enforcement provisions and through County Health Department's participation on the Regulatory Advisory Committee for well construction standards development (DOH BWSP official, interview, 25 July, 2007).

5.2.2 Preliminary Findings: Well Drilling Regulations and Organizational Environment

The organizational environment surrounding the evolution of New York well drilling legislative and regulatory changes has been examined for the only available period, 1996-2006. It was a convergence of factors, including the need for well driller logs to assess the state's aquifers and the drillers desire to professionalize the industry, that led to the licensing and mandatory well construction requirements for the rest of the state (outside Long Island). The policy changes represent changes in policy goals, instruments and instrument settings.

In terms of the organizational environment, New York had a diffuse institutional structure owing to the fact New York is a home rule state. This is seen in both the number of governance units (sixteen) and the number of vertical governance layers (4) involved in the process. Surprisingly, little conflict was present (pump exams being the exception) and/or mainly contained within specific governance units. This diffuse institutional structure is also seen in the elaborate enforcement and adjudication procedures which are spread out over multiple governance units. Finally, note the centrality of the three main governance units in the process: the NYSDEC, the NYSDOH and the ESWWDA.

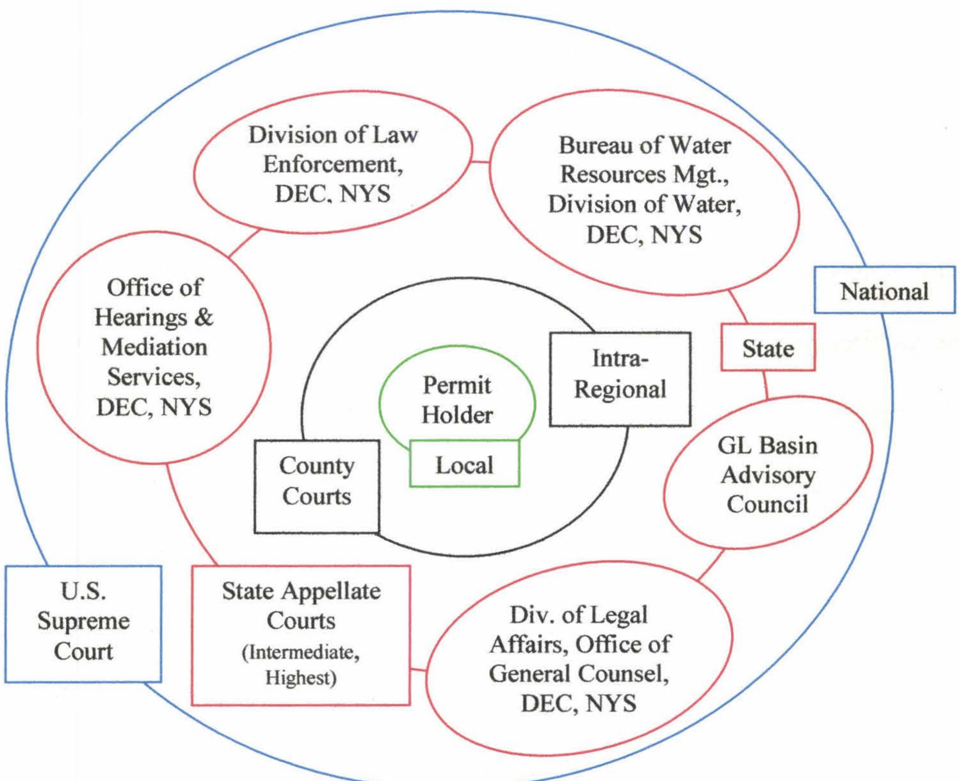
5.3 Water Takings Independent Variable Summary, New York

The effects of nested institutional arrangements on water takings are examined over the one available time frame, 1985-1991. Note that New York had no prior Great Lakes Basin water withdrawal legislation as previously discussed.

5.3.1a 1985-1991: Number of Governance Units

Eight governance units impacted water takings in New York. This included three vertical governance units (intra-regional, state and national) and one intra-regional, six state and one national horizontal governance units as shown in Figure 5.2.

Figure 5.2: Water Takings Governance Units, 1985-1991, New York



5.3.1b 1985-1991: Types of Linkages

Water withdrawal linkages between governance units are summarized in Table 5.4. Regulatory changes were internally developed within the DEC between the Bureau of Water Resources Management (BWRM) and the Division of Legal Affairs (DLA). The two had a functionally positive linkage since the BWRM was charged with the management of the State's water resources and, therefore, developed the regulations to meet New York's Great Lakes Charter requirements. However, the development of the regulations necessitated the help of the DLA for legal counsel (DEC official, interview, 30 July 2007; Onondaga Water Authority official, personal communication, 16 August, 2007).

The linkage between DEC BWRM and the Great Lakes Basin Advisory Council (GLBAC) was functionally positive and strategic. Functionality was indicated in the DEC BWRM's responsibility to develop water withdrawal registration regulations while the GLBAC's role was to advise the state in its role in Great Lakes Basin issues largely in regards to water *quality* issues. These activities were inherently positive and mildly strategic given timelines (the GLBAC was created in 1988 and the regulations were passed in 1989), and the GLBAC's focus (for timelines, see NYSDEC, n.d.-h, n.d.-a). In other words, the regulations were well developed and undergoing public comment, as per New York's State Administrative Procedures Act (SAPA), at the time of the GLBAC's formation and early activities (DEC & Monroe County Water Authority officials, interviews, 30 July, 2007 and 17 August, 2007).

Linkages between the DEC DLA and the DEC Office of Hearings and the courts were functional in nature. The DLA provided legal counsel in regards to regulatory development while the two adjudicatory bodies settled disputes. Whether the linkage was positive or negative depended on the individual decisions reached. Also note the functionally positive linkage the DEC DLA had with the DEC Division of Law Enforcement which reflected their respective activities; one aided in regulatory development while the other enforced such regulations. Other linkages between adjudicatory bodies, shown in Table 5.4, were functionally neutral with each body adjudicating disputes.

Table 5.4: Linkage Types, Water Takings Regulatory Changes, 1985-1991, NY

	Bureau Water Res. Mgt., DEC	Div. Legal Aff., DEC	Div. Law En., DEC	Office of Hear., DEC	GL Basin Adv. Coun.	Courts
Bureau Water Res. Mgt., DEC	-----	F +	F +/-	F +/-	F + , S	F +/-
Div. Legal Aff., DEC	F +	-----	F +	F +/-	F neu	F +/-
Div. Law En., DEC	F +/-	F +	-----	F neu	F neu	F neu
Office of Hear., DEC	F +/-	F +/-	F neu	-----	F neu	F neu
GL Basin Adv. Coun.	F + , S	F neu	F neu	F neu	-----	F neu
Courts	F +/-	F +/-	F neu	F neu	F neu	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

5.3.1c 1985-1991: Complementarity of Linkages

governance vision (goals)

The goals of each governance unit are shown in Table 5.5 and goal similarities are summarized in Table 5.6. Of note were the high goal similarities between the DEC, BWRM, the DEC DLA and the two DEC adjudicatory bodies given their related regulatory overlap, enforcement and adjudicatory functions. The DEC BWRM and the DEC DLA had moderately similar goals given their similar regulatory development functions and dissimilar mandates; the former in terms of program management and the latter in relation to legal claims and interpretations. All governance units had low goal similarities with the GLBAC, which simply reflected different mandates yet all related to the Great Lakes Basin. Finally, adjudicatory bodies had a high goal similarity given each party's function(s) in enforcement and adjudication activities and no similarities in goals existed between the GLBAC and the courts which reflected different mandates.

Table 5.5: Goals of Governance Units, 1985-1991, Water Takings Regs., NY

Bureau of Water Resources Management, Division of Water, DEC, NYS
• Protect, conserve NYS's water supply source; provide watershed geographic information technology support; promote collaborative partnership programs. • Program management (e.g. Great Lakes water withdrawal registration); regulatory development.
Division of Legal Affairs, Office of Counsel, DEC, NYS
• Develop, review legislation, regulations and provide interpretations, advice; • Liaison with Dept. of Law re claims, lawsuits.
Division of Law Enforcement, DEC, NYS
• Protect environment, natural resources/people via law enforcement, education, public outreach.
Office of Hearings, DEC, NYS
• Independent office; conducts hearings related to DEC's permitting/enforcement activities; • May employ less formal means such as mediation.
Great Lakes Basin Advisory Council
• Advises Governor, DEC Commissioner re NY's role in inter-jurisdictional water quality issues; • Link between government and public.
Courts
• Adjudicate disputes.

communication level (meeting frequency, proposals, personal communication)

Communication levels were low among governance units as shown in Table 5.6. The exceptions were communication levels between the DEC BWRM and the DEC DLA and between the DEC BWRM and the GLBAC which were moderate in nature. In terms of communications between the BWRM and the DLA, the process was one of which the BWRM developed draft regulations and forwarded them to the DLA for review. Only a couple of formal meetings were held with the bulk of communication done informally via staff discussions as part of their daily affairs. The same applied for two Great Lakes Basin Water Withdrawal Registration guidance booklets[37] the BWRM developed and released in 1991 with the booklets being departmentally reviewed (DEC official, interview, 30 July 2007).

[37]The booklets are now available electronically as "factsheets" (See NYSDEC, n.d.-i).

Communications between the DEC BWRM and the GLBAC were also moderate. This reflects the GLBAC establishment date previously discussed which limited communication and their different mandates though the GLBAC was kept informed of both regulatory and guidance booklet development. Note also that the DEC had one seat on the GLBAC (NYSDEC, n.d.-h). However, no formal comments were received from the GLBAC nor asked for by the DEC BWRM in regards to either item which reflected a "strong internally driven process" (DEC, Monroe & Onondaga County Water Authorities officials, interviews, 30 July 2007 and 17, 16 August, 2007).

Table 5.6: Linkage Complementarity Summary, 1985-1991, Water Takings, NY:

	Bureau Water Res. Mgt., DEC	Div. Legal Aff., DEC	Div. Law En., DEC	Office of Hear., DEC	GL Basin Adv. Coun.	Courts
Governance Vision (Goals)						
Bureau Water Res. Mgt., DEC	-----	Mod	High	High	Low	Low
Div. Legal Aff., DEC	Mod	-----	High	High	Low	Mod
Div. Law En., DEC	High	High	-----	High	Low	High
Office of Hear., DEC	High	High	High	-----	Low	High
GL Basin Adv. Coun.	Low	Low	Low	Low	-----	-nil-
Courts	Low	Mod	High	High	-nil-	-----
Communication Level (Meetings, Proposals, Personal Communication)						
Bureau Water Res. Mgt., DEC	-----	Mod	Low	Low	Mod	Low
Div. Legal Aff., DEC	Mod	-----	Low	Low	Low	Low
Div. Law En., DEC	Low	Low	-----	Low	-nil-	Low
Office of Hear., DEC	Low	Low	Low	-----	-nil-	-nil-
GL Basin Adv. Coun.	Mod	Low	-nil-	-nil-	-----	-nil-
Courts	Low	Low	Low	-nil-	-nil-	-----
Frequency and Type of Collaboration						
Bureau Water Res. Mgt., DEC	-----	Low	Low	-nil-	Low	-nil-
Div. Legal Aff., DEC	Low	-----	Low	Low	Low	-nil-
Div. Law En., DEC	Low	Low	-----	-nil-	-nil-	-nil-
Office of Hear., DEC	-nil-	Low	-nil-	-----	-nil-	-nil-
GL Basin Adv. Coun.	Low	Low	-nil-	-nil-	-----	-nil-
Courts	-nil-	-nil-	-nil-	-nil-	-nil-	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

Other communication levels were low or non-existent. For instance, low levels of communication existed between the DEC DLA and all other governance units and between all adjudicatory bodies. This largely reflected the fact that few enforcement actions were required with only a few actions taken (e.g. letters) at the GLWWRP's inception to ensure registration. The DEC's integrated permit review system also contributed to the low enforcement actions required. An application for or renewal of a Pollution Elimination Discharge Systems Permit, for instance, automatically triggered consideration for Great Lakes water withdrawal registration (DEC official, interview, 30 July 2007).

frequency and type of collaboration

Collaboration levels were low to non-existent between the governance units (see Table 5.6). For instance, no collaboration existed between the courts and other governance units, as well as, between the other adjudicatory units. Low collaboration levels existed between the DEC BWRM and the DEC DLA, the DEC Law Enforcement and the GLBAC. This reflected the DEC BWRM's lead role in regulatory development, as well as, the development of the guidance booklets which necessitated review and training of personnel. The situation between the DEC BWRM and the GLBAC was different since the DEC BWRM was a member of the GLBAC and participated in its activities as required. A similar situation to the DEC BWRM existed with the DEC's DLA and the aforementioned bodies.

As an addendum to both communication and collaboration levels in relation to water takings regulatory change, legislation requiring withdrawal registration and establishing the GLBAC was passed in 1988 (NYSGLBAC, 2002), the regulations were passed in 1989 (NYSDEC, 1990) and the guidance booklets were issued in 1991 (NYSDEC official, interview, 30 July 2007). The timelines were tight yet the work was narrow in scope and, as officials remarked, straightforward, as previously noted. The fact that no changes in the law, the regulations and no updates to the guidance booklets or other materials has since occurred has largely ensured low levels of communication and collaboration.

5.3.2 Preliminary Findings: Water Takings and Organizational Environment

Statewide water takings legislation does not exist in New York. Rather, legislation is sporadic. In terms of the Great Lakes Basin, registration of water withdrawals greater than 100,000 gal(US)/day (thirty day average) and for large consumptive uses (>5,000,000 gal(US)/day) is required. These are high thresholds and the requirement is one of registration, not a permitting one and is done to meet its obligations under the Great Lakes Charter (1985). The organizational environment surrounding the enactment and implementation of the registration program is straight forward. Few governance units were and continue to be involved in the process with most contained within the NYSDEC.

5.4 Source Water Protection Independent Variable Summary, New York

The effects of nested institutional arrangements on source water protection are examined over one time frame, 1986-1996. The number of governance units, linkage types and complementarity of linkages are assessed to reveal their effects on the type, frequency and magnitude of groundwater policy change.

5.4.1a 1986-1996: Number of Governance Units

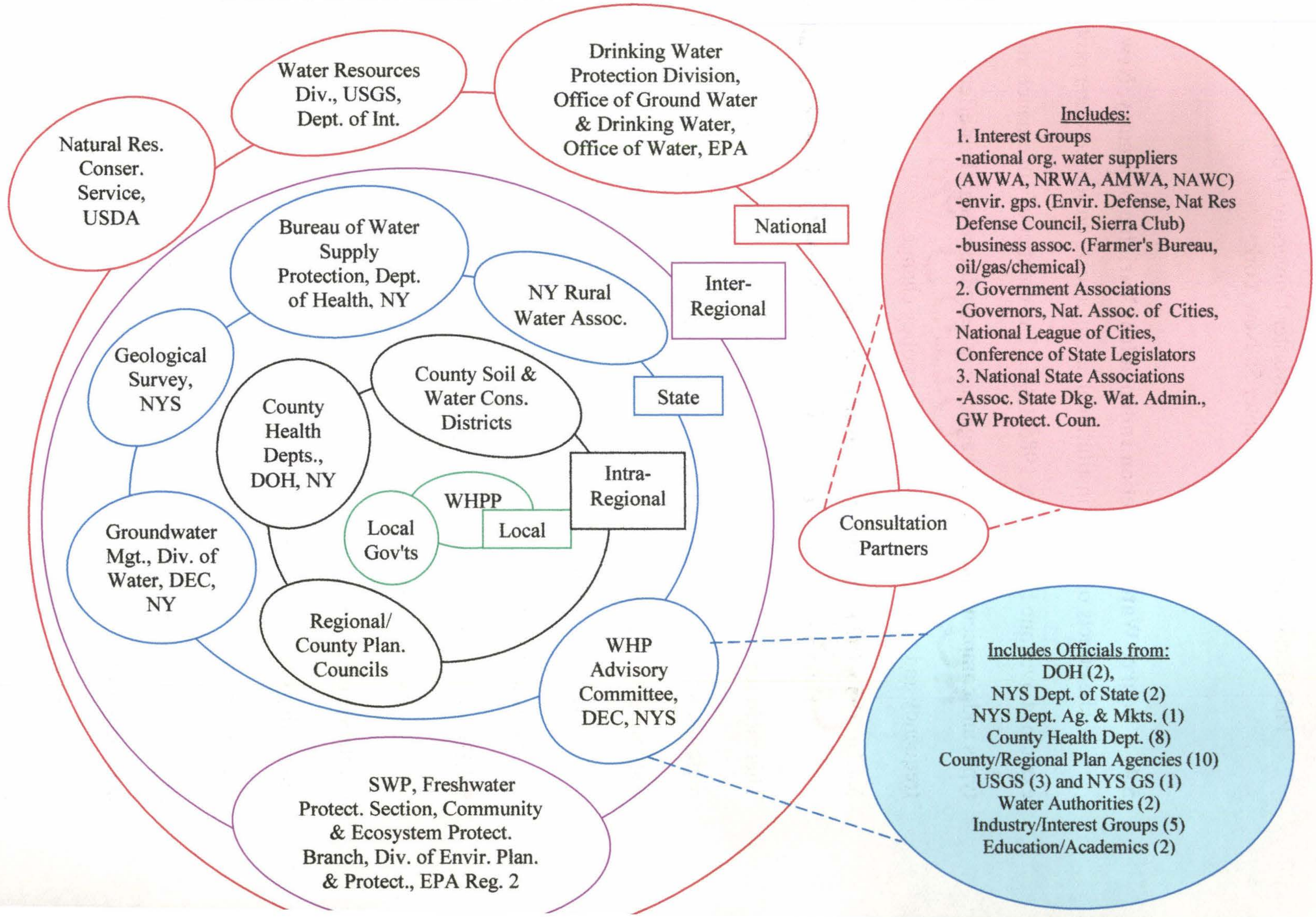
Fourteen governance units, as shown in Figure 5.3, were active at this time. This included five vertical governance units (local, intra-regional, state, inter-regional, national) and one local, three intra-regional, five state, one inter-regional and four national horizontal governance units. It also included both the NYSDEC WHP Advisory Committee and the national Consultation Partners even though they had much smaller functions in the process.

5.4.1b 1986-1996: Types of Linkages

Two processes were at work simultaneously during this time frame; the first in relation to the 1986 Safe Drinking Water Act (SDWA) changes which, among other things, initiated state wellhead protection programs and was largely a federal endeavour, and the second being the actual creation of state wellhead protection programs and local wellhead protection plans (WHPPs) which occurred at the state and local levels. Table 5.7 summarizes the linkage types.

At the federal level, legislative and regulatory change was driven by the USEPA Drinking Water Division (DWD) which was charged with ensuring safe drinking water supplies and the protection of groundwater which included the SDWA's administration (USEPA, 1986). The USEPA DWD had a functionally

Figure 5.3: Source Water Protection Governance Units, 1986-1996, NY



positive relationship with the other two main federal entities involved in the process, the Water Resources Division of the US Geological Survey (USGS WRD) and the Natural Resources Conservation Service of the US Department of Agriculture (USDA NRCS) due to the nature of their work. The USGS WRD provided scientific information in relation to water resources (Rabbitt, 1989) while the USDA NRCS aided private landowners in various conservation efforts including those related to water and soil activities (USDA NRCS, 2006). The USEPA DWD also consulted widely with various agencies largely on an individual basis throughout the legislative change process (USEPA official, interview, 27 July 2007). The linkage with the consultation partners was functional and could be either positive or negative in nature depending on whether the outcome met a particular agency's interests.

Other USEPA DWD linkages were mixed. For instance, the USEPA DWD had a functionally positive and strategic linkage with the USEPA Region 2 Office since EPA programs were delivered through its ten regional offices. Functionally positive relationships also existed between the USEPA DWD and the NYSDEC GWMD, the Regional/County Planning Councils and the Local Governments given the latter's heavy involvement in developing state WHP programs and local WHPPs. The USEPA's Region 2 Office had similar linkages with these bodies too (USEPA Region 2 & G/FLRPC officials, interviews, 19 July & 21 August 2007). Also of note and at the inter-regional level, the USEPA Region 2 was functionally linked to the NYSDEC GWMD given their respective roles. New York's WHP program needed to be approved by the USEPA Region 2 Office and the linkage was both positive and negative depending on the issue at hand. For instance, NY's first submission in 1989 was deemed incomplete due to limited public input (NYSDEC, 1990).

At the state and local levels, the NYSDEC GWMD was functionally linked to all governance units given its leadership role in the process and the core activities of the others. For instance, the NYSDEC GWMD was charged with protecting groundwater resources through the development of WHPPs, among other things, while the geological services of either the State or the federal government were charged with providing scientific information related to water resources needed in the development of WHPPs (NYSDEC, 1990; Rabbitt, 1989). Furthermore the nature of the relationship with local governments and the DEC Wellhead Advisory Committee was either functionally positive or negative depending on whether their interests were fulfilled. For instance, local governments were initially hesitant to develop WHPPs fearing increased regulation and associated financial considerations (e.g. who pays for the WHHP?; NYSDEC official, interview, 06 July 2007; Genesee/Finger Lakes Regional Planning Council official, personal communication, 21 August 2007). At a strategic level, the NYSDEC GWMD worked hand in hand with the Regional/County Planning Councils to initiate local WHPPs and with the Wellhead Advisory Committee in the State's WHP program submittal to the USEPA Region 2 Office (NYSDEC, 1990).

One linkage to note was the functionally negative one between the Regional/County Planning Councils and the New York Rural Water Association

(NYRWA). The role of Planning Councils began to diminish when the NYRWA hired a hydrogeologist to specifically help smaller municipalities develop WHPPs in 1995 to the point where by 1998 the Planning Councils had very little to no role in the process (Genesee-Finger Lakes Regional Planning Council official, personal communication, 21 August 2007; NYRWA, n.d.).

Other linkages, shown in Table 5.7, were functional (positive or neutral) and reflected the core activities of each governance unit; two linkages of which are highlighted to illustrate this assessment. The NYSDOH Bureau of Water Supply Management (BWSM) had a functionally neutral linkage with the NYS Geological Service illustrating the fact that the BWSM had some oversight of public water supply systems in terms of water quality, for instance, while the Geological Service had a role in providing scientific information related to NY's water resources. Both were performing work related to groundwater supplies. The second example demonstrates a functionally positive linkage between County Soil and Water Conservation Districts (County SWCD) and Regional/County Planning Councils. The Planning Councils were heavily involved in the development of WHPPs with local governments while County SWCDs aided rural landowners, largely farmers, to address various water and soil issues that could negatively impact municipal wellheads (e.g. Cayuga County SWCD, 2006; Warren County SWCD & Genesee-Finger Lakes Regional Planning Council official, personal communication, 06 July & 21 August 2007).

5.4.1c 1986-1996: Complementarity of Linkages

Table 5.7: Linkage Types, Source Water Protection Regulatory Changes, 1986-1996, NY

	DEC GW Mgt. Div.	DEC WHP Ad. Com.	NYS GS	DOH Bur. Wat. Sup. Mgt.	NY Rural Wat. As.	DOH Cty. Health Dept.	Reg/Cty Plan. Coun.	Cty. SWCD	Local Gov't	EPA Reg. 2	EPA Dkg. Wat Div.	Wat. Res. Div., USGS	USDA Nat. Res. C.S.	Consul. Partners
DEC GW Mgt. Div.	-----	F +/- S	F +	F +	F +	F +	F + S	F +	F +/-	F +/-	F +	F +	F +	F +/-
DEC WHP Ad. Com.	F +/- S	-----	F +	F +	F +	F +	F neu	F +	F +/-	F neu	F neu	F +	F +	F +/-
NYS GS	F +	F +	-----	F neu	F +	F neu	F +	F neu	F neu	Fneu	Fneu	F +, S	F neu	F neu
DOH Bur. WatSupMgt	F +	F +	F neu	-----	F neu	F + S	F neu	F +	F neu	F neu	F neu	F neu	F +	F +/-
NY Rural Wat. Assoc.	F +	F +	F +	F neu	-----	F neu	F -	F +	F +	F +	F neu	F neu	F +	F +/-
DOH Cty. Health Dept.	F +	F +	F neu	F + S	F neu	-----	F neu	F +	F neu	F neu	F neu	F neu	F neu	F +/-
Reg/Cty Plan. Coun.	F + S	F neu	F +	F neu	F -	F neu	-----	F +	F + S	F +	F +	F +	F +	F +/-
Cty. SWCD	F +	F +	Fneu	F +	F +	F +	F +	-----	F +	Fneu	Fneu	Fneu	F +	F +/-
Local Gov't	F +/-	F +/-	Fneu	F neu	F +	F neu	F +, S	F +	-----	F +	F +	F neu	F neu	F +/-
EPA Reg. 2	F +/-	F neu	Fneu	F neu	F +	F neu	F +	F neu	F +	-----	F+ S	F +	F +	F +/-
EPA Dkg. Wat. Div.	F +	F neu	F neu	F neu	F neu	F neu	F +	F neu	F +	F + S	-----	F +	F +	F +/-
Wat. Res. Div., USGS	F +	F +	F + S	F neu	F neu	F neu	F +	F neu	F neu	F +	F +	-----	F neu	F neu
USDA Nat. Res. C. S.	F +	F +	F neu	F +	F +	F neu	F +	F +	F neu	F +	F +	F neu	-----	F +/-
Consul. Partners	F +/-	F +/-	F neu	F +/-	F +/-	F +/-	F +/-	F +/-	F +/-	F +/-	F +/-	F neu	F +/-	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

governance vision** **(goals)

The goals of each governance unit are shown in Table 5.8 and similarities in goals are summarized in Table 5.9. A number of points are important here. Note the high similarity in goals between governance units that developed and oversaw the WHP program, that is, the NYSDEC GWMD, the USEPA Region 2 and the USEPA DWD. This was not surprising given their direct responsibilities. Also, a high similarity in goals between governance units responsible for program delivery across vertical levels of governance existed, especially between the intra-regional and the other levels. For example, high goal similarities existed between NYSDOH BWSM and the County Health Departments, between the Local Governments and Regional/County Planning Councils, as well as, between County SWCDs and the USDA NRCS. Again, this was not surprising given they performed similar program delivery aspects and/or inter-related functions at different scales. The high goal similarity between the federal and state geological surveys is an example of the latter. High goal similarities also existed between governance units that aid WHPP development "on the ground" in conjunction with Local Governments. This can be seen in the high goal similarities that existed between Local Governments, the Regional/County Planning Councils and the NYRWA.

The diversification of a governance unit's goals also affected matters. For instance, the planning units that worked with local governments on the ground, the Regional/County Planning Councils and the NYRWA, while performing largely the same functions, had different goal similarities in relation to the lead agency, the

NYSDEC GWMD, with the Planning Councils having a low goal similarity and the NYRWA having a moderate similarity in goals with the DEC. This largely reflected the wider mandate of Planning Councils which included, for example, economic development planning. In comparison, the NYRWA expressly focused on small

Table 5.8: Goals of Governance Units, Source Water Protection, 1986-1996, NY

NYS DEC GW Management Branch
• Contribute to Div. of Water's Mission re protect and conserve waters of New York State; • Achieved through many programs including wellhead protection planning.
NYS DEC WHP Advisory Committee
• Assist in development of NYS's WHP Program submittal to EPA.
NYS Geological Survey
• Provide scientific information regarding the state's geology and groundwater resources.
NYS DOH Bureau Water Supply Management
• Aids in delivery of protecting and promoting the health of New Yorkers through prevention, science and the assurance of quality health care delivery; • Activities related to delivery of safe drinking water including regulation of public water supplies, and well construction standards (guidelines).
NY Rural Water Association
• Represent small water/wastewater systems in New York (population <10,000); • Assist communities/systems comply with regulations; to protect public health and environment; • Achieved through various programs including assistance in developing WHPPs.
NYS DOH County Health Departments
• Aids in delivery of protecting and promoting the health of New Yorkers through prevention, science and the assurance of quality health care delivery; • Includes delivery of safe drinking water via many programs like water quality standards.
Regional/County Planning Councils
• Foster coordination among neighboring counties or within counties and to provide a regional approach to those concerns crossing local boundaries. • Achieved through various programs including those related to water resources planning.
County Soil & Water Conservation Districts
• Implement projects/programs to improve/protect the lakes/streams/natural resources of the County.
Local Governments
• To promote, enhance, and foster a community's social and economic well-being.
USEPA Region 2
• Work to ensure clean air, pure water and better-protected land; compliance with environmental regulations and environmental stewardship. • Achieved through various programs including WHPPs.
USEPA Drinking Water Division
• Ensure safe drinking water; restore/maintain watersheds, aquatic ecosystems to protect human health, support economic/recreational activities, provide healthy habitat for fish, plants, wildlife. • Achieved through various programs including WHPPs.
USGS (Dept. of Interior) Water Resources Division
• Provide water information that benefits the Nation's citizens.
USDA Natural Resources Conservation Service
• Provide leadership in a partnership effort with private land owners and managers to conserve their soil, water, and other natural resources through technical assistance based on sound science.
Consultation Partners (National)
• Assist in development of legislative and regulatory framework.

water and wastewater systems, which was a much narrower mandate (NYRWA, n.d.-a).

Goal diversification effects can also be seen in relation to other governance units. For instance, the NYRWA had a moderate similarity in goals with the DOH BWSM while the Regional/County Planning Councils had a low similarity in goals with the DOH BWSM. This reflected the narrow focus of the NYRWA on water and waste water operations which was consistent with the DOH BWSM's goals of public water supply system operations and water quality standards. Keep in mind, the Regional/County Planning Councils did not solely focus on water issues, as previously noted. The same pattern was seen in relation to the DOH BWSM, the County Health Departments and the County SWCD with the latter having a narrow mandate in relation to the other two. As such, goal similarities between these units were low.

communication level ***(meeting frequency, proposals, personal communication)***

Communication levels were generally low during this time frame as shown in Table 5.9. Of note were the low communication levels between the NYSDEC Advisory Committee, the national Consultation Partners and all other governance units. These governance units had little interaction with the exception being communication levels between the national Consultation Partners and Local Governments which are classified as moderate in nature. This was due to the fact a number of the national interest groups, especially the business associations, lobbied local government officials to remind them of the long constitutional tradition of land use decisions made at the local level and to ensure that any new national legislative changes did not encroach on that tradition. This lobby continued throughout the 1980s and was successful in thwarting the EPA's attempt at passing a national groundwater law in 1989 (USEPA official, interview, 27 July 2007).

Similarly, communication levels among national governance units were low. This reflected the internalization of the legislative change process by the USEPA DWD. This did not mean that other federal governance units were not consulted, rather, they were consulted on an "as needed" and on a "bi-lateral basis, never together" to determine how the legislative changes would impact them (USEPA DWD official, interview, 27 July 2007). This consultation was done through few "official" meetings, typically one or two per year, with the bulk of the work being done informally at the lower staff level. Communication with the Consultation Partners was, however, moderate and reflected the same on an "as needed" process. For instance, different "partners" were consulted when they were pulled into the "negotiation process in Congress", via small roundtables, leading to the 1986 SDWA changes, and were in addition to periodic one on one consultations with the same groups that led to the USEPA's 1984 and 1991 groundwater strategies and the USEPA's 1989 WHPP Conference where all interests were present (e.g. USEPA, 1984; USEPA DWD official, interview, 27 July 2007).

At the state level, the NYSDEC GWMD had low communication levels with the DEC Wellhead Advisory Committee. This was reflected in the fact that, while the Advisory Committee was mandated by the USEPA in order to develop the State's WHPP, the NYSDEC GWMD only formally met with the Committee a total of three times to discuss the issues and, on an informal basis, Advisory Committee members were provided with drafts of the State's USEPA submission (NYSDEC, 1990).

Exceptions to these low communication levels existed and were centred on the main governance units. For instance, the NYSDEC GWMD had moderate levels of communication with the NYSDOH BWSM and the USEPA Region 2 Office. This largely reflected overlapping roles in the process with the NYSDOH BWSM responsible for water quality guidelines, review of new public water supply systems, as well as, their ongoing operation (NYSDEC, 1990). Essentially, WHPPs were often, though not necessarily, mandated when new public water supply systems were contemplated. As one Official noted, New York is a "strange state in that it is very regionalized" and, much flexibility was allowed in the implementation of State programs by regional offices (e.g. NYSDEC, 1990; NYRWA official, interview, 23 July 2007).

High communication levels existed between the Regional/County Planning Councils and the NYSDEC GWMD, Local Governments and the EPA Region 2 Office. This reflected what one Official noted was the "significant role" the Planning Councils had with these bodies in the development of voluntary local WHPPs. It was the Planning Councils that led the process on behalf of Local Governments and formed technical and advisory committees with a regional DEC representation on such committees which met on a monthly basis over the course of a year in a WHP plan's development. The USEPA Region 2 Office's role was largely in regards to funding though they were also kept informed via periodic updates (Genesee/Finger

Lakes Regional Planning Council official, personal communication, 21 August 2007). Communication levels were moderate between both Geological Services and the Planning Councils. As officials pointed out, both were drawn upon for scientific information in the development of a local WHPP on an "as needed basis" which, at times, was quite frequent (Genesee/Finger Lakes Regional Planning Council official, personal communication 21 August 2007; USEPA Region 2 official, interview, 19 July 2007; NYSDEC, 1990). Note that high communication levels did not exist between the NYRWA, another governance unit that did WHPPs, Local Governments, the NYSDEC GWMD and the USEPA Region 2 Office. This was due to the fact the NYRWA only became involved in WHP planning in 1995 when they hired a hydrogeologist to specifically work on WHPP development through their newly created Wellhead Protection Technical Assistance Program (NYRWA, n.d.; USEPA Region 2 & NYRWA officials, interviews, 19, 23 July 2007).

Also important are the mixed communication levels between "linked" governance units. For instance, the NYSDOH BWSM and the County Health Departments had high communication levels while the County SWCD and the USDA NRCS had low communication levels which reflected different levels of autonomy, program delivery functions and geographical focus (NYSDOH BWSM official, interview, 20 July 2007; Warren County SWCD official, personal communication, 05 July 2007). This pattern was also evident in the moderate communication levels between the two EPA units. As a USEPA Region 2 Official explained, there is "good communication both ways, up and down, with headquarters and the other regions" and "we are constantly in touch with them" even though "we don't contact them, they contact us" via monthly interactions (meeting typically via teleconference) in addition to e-mailing them information periodically in regards to success stories (USEPA Region 2 & USEPA officials, interviews, 19, 27 July 2007).

frequency and type of collaboration

Collaboration levels are shown in Table 5.9 and largely reflected involvement in WHPPs with one notable exception discussed below. A governance unit's involvement in WHPPs dictated collaboration with other governance units since they were not mandatory. The NYSDEC GWMD, for example, had moderate levels of collaboration with both Geological Surveys, Local Governments and Regional/County Planning Councils. All parties had an integral role in the development of WHPPs with the Planning Councils or Local Governments typically leading the process and drawing on other governance units' resources for guidance and scientific information. Note that collaboration between the NYSDEC GWMD and the NYSDOH BWSM is characterized as high due to the fact the two governance units frequently collaborated in the public water supply permitting process which at times included WHP plan development (NYSDEC, NYSDOH & NYRWA officials, interviews, 06, 20, 23 July 2007; NYSDEC, 1990).

The exception involved the NYRWA. Recall, as previously discussed, that it was not until the mid-1990s when the NYRWA became very involved in the development of WHPPs which was reflected in their low levels of collaboration with the other governance units. However, the NYRWA's involvement with Local

Table 5.9: Linkage Complementarity Summary, 1986-1996, Source Water Protection, NY

	DEC GW Mgt.Div	DEC WHP Ad.Com	NYS GS	DOH Bur. Wat. Sup. Mgt.	NYR Wat. A.	DOH Cty. Hth.	Reg/Cty Plan. Coun.	Cty SW CD	Local Gov't	EPA Reg. 2	EPA Dkg. Wat Div.	Wat. Res.Div USGS	USDA Nat. Res.C.S.	Cons. Part.
Governance Vision (goals)														
DEC, GW Mgt. Div.	-----	Mod	Mod	Low	Mod	Low	Low	Mod	Low	High	High	Mod	Mod	Mod
DEC WHP Ad. Com.	Mod	-----	Low	Low	Mod	Low	Mod	Mod	Low	M	Mod	Low	Mod	Mod
NYS GS	Mod	Low	-----	Low	Low	Low	Low	L	Low	M	Mod	High	Low	Low
DOH Bur. WatSupMgt	Low	Low	Low	-----	Mod	High	Low	Low	Mod	M	Mod	Low	Low	Mod
NYR Wat. A.	Mod	Mod	Low	Mod	-----	Mod	Mod	L	High	M	Mod	Low	Low	Mod
DOH CtyHth	Low	Low	Low	High	Mod	-----	Mod	L	Mod	Low	Low	Low	Low	Mod
Reg/Cty Plan. Coun.	Low	Mod	Low	Low	Mod	Mod	-----	Mod	High	M	Mod	Low	Mod	Mod
Cty. SWCD	Mod	Mod	Low	Low	Low	Low	Mod	----	Mod	M	Mod	Low	High	Mod
Local Gov't	Low	Low	Low	Mod	High	Mod	High	M	-----	L	Low	Low	Mod	Mod
EPA Reg. 2	High	Mod	Mod	Mod	Mod	Low	Mod	M	Low	-----	High	Mod	Mod	Mod
EPA Dkg. Wat. Div.	High	Mod	Mod	Mod	Mod	Low	Mod	Mod	Low	High	-----	High	Mod	Mod
Wat. Res. Div., USGS	Mod	Low	High	Low	Low	Low	Low	Low	Low	M	High	-----	Low	Low
USDA Nat. Res. C. S.	Mod	Mod	Low	Low	Low	Low	Mod	High	Mod	M	Mod	Low	-----	Mod
Cons. Part.	Mod	Mod	Low	Mod	Mod	Mod	Mod	M	Mod	M	Mod	Low	Mod	-----
Communication Level (Meetings, Proposals, Personal Communication)														
DEC, GW Mgt. Div.	-----	Low	Low	Mod	Low	Low	High	Low	Low	Mod	Low	Low	Low	Low
DEC WHP Ad. Com.	Low	-----	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
NYS GS	Low	Low	-----	Low	Low	Low	Mod	M	Low	Low	Low	High	Low	Low
DOH Bur. WatSupMgt	Mod	Low	Low	-----	Low	High	Low	Low	Low	Low	Low	Low	Low	Low
NYR Wat. A.	Low	Low	Low	Low	-----	Low	Low	L	Low	Low	-nil-	Low	Low	Low
DOH CtyHth	Low	Low	Low	High	Low	-----	Mod	L	Low	Low	Low	Low	Low	Low
Reg/Cty Plan. Coun.	High	Low	Mod	Low	Low	Mod	-----	Mod	High	High	Low	Mod	Low	Low

Table 5.9: Linkage Complementarity Summary, 1986-1996, Source Water Protection, NY (cont'd.)

	DEC GW Mgt.Div.	DEC WHP Ad.Com	NYS GS	DOH Bur. Wat. Sup. Mgt.	NY Rural Wat. As.	DOH Cty Hth Dept.	Reg/Cty Plan. Coun.	Cty SW CD	Local Gov't	EPA Reg. 2	EPA Dkg. Wat Div.	Wat. Res.Div. USGS	USDA Nat. Res.C.S.	Cons. Part.
Communication Level (Meetings, Proposals, Personal Communication) (cont'd)														
Cty. SWCD	Low	Low	Mod	Low	Low	Low	Mod	-----	Mod	Low	-nil-	Low	Mod	Low
Local Gov't	Low	Low	Low	Low	Low	Low	High	M	-----	Low	-nil-	Low	Low	Mod
EPA Reg. 2	Mod	Low	Low	Low	Low	Low	High	L	Low	-----	Mod	Low	Low	Low
EPA Dkg. Wat. Div.	Low	Low	Low	Low	-nil-	Low	Low	-nil-	-nil-	Mod	-----	Low	Low	Mod
Wat. Res. Div., USGS	Low	Low	High	Low	Low	Low	Mod	Low	Low	Low	Low	-----	Low	Low
USDA Nat. Res. C. S.	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	Low	-----	Low
Cons. Part.	Low	Low	Low	Low	Low	Low	Low	L	Mod	Low	Mod	Low	Low	-----
Frequency and Type of Collaboration														
DEC, GW Mgt. Div.	-----	Low	Mod	High	Low	Low	Mod	Low	Mod	Low	Low	Mod	Low	Low
DEC WHP Ad. Com.	-nil-	-----	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-
NYS GS	Mod	-nil-	-----	Low	Low	Low	Mod	L	Low	Low	-nil-	Low	-nil-	Low
DOH Bur. WatSupMgt	High	-nil-	Low	-----	Mod	Mod	Low	Low	Low	Mod	Mod	Low	Low	Low
NYR Wat. A.	Low	-nil-	Low	Mod	-----	Mod	Low	L	High	Low	-nil-	Low	-nil-	Low
DOH CtyHth	Low	-nil-	Low	Mod	Mod	-----	Low	L	Low	Low	-nil-	Low	Low	Low
Reg/Cty Plan. Coun.	Mod	-nil-	Mod	Low	Low	Low	-----	Low	High	Mod	-nil-	Mod	Low	Low
Cty. SWCD	Low	-nil-	L	Low	Low	Low	Low	----	Low	Low	-nil-	-nil-	Low	Low
Local Gov't	Mod	-nil-	L	Low	High	Low	High	L	-----	Low	-nil-	-nil-	Low	Low
EPA Reg. 2	Low	-nil-	L	Mod	Low	Low	Mod	L	Low	-----	Mod	Low	Low	Low
EPA Dkg. Wat. Div.	Low	-nil-	nil	Mod	-nil-	-nil-	-nil-	nil	-nil-	Mod	-----	Low	Low	Low
Wat. Res. Div., USGS	Mod	-nil-	Low	Low	Low	Low	Mod	-nil-	-nil-	Low	Low	-----	Low	Low
USDA Nat. Res. C. S.	Low	-nil-	-nil-	Low	-nil-	Low	Low	Low	Low	Low	Low	Low	-----	Low
Cons. Part.	Low	Low	Low	Low	Low	Low	Low	L	Low	Low	Low	Low	Low	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

Governments in terms of local water issues and water systems necessitated high levels of collaboration in meeting existing State regulatory requirements. This also necessitated a moderate level of collaboration with both Departments of Health due to their oversight functions related to a water system's ongoing operation. In essence, the NYRWA was a liaison between the three governance units (NYRWA, n.d.-a; NYRWA & NYSDOH officials, interviews, 23, 20 July 2007).

Two other points should be noted. First, collaboration levels between the Regional/County Planning Councils and the Local Governments were high. This simply reflected a deeper integration between the two governance units that went beyond WHP planning to include such functions as watershed planning and economic development (e.g. Genesee/Finger Lakes Regional Planning Council, Yearly Issues; Central New York Regional Planning and Development Board, 2002). The second point to recognize is the lack of collaboration between the USEPA DWD and any of the local and intra-regional governance units. This was not necessarily surprising since it was the USEPA Regional 2 Office's responsibility to directly interact with these units yet the clear distinction in roles needs to be noted. A related point involves collaboration levels in regards to the NYSDEC Wellhead Advisory Committee and the national Consultation Partners. The Advisory Committee's collaboration levels are characterized as "-nil-" due to the fact the committee had no collaboration with other groups outside of fulfilling its functions for the DEC and the fact that the committee was itself comprised of various group members previously discussed. In relation to the national Consultation Partners, collaboration levels with other governance units is characterized as "Low" due to the plethora of interests included in this unit which had, to varying degrees, collaborated with other units, as previously noted, by the business units' efforts in relation to Local Governments.

5.4.2 Preliminary Findings: Source Protection Planning and Organizational Environment

Source protection planning (SPP) in New York was federally driven. Prior to its inception in 1990, no formal SPP activities existed. Rather different elements of wellhead protection were being addressed by various pieces of legislation. SPP merely clarified these efforts and brought them under one unifying framework. Note that the development of a SPP was mandated by the US federal government while actual "on the ground" protection activity was voluntary.

In terms of the organizational framework, a diffuse vertical and horizontal institutional structure was present. SPP involved many governance units both individually and through multilateral approaches such as national Consultation Partners and the NYS WHP Advisory Committee. This is not unusual given the fragmented institutional framework that existed in New York and the jurisdictional overlap present at the time due to existing programs and the proposed SPP activities.

5.5 Summary

Data in regards to New York legislative and regulatory changes related to well drilling, water takings and source water protection was presented in this chapter. Generalizations about the patterns for the independent variables, that is, the number of governance units, the nature of the linkages (functional, strategic) and linkage complementarity, are briefly offered here to summarize the chapter's findings.

The examination of well drilling policy changes revealed a high number of governance units involved in the process (especially when compared to Ontario) and is partly attributed to New York's fragmented institutional structure (i.e. home rule state). Four vertical governance layers were involved and an overall low linkage complementarity existed. The vast majority of linkages were functionally positive and negative and depended on the outcome to an issue or were functionally neutral. Again, these patterns were partly due to the diffuse institutional structure present in the state.

Institutional diffusion in relation to water takings did not exist. Rather, few governance units were involved (eight) and, outside of two adjudication units, all were centred at the state level and had a low level of functionally positive and strategic linkages. This was largely due to the fact water takings regulatory changes were driven by one main governance unit (NYSDEC BWRM) with most other governance units involved in enforcement and adjudicatory activities. This is evidenced in the high number of functionally positive and negative and functionally neutral linkages. In other words, the nature of the relationships largely depended on the outcome to an issue at hand. The low linkage complementarity is further evidence in support of this claim.

A complex institutional framework existed for source water protection legislative and regulatory changes. A high number of governance units were involved spread out over five vertical governance layers. A multilateral approach was undertaken for SPP due to the potential divisiveness of the issue. Simply put, wellhead protection may involve limiting activities on surrounding land, land which may not fall within a municipality's jurisdiction and which is privately held. Also important is the moderate level of linkage complementarity, the high level of functionally positive linkages and the low level of functionally negative linkages. This is surprising given the jurisdictional issues involved yet SPP did not alter existing relationships per se; it mainly clarified existing roles and brought them within a unified framework which was achieved largely through a multilateral process.

These generalizations and preliminary results are further analyzed in Chapter 7. The next chapter presents data for Nebraska, our third data chapter.

Chapter Six

Nebraska Groundwater Policy Change

"turbulent flow"

6.1 Context

Water and Nebraska are intrinsically linked both in name and substance. Nebraska is an aboriginal word meaning "broad, flat water" in reference to the state's many rivers such as the Platte which can vary up to a mile wide and between a few inches to a couple of feet deep (Manley, 1993, pp. 9-11). Nebraska is also the "Groundwater State" of North America with the majority of the state overlying the Ogallala Aquifer and possessing two thirds of the aquifer's water volume (UN-L C/S Division, 1998, p. 7; Ashworth, 2006, pp. 25-26). It is this abundance of groundwater that Nebraskans are dependant on as a source of drinking water and for agricultural production. Overall, eighty-five per cent of the state's population is dependent on groundwater as a source of drinking water, a number that rises to almost one hundred per cent for rural residents (NDEQ – Water Quality Assessment Section, 2005, p. 3; Exner, 1993, p. 160). Similarly, agricultural groundwater withdrawals account for 95.3% of all groundwater withdrawals by volume (NDNR, n.d.-a, p. 2). An elaborate groundwater policy framework has evolved over five main periods: pre-1966, 1967-1979, the 1980s, the 1990s and post-2000.

A groundwater regulatory framework was largely non-existent prior to 1957 largely due to aggressive surface water development and technological factors. Early settlers, encouraged through the misguided belief that "rainfall follows the plow", soon learned that sustained agricultural production was only feasible with irrigation which led to the rallying cry "irrigate or emigrate" (Bleed, 1993, p. 48; Manley, 1993, pp. 17-26).[38] As a result, many irrigated works were built such as canals, dams and reservoirs, often with the aid of federal funds, and the number of surface water irrigated acres grew from 12,000 in 1890 to 450,000 acres in 1940 (Dreeszen, 1993, pp. 84-87; Gaul, 1993, pp. 203-207).

Groundwater irrigation, however, remained stunted. By 1900, for instance, only 1,000 acres were irrigated with groundwater, a figure that grew slowly as pump technology improved and proliferated after the introduction of center-pivot irrigation technology (Dreeszen, 1993, p. 84).[39] By 1965, groundwater was used to irrigate 2.1 million acres compared to 800,000 acres irrigated with surface water (Olson & Naugle, 1997, p. 359). It was this development coupled with a comprehensive government reorganization that led to the creation of the Nebraska Department of Water Resources (NDWR) in 1957 to administer and manage water rights in the state. Domestic groundwater use (i.e. for human health, fire, sanitation, domestic livestock) was given preference over agricultural purposes (e.g. irrigation) which had preference

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[38]This position was one of the "natural laws" used to counter Powell's claim that agricultural production west of the 100th meridian was futile largely due to the lack of reliable rainfall (Powell, 2004 (Reprint); Olson & Naugle, 1997 especially pp. 166-168; Manley, 1993, pp. 14-20).

[39]Center-pivot irrigation, introduced by Frank Zybach in 1952, greatly increased water use and labour efficiency and is noted for producing their characteristic large green crop circles though with technological advances even the corners of fields can now be irrigated (e.g. Sheffield, 1993; Sheffield & Rundquist, 1993; Olson & Naugle, 1997, pp. 339-344, 359-360).

over other uses (NE Session Laws 1957, c. 199, § 1, p. 701 and 1963, c. 279, § 1, p. 835). Regulatory measures included the mandatory registration and minimum spacing of irrigation wells to ensure adequate groundwater supplies (NE Session Laws 1957, c. 200, § 2, p. 702; c. 201, §. 2, p. 705 and 1965, c. 270, § 1, p. 771; see also Gaul, 1993, p. 214). The early 1960s saw the introduction of a water permitting system for irrigation wells in close proximity to streams (to ensure surface water rights could be met), for public water suppliers and for water transfers (NE Session Laws 1963, c. 275, § 1, p. 828 and c. 276, § 1-8, p. 829-831). These developments coincided with the development of voluntary standards for the construction of irrigation wells in 1957 and for sanitary wells in 1965 which was a collaborative effort between the Nebraska Well Drillers Association (NWDA), the UN-L C/S Division and state agencies (NDWA Annual Conference Minutes, 1957, 1965-1966; Seidel, 1993, p. 236). Note that source protection activities did not exist per se, yet were partly addressed through various soil conservation measures. In short, a substantial groundwater regulatory framework was established by 1966, something that would substantively increase over time.

Few groundwater regulatory changes occurred in the 1967-1979 period, yet the changes that did occur were profound. The Natural Resources Districts Act, 1969, authorized the creation of twenty-four Natural Resource Districts (NRDs) through the amalgamation of 154 special-purpose districts (e.g. flood, soil/water, watershed protection). Delineated along hydrological boundaries, NRDs began operation in 1972, are unique to Nebraska[40], are comprised of locally elected boards, have property taxation powers, and administer numerous programs. Essentially, NRDs consolidated the previously fragmented single purpose bodies into more inclusive (i.e. for stakeholders and resources) multi-purpose bodies that could develop the State's water resources in a cohesive and integrated fashion (Gaul, 1993, pp. 215-216; Aucoin, 1984, pp. 65-69; NARD, n.d.-a). NRD powers increased significantly with the passage of the Ground Water Management Act, 1975. It allowed for the establishment of Groundwater Control Areas, upon approval by the Director of the NDWR, in areas of its depletion which allowed NRDs to establish restrictive groundwater regulations such as the banning of new irrigation wells (NE Session Laws 1975, LB 577, § 24; Aucoin, 1984, pp. 69-72). The 1970s also saw a rapid increase in irrigation demands in Nebraska largely due to favourable crop prices, favourable interest rates, and increased availability and knowledge of center-pivot irrigation technology. By 1980, 7.2 million acres were under irrigation, 6.2 million acres of which were being supplied with groundwater (Sheffield, 1993, pp. 127-128).

The 1980s ushered in many regulatory changes. Well driller licensing was enacted in 1986 and the authority to promulgate water well construction standards was assigned to a newly created Water Well Standards and Contractor's Licensing Board (WWSCLB). Driller licensing requirements were long desired by some in the industry to address shoddy well construction, especially by out of state contractors that would flood the state in irrigation well "boom" times. As officials stated, the

[40]No other US state has NRDs. NRDs are similar to Conservation Authorities in Ontario.

need existed to ensure that "those on the rigs [could] put them into practice" and fear had grown that if the industry did not address the situation, the federal government and the NDEC would do so (NDWA & UN-L C/S Division officials, interviews, 14, 16 November 2007). The legislation was an industry initiated action but the "product was a consensus reached between all parties" (NDHHS officials, interviews, 16 November 2007).

The WWSCLB is of interest itself since it also operated by consensus, consisted of nine members, five of which were industry related, and was charged with advising the regulatory agencies in regards to various functions including the ongoing development of contractor licensing standards (e.g. tests, continuing education), well construction standards and enforcement activities. Note that every well is inspected within one year of its construction (NDHHS officials, interviews, 16 November 2007).

The 1980s also brought many regulatory changes in relation to *groundwater* takings. The NDWR now required water transfer permits for transfers to *any* state. Furthermore, public notification procedures were elaborated for municipal water permits and water permits were now required for the first time for industrial water uses greater than 3,000 acre feet per year.[41] As for all permits, the NDWR would receive the application and forward it to the NRD in question for comment before making a final decision. This changed in 1983 when NRDs assumed authority over the issuance of water permits[42] and came on the heels of NRD authority over the

[41] An acre foot of water is one acre of water one foot deep.

[42] NDNR becomes involved in groundwater permit issues when a transfer of water is proposed from one property to another that crosses an intervening property which one does not own (e.g. neighbour, road; NDNR official, interview, 15 November 2007).

establishment of less restrictive Groundwater Management Areas.[43]

Groundwater protection received increased attention in the 1980s. For instance, the NDOH had long encouraged the regulation of potential contaminant sources in wellhead areas and the NDEC had long developed a Water Quality Standards and Use Classification system (Title 118) for point and non-point sources of contamination assigning wellheads the most stringent protection classification (NDEC, 1991, p. 1). It is no surprise that Nebraska welcomed the development of a wellhead protection program as mandated by the 1986 changes to the federal Safe Drinking Water Act. As a USEPA official noted, Nebraska "welcomes any opportunity to protect its groundwater" and that "it is above the curve when compared to other states" (USEPA Region 7 Office official, interview, 02 November 2007). However, the lack of federal and state dollars ensured that Nebraska developed a "no budget, low budget wellhead protection program" (NDEC, 1991; NDEQ official, interview, 14 November 2007).

The fast pace of regulatory changes in relation to water takings continued in the 1990s. The changes were largely in relation to program refinement such as enhanced public notification procedures, and permit exemption removal for small industrial water takings, dewatering and small capacity wells (<50gpm). Similarly, NRDs could also now impose added restrictions for wells where groundwater and surface water connections existed for integrated management purposes. These types of changes were mimicked in relation to well driller regulatory changes which

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[43]The advantage here is that general well permits could be established, as well as, other land use regulations without needing to show groundwater level declines and without NDWR approval.

included an increase in the number of continuing education hours required for license renewal and water well registration time limit changes (see Appendices VII and VIII).

Similar programmatic changes continued into the twenty-first century. For instance, licensing requirements were diversified with the addition of two new classes (water well monitoring technician, natural resources groundwater technician) and changes in technology brought the processing of well registrations online. Much less regulatory change surrounded water takings though changes were significant. For instance, the need for a well construction permit was expanded to include pump installations. Of greater significance were the changes in permit considerations for water transfer permits where future water demands in the jurisdiction (NRD) were now to be considered in permit applications as were interstate water compacts and environmental effects including cumulative ones. The latter two are controversial due to the recent enactment of a well drilling moratorium to meet compact requirements and minimum flow requirements in streams to ensure sufficient habitat for endangered species.

As the above overview highlights, Nebraska has an elaborate groundwater policy framework. Indeed, a dense web of activity and relationships exist as will be unravelled below but even this web masks the significance of the University of Nebraska (Lincoln) Conservation and Survey Division (UN-L C/S Division) and the interchange of personnel between public and private agencies.

The UN-L C/S Division is the one constant factor throughout the legislative and regulatory changes. They have been charged with mapping the state's extensive water, geological and soil resources and have done so since the turn of the twentieth century. Numerous geological and hydrological studies have been completed which form the scientific basis for the groundwater regulatory framework. Moreover, the UN-L C/S Division was instrumental in organizing the NWDA in 1929 with numerous university personnel having served on the NWDA's executive over the years and was largely charged with organizing the NWDA's Annual Convention and Short Course. The C/S Division and the NWDA also worked closely together in developing voluntary well construction standards previously discussed which form the basis for the current well construction standards. This close working relationship continues to this day, despite the NWDA's organizational independence in 1981[44], in that both entities worked together through membership on the WWSCLB to develop mandatory well driller licensing standards. The C/S Division also played a significant role in the establishment and management of the NDNR well registration database and in the provision and scientific assessment of technical data related to source water protection and water takings applications. In short, the UN-L C/S Division's geological and hydrological expertise and contribution is significant and permeates all facets of Nebraska's groundwater regulatory framework.

Beneath the institutional facade presented above lies an elaborate and important complex of personnel interchange among and between public and private agencies. For instance, the current Executive Director of the NWDA also holds the

[44]The relationship between the UN-L C/S Division and the NWDA is not unusual if one considers the fact that few natural rock outcroppings exist in Nebraska from which to study the State's geological features. As such, geological studies are accomplished through the examination of well drilling cores (I thank a UN-L C/S Division official for pointing this out, 16 November 2007).

same position for the Nebraska State Irrigator's Association and was formerly the Executive Director of the Nebraska Association of Resources Districts (Aucoin, 1984, p. 69; *Water Writes*, 1985, p. 2; NSIA, n.d.). Similarly, the former Director of the NDWR is currently a Professor and Assistant Director of the UN-L Water Center (UN-L, n.d.-a). Many more examples exist yet even these personnel moves disregard the fact that many individuals have obtained graduate degrees in geology at UN-L (NARD official, interview, 12 November 2007). Inter-agency personnel changes are pervasive in Nebraska and are seen as necessary by many since a greater understanding of the issues at hand is gained through such experiences (NDHHS officials, interviews, 16 November 2007; *Well Bits*, 2005 (Spring), p. 1). No doubt, this has also aided the facilitation of legislative and regulatory changes.

6.2 Well Driller Regulations Independent Variable Summary

Changes in well driller legislation and regulations are examined over three time frames: 1980-1986, 1988-1994, 2000-2004. The changes are examined in terms of well driller licensing, well construction (e.g. permits, registration, spacing) and enforcement (e.g. inspections, enforcement) procedures.

6.2.1a 1980-1986: Number of Governance Units

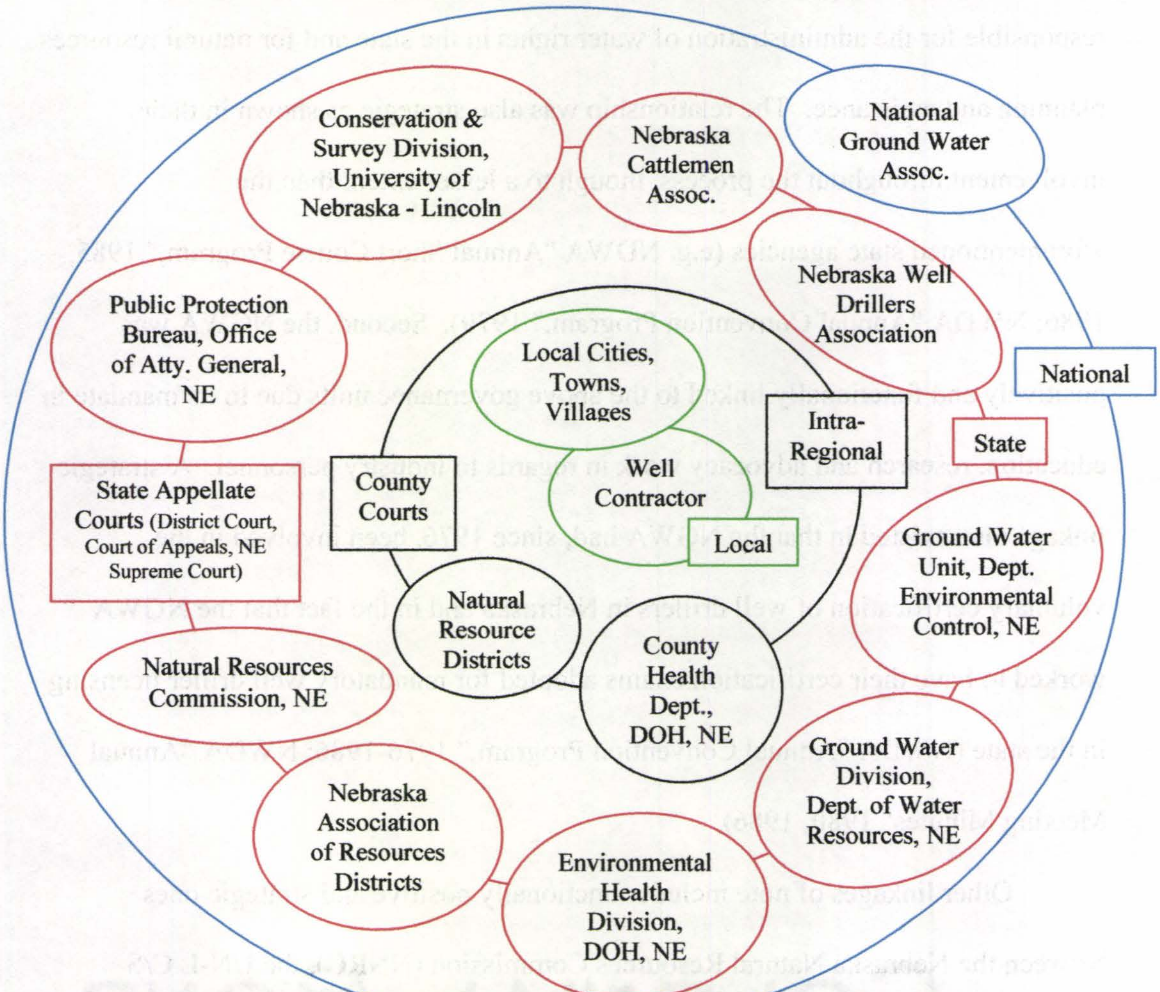
As Figure 6.1 illustrates, seventeen governance units dispersed over four vertical governance levels were active at this time. This included one local, three intra-regional, twelve state and one national level horizontal governance units.

6.2.1b 1980-1986: Types of Linkages

Linkage types are summarized in Table 6.1. Overall, two processes were at work simultaneously in regards to well driller licensing and to the crafting of mandatory well standards. Regulatory changes primarily involved four main governance units, the NWDA, the UN-L C/S Division, the NDOH and the NDEC. The linkages between these governance units were functionally positive and strategic in nature. A positive functionality between the NWDA and the UN-L C/S Division is indicated in the NWDA's interest in the training of well drillers and the C/S Division's groundwater research and educational goals. The strategic nature between the units lies in their then work to develop binding well construction standards.

This strategic linkage extended to the NDOH since it was actively involved in the development of mandatory well construction standards. Furthermore, the NDOH was the lead agency for the implementation and enforcement of the standards given its similar duties for the construction and operation of public water supply facilities, which highlights the functionally positive linkage that existed.

Figure 6.1: Well Driller Governance Units, 1980-1986, NE



Functionally positive and strategic linkages existed with the NDEC GWU due to its mandate which included water quality protection, such as setting groundwater quality standards, and remedial oversight once a contamination event occurred. As a result, the NDEC GWU had a keen interest in the well construction standards that were developed (*Water Writes*, 1985 (February), pp. 10-11).

Two other governance units were noteworthy throughout this process. First, the NDWR GWD had a functionally positive linkage with both the NWDA and the UN-L C/S Division as illustrated in the fact that the NDWR had long been responsible for the administration of water rights in the state and for natural resources planning and assistance. The relationship was also strategic as shown in their involvement throughout the process, though to a lesser extent than the aforementioned state agencies (e.g. NDWA "Annual Short Course Program," 1985, 1986; NWDA "Annual Convention Program," 1979). Second, the NGWA was positively and functionally linked to the above governance units due to its mandate in education, research and advocacy work in regards to industry personnel. A strategic linkage also existed in that the NGWA had, since 1976, been involved in the voluntary certification of well drillers in Nebraska and in the fact that the NGWA worked to have their certification exams adopted for mandatory well driller licensing in the state (NWDA "Annual Convention Program," 1976-1986; NWDA "Annual Meeting Minutes" 1980, 1986).

Other linkages of note include functionally positive and strategic ones between the Nebraska Natural Resources Commission (NNRC), the UN-L C/S Division, the NDOH EHD, the NRDs and the NARD. This is seen in the basic functions each governance unit performed. For instance, the NNRC largely promoted natural resource development and conservation including those related to water resources, such as development of the State Soil and Water Conservation Strategy, and water resource planning assistance (e.g. funding) offered to the NRDs. The

NRDs largely carried out water and land use planning functions "on the ground" such as soil erosion prevention programs and could designate Groundwater Management Areas and institute more intensive management of the resource through various measures which included increased well spacing requirements (Flowerday & Herrin, 1993, pp. 178-185; Aucoin, 1984, pp. 69-73; NDWR, 1981, p. 5; Little Blue NRD, 1986, pp. 13-16). Similarly, the NARD represented the interests of the NRDs. It lobbied on their behalf when needed and kept the NRDs informed of pending legislation thus demonstrating both functionally positive and strategic linkages (Aucoin, 1984, p. 69; LBNRD official, interview, 09 November 2007).

Table 6.1: Linkage Types, Well Driller Regulatory Changes, 1980-1986, NE

	NW DA	DWR GW Div.	Nat. Res. Com	NG WA	DEC GW Unit	UNL C/S Div.	DOH En. Hth. Div.	DOH Cty. Hth	N R D	NA RD	AG Off.	L. Gov 't	Cou rts	N C A
NWDA	---	F+S	F+	F+S	F+S	F+S	F+, S	F+	F+/-	F+/-	F+/-	F+/-	F+/-	F-
DWR GWD	F+S	-----	F+	Fn	F+	F+, S	F+	Fn	F+	F+	F+/-	Fn	F+/-	F -
Nat Res Comm.	F+	F+	-----	Fn	F+	F+, S	F+, S	F+	F+S	F+ S	F+/-	Fn	F+/-	F -
NGWA	F+S	Fn	Fn	-----	Fn	F+, S	F+, S	F+	Fn	Fn	Fn	F+	Fn	F -
DEC GWU	F+S	F+	F+	Fn	-----	F+, S	F+, S	F+	F+/-	Fn	Fn	Fn	Fn	F -
UN-L C/S Div	F+S	F+, S	F+, S	F+, S	F+, S	-----	F+, S	F+, S	F+	F+	Fn	F+	Fn	Fn
DOH En. Hth	F+ S	F+	F+, S	F+, S	F+, S	F+, S	-----	F+, S	F+	F+	F+/-	F+	F+/-	F -
DOH Cty Hth	F+	Fn	F+	F+	F+	F+, S	F+, S	-----	F+	F+	F+/-	F+	F+/-	F -
NRD	F+/-	F+	F+S	Fn	F+/-	F+	F+	F+	---	F+S	F+/-	F+	F+/-	Fn
NARD	F+/-	F+	F+S	Fn	Fn	F+	F+	F+	F+S	---	F+/-	F+	F+/-	Fn
AG Off.	F+/-	F+/-	F+/-	Fn	Fn	Fn	F+/-	F+/-	F+/-	F+/-	-----	F+/-	F+/-	Fn
L. Gov't	F+/-	Fn	Fn	F+	Fn	F+	F+	F+	F+	F+	F+/-	-----	F+/-	F -
Courts	F+/-	F+/-	F+/-	Fn	Fn	Fn	F+/-	F+/-	F+/-	F+/-	F+/-	F+/-	---	Fn
NCA	F -	F -	F -	F -	F -	Fn	F -	F -	Fn	Fn	Fn	F -	Fn	--

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative;
Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

The UN-L C/S Division was also strategically and functionally (positive) linked to the above governance units since it provided much of the scientific data from which to base the State's Soil and Water Conservation Strategy and NRD control and management area designations (e.g. Little Blue NRD, 1986). The linkage between the NNRC and the NDOH was functionally positive and strategic given the latter's interest in developing drinking water quality standards (see Table 6.2).

The UN-L C/S Division also had strategic and functionally positive linkages with the NDOH and the NDOH County Health Departments. It was the University's research that formed the basis for well driller regulations and contributed to the pool of information used by the NDOH EHD (and associated County Health Units) to develop sources of water for local municipalities and associated water quality standards (e.g. Spalding & Loope, 1984; Eisenhauer, Manbeck & Stork, 1982; Souders, Smith & Swinehart, 1980; Engberg & Spalding, 1978). Note the functionally positive and strategic linkage between the NDOH and County Health Departments. The County Health Departments are divisions of the state agency and aid in the delivery of the agency's mandate.

Functionally negative linkages existed between the Nebraska Cattlemen Association (NCA)[45] and most of the other governance units. The NCA represented the cattle industry in the state and worked to ensure its sustainability. Note that the proposed water well construction standards which mandated the use of licensed well drillers would have, as argued by NCA, negatively impacted the cattle industry. As one UN-L C/S Official stated, the "NCA argued that its members were located in

[45]The Nebraska Cattlemen Association was formed in 1988 through the consolidation of the Nebraska Stock Growers Association, the Nebraska Livestock Feeders Association and the Nebraska Feedlot Council (Nebraska Cattlemen Association, n.d.).

small remote areas [and that] it was unfair to expect ranchers to call on the services of professional well drillers" (UN-L C/S Division official, interview, 16 November 2007). Simply put, NCA members would not comply with the proposed regulations and there was little potential danger to groundwater. As such, farmers were exempted from the need to hire licensed well drillers. Most parties noted that the exemption was not a good decision in terms of groundwater protection. Farm and ranch wells had been noted for their poor construction practices and, as officials explained, many cattle watering wells are located in the Sand Hills area of the state where infiltration rates are high, water wells are shallow, and cattle watering troughs are typically located five to ten feet away from a well. In short, where there are cattle, there is manure and "in those conditions, aquifer contamination is potentially high" (UN-L C/S Division official, interview, 16 November 2007). As such, the linkage was functionally negative with most governance units, as shown in Table 6.1, yet the linkage was functionally neutral with the University, NRDs and the NARD due to more complex relationships. For example, while the latter three were in favour of the proposed standards which negatively impacted the NCA, they were, nonetheless, heavily involved in soil conservation, fertilizer application, and irrigation activities which were of much interest to farmers and ranchers (e.g. Spalding, 1977; Spalding, Gormly, Curtiss, & Exner, 1978; Hanson, 1983; UN-L, C/S Division, 1980; Lawton & Teahon, 1984).

6.2.1c 1980-1986: Complementarity of Linkages

governance visions (goals)

The goals of each governance unit are shown in Table 6.2 and similarities in goals are summarized in Table 6.3. Note the moderate similarity in goals between the NWDA and the NDWR, the NGWA, the NDEC GWU, the UN-L C/S Division and the NDOH EHD which reflected each governance unit's contribution to groundwater governance. For instance, the NWDA desired well construction standards and a licensing program that were feasible from an implementation perspective to professionalize the industry yet protected the groundwater resource. The NDOH EHD also desired workable standards to ensure effective implementation and reduce enforcement costs. The NDEC GWU worked to develop water quality standards and protect the environment which included water resources. Similarly, the NDWR had a large natural resources planning element and were directly involved in water rights administration. The UN-L C/S Division goals overlapped in that its research directly impacted any regulatory framework that developed. The NGWA had a direct interest in proceedings since it is part of its mandate to increase the expertise of groundwater professionals and licensing and related education programs are one way of achieving this goal. The similarity in goals between the NWDA and the NGWA is not classified as high due to the NGWA's broader mandate which encompassed other groundwater professionals such as engineers.

The moderate similarity in goals does not necessarily transfer over to the other governance units noted above. The NDWR, for instance, had a low similarity in goals with the NGWA which reflected its much larger mandate. The NGWA also had a low similarity in goals with most other governance units which again reflected the broader mandates of the other governance units. A similar situation existed in relation to NDEC GWU and the NDOH EHD and between the UN-L C/S Division and the NDOH EHD.

Table 6.2: Goals of Governance Units, Well Driller Regs., 1980-1986, NE .

Nebraska Well Drillers Association
• Promote common business interest of drilling of water wells and related services including development of publications, trade-shows and educational material; development of principals of uniformity/cooperation among water well contractors; organization and promotion of legislative activity on behalf of commercial water well contractors.
NE Department Water Resources Groundwater Division
• Effective management of NE's water resources via administration of water rights and natural resources planning/assistance (e.g. stream gauging, engineering, planning).
NE Natural Resources Commission
• Promote resource development and conservation for soil and water resources; • Aid in State planning via development of State Soil & Water conservation Strategy and provide assistance to NRDs re water resources planning; • Facilitate coordination, cooperation between governance units.
National Ground Water Association
• Advance expertise of all groundwater professionals; • Increase groundwater awareness and protection through education and outreach; • To be leading community of groundwater professionals that promotes responsible development, use, and management of groundwater resources.
NE Department of Environmental Control Groundwater Unit
• Contribute to NDEC's overall goals of protecting water, land, air resources; • Specific functions relate to improving and protecting quality of NE's waters including groundwater quality standards setting, hydrogeologic reviews, remedial oversight.
University of Nebraska - Lincoln Conservation & Survey Division
• Research, service, data collection related to State's geology, hydrology, and soils (includes taking inventory of quality and quantity of water resources).
NE Department of Health Environmental Health Division
• Contribute to Department's goals of promoting, protecting health/wellness of citizens; • Achieved via Public Health Assurance including water well standards and licensing.
NE Department of Health County Health Departments
• Improve, promote health of community including public education for well water issues.
Natural Resource Districts
• Local government entities to regulate water and land use.
Nebraska Association of Resource Districts
• Unite, coordinate efforts of NRDs including administrative ones (e.g. training); • To represent NRDs in State lobbying efforts.
NE Attorney General's Office Public Protection Bureau
• Represent, advise State agencies/boards re natural resources, environment; • Enforcement of environmental laws, rules/regulations for State agencies.
Local Governments
• To promote, enhance, and foster a community's social and economic well-being.
Courts
• Adjudicate Disputes.
Nebraska Cattleman, Inc.
• Represent beef cattle industry to legislative and administrative branches of government; • Explain beef production to policy makers and public alike; • Provide membership services to ensure sustainability.

Of significance were the high similarities in goals between the NDWR and the NNRC. This reflected a significant overlap in water planning functions the two had in the state. Similarly, the NNRC and the NRDs shared a high similarity in goals. The NNRC was responsible for the development and conservation of water and soil resources and administrated state funds which the NRDs drew upon in support of their programs. A high similarity in goals also existed between the NDOH EHD and NDOH County Health Departments with both having a diverse mandate in the pursuance of the protection of public health which included water well standards. A similar high goal similarity also exists between the NRDs and the NARD since it was the NARD that worked on behalf of the NRDs to represent their interests with most other state agencies.

Other similarities in goals shown in Table 6.2 are straightforward. Local governments, for instance, had low similarities in goals with most other governance units except the NDOH County Health Departments which are classified as moderate in nature given the goals of each unit in protecting and enhancing public health "on the ground".

communication level ***(meeting frequency, proposals, personal communication)***

As Table 6.3 shows, communication levels were mixed during this time frame. For instance, high communication levels existed between the NWDA and the NDWR GWD, the NGWA, the NDEC GWU, the UN-L C/S Division and the NDOH EHD. Meetings between the NWDA and the UN-L C/S Division were continually held to develop the well construction standards which were relatively "easy" to develop given previous work with state agencies to develop voluntary standards (UN-L C/S Division & NDHHS EHD officials, interviews, 16 November 2007). While there were approximately a dozen meetings which led to a draft of the proposed legislation, written by the NWDA Executive Director, there were "many, many, more phone conversations between all parties" (UN-L C/S Division & NWDA officials, interviews, 16, 14 November 2007). Furthermore, some UN-L C/S Division staff (1-2) were, until 1982, Officers of the NWDA. Since then, UN-L C/S Division officials have continued to attend NWDA Board meetings as Coordinators of the NWDA Annual Short Course and have participated in these events by either chairing the sessions, participating in a panel and/or presenting research findings (NWDA Annual Short Course Programs, 1970-1986; NWDA Annual Conventions and Trade Show Programs, 1975-1986).

Similar patterns of communication existed between the NDOH EHD and the NWDA. The NDOH EHD was a party in the meetings that led to the regulatory changes and attended and/or participated in the NWDA Annual Short Course discussing topics such as legislative changes that impacted well contractors (NWDA Annual Short Course Programs, 1979-1986; NDHHS EHD officials, interviews, 16 November 2007). Communication levels were also high between the NWDA and the NDWR GWD and the NDEC GWU. Staff from each of these units also attended and participated in the NWDA Annual Short Course. Well drillers and the NWDA also had frequent interactions with the NDWR GWD given it was responsible for water well registrations (*Water Writes*, August 1985, p. 18).

The NWDA also had high communication levels with the NGWA. For instance, NGWA officials had attended the NWDA Annual Convention and Trade Show from 1974 to 1986. In fact, beginning in 1976, the NGWA administered certification exams (voluntary) for well contractors at the Annual Convention. It also typically participated in the NWDA Annual Meeting with the NWDA becoming a state affiliate of the NGWA in 1982. Furthermore, a Past President of the NDWA became President of the NGWA in 1983 and the NGWA regularly advertised and provided summaries of their national conference in the NWDA's publication *Water Writes* (e.g. NWDA Annual Meeting, 1982; *Water Writes*, 1982 (March), p. 4).

Communication levels were similarly high between the state agencies: the NDWR GWD, the NDEC GWU, the NDOH EHD and the UN-L C/S Division. Each of these governance units had an interest in regulatory development in terms of responsibility for well registrations, water quality issues and drinking water issues respectively, all of which directly affected well construction standards and contractor licensing. The UN-L C/S Division's research underscored all of these efforts. All of the above roles and avenues of interaction were in addition to their participation at annual conferences identified by officials such as the NWDA Annual Short Course, the NWDA Annual Convention and Trade Show, the Nebraska Water Resources Association Conference, the Nebraska Rural Water Association Annual Conference, the Nebraska State Irrigators Association and the Annual Midwest Ground Water Conference.

Other communication levels varied. For instance, high communication levels existed between both the NDOH EHD and the NDOH County Health Departments where communication occurred at least "a few times per week" (NDHHS officials, interviews, 16 November 2007). The same situation existed for communication levels between the NARDs and the NRDs where local NRDS "get weekly reports from the NARD" on current legislative activity, unless the situation was "hot" then daily communication with NRDs were the norm (LBNRD & NARD officials, interviews, 09, 12 November 2007).

frequency and type of collaboration

The preceding discussion reveals much about collaboration levels during this time frame. First, collaboration levels between the Attorney General's Office, the Courts and the other governance units were largely non-existent (NWDA & NDHHS EHD officials, interviews, 14, 16 November 2007). A similar situation existed in regards to the NCA except for low collaboration levels they had with the UN-L C/S Division, the NNRC, the NRDs and the NDEC GWU in regards to facilitating research projects including the development of Best Management Practices (e.g. Hanson, 1983; NARD & LBNRD, interviews, 12, 09 November 2007). In contrast, there were high collaboration levels between the NRDs and the NARD. For instance, the NRDs enlisted the help of the NARD in the development and designation of Groundwater Control Areas and in securing funds from the NNRC for various projects. The two governance units also collaborated in commenting on the proposed regulatory changes (Gaul, 1993, pp. 220-221; LBNRD officials, interview, 09 November 2007).

Table 6.3: Linkage Complementarity Summary, 1980-86, Well Driller Regs, NE.

	NWDA	DWR GW Div.	Nat. Res. Com	NGWA	DEC GW Unit	UNL C/S Div.	DOH En. Hth Div.	DOH Cty. Hth	NRD	NARD	AG Off.	L. Gov't	Courts	NCA
Governance Vision (Goals)														
NWDA	---	Mod	Low	Mod	Mod	Mod	Mod	Low	Low	Low	Low	Low	L	L
DWR GWD.	Mod	-----	High	Low	Mod	Mod	Mod	Low	Mod	Low	Low	Low	L	L
Nat. Res. Comm.	Low	High	-----	Low	Mod	Mod	Low	Low	High	Mod	Low	Low	L	L
NGWA	M	Low	Low	-----	Low	Low	Low	Low	Low	Low	-nil-	Low	nil	L
DEC GW Unit	Mod	Mod	Mod	Low	-----	Mod	Low	Low	Mod	Low	Low	Low	L	L
UN-L C/S Div.	Mod	Mod	Mod	Low	Mod	-----	Low	Low	Mod	Low	-nil-	Low	nil	L
DOH En. Hth.	Mod	Mod	Low	Low	Low	Low	-----	High	Low	Low	Mod	Low	L	L
DOH Cty. Hth.	Low	Low	Low	Low	Low	Low	High	-----	Low	Low	Low	Mod	L	L
NRD	L	Mod	H	Low	Mod	Mod	Low	Low	---	H	Low	Low	L	L
NARD	L	Low	Mod	Low	Low	Low	Low	Low	High	---	Low	Low	L	L
AG Off.	L	Low	Low	-nil-	Low	-nil-	Mod	Low	Low	Low	-----	Low	H	L
L. Gov't	L	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	-----	L	L
Courts	L	Low	Low	-nil-	L	-nil-	Low	Low	Low	Low	High	Low	---	L
NCA	L	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	L	--
Communication Level (Meetings, Proposals, Personal Communication)														
NWDA	---	High	Low	H	High	High	High	Low	Low	Low	Low	Low	nil	L
DWR GWD	High	-----	Low	Low	High	High	High	Low	Mod	Low	Low	Low	nil	nil
Nat. Res. Comm.	Low	Low	-----	Low	Low	Low	Low	Low	Mod	Mod	Low	Low	Low	L
NGWA	H	Low	Low	-----	Mod	Mod	Mod	Low	Low	Low	nil	nil	nil	n
DEC GW Unit	High	High	Low	Mod	-----	High	High	Low	Mod	Low	Low	Low	Low	L
UN-L C/S Div.	High	High	Low	Mod	High	-----	High	Low	Low	Low	Low	Low	Low	L
DOH En. Hth.	High	High	Low	Mod	High	High	-----	High	Low	Low	Low	Low	Low	L
DOH Cty. Hth.	Low	Low	Low	Low	Low	Low	High	-----	Mod	Low	Low	Low	Low	n
NRD	L	Mod	Mod	Low	Mod	Low	Low	Mod	---	H	Low	Mod	L	M
NARD	L	Low	Mod	Low	Low	Low	Low	Low	High	---	Low	Low	L	L
AG Off.	L	Low	Low	nil	Low	Low	Low	Low	Low	Low	-----	Low	L	L
L.Gov't	L	Low	Low	nil	Low	Low	Low	Low	Mod	Low	Low	-----	L	L
Courts	nil	nil	Low	nil	Low	Low	Low	Low	Low	Low	Low	Low	---	n
NCA	L	nil	Low	nil	Low	Low	Low	nil	Mod	Low	Low	Low	nil	--
Frequency and Type of Collaboration														
NWDA	---	Mod	Low	H	Low	High	Mod	Low	Low	nil	nil	nil	nil	n
DWR GWD.	Mod	-----	Mod	nil	Low	Mod	Mod	Low	Mod	nil	nil	Low	nil	n
Nat. Res. Comm.	Low	Mod	-----	nil	Mod	Mod	Mod	nil	Mod	Mod	nil	Low	nil	L
NGWA	H	nil	nil	-----	nil	Low	Low	nil	nil	nil	nil	nil	nil	n
DEC GW Unit	Low	Low	Mod	nil	-----	Mod	Mod	Low	Mod	Low	nil	Low	nil	L

	NWDA	DWR GW Div.	Nat. Res. Com	NGWA	DEC GW Unit	UNL C/S Div.	DOH En. Hth Div.	DOH Cty. Hth	NRD	NARD	AG Off.	L. Gov't	Courts	NCA
Frequency and Type of Collaboration (cont'd)														
UN-L C/S Div.	High	Mod	Mod	Low	Mod	-----	Mod	Low	Mod	Low	nil	Low	nil	L
DOH En. Hth.	Mod	Mod	Mod	Low	Mod	Mod	-----	High	Low	nil	nil	Low	nil	n
DOH Cty. Hth.	Low	Low	nil	nil	Low	Low	High	-----	Low	Low	nil	Low	nil	n
NRD	L	Mod	Mod	nil	Mod	Mod	Low	Low	---	High	nil	Low	nil	L
NARD	nil	nil	Mod	nil	Low	Low	nil	Low	High	---	nil	nil	nil	n
AG Off.	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	-----	nil	nil	n
L. Gov't	nil	Low	Low	nil	Low	Low	Low	Low	Low	nil	nil	-----	nil	n
Courts	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	---	n
NCA	nil	nil	Low	nil	Low	Low	nil	nil	Low	nil	nil	nil	nil	--

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

Similar high collaboration levels existed between the NWDA and the UN-L C/S Division as seen in the fact the two governance units were intimately involved in the crafting of the proposed legislation. The UN-L C/S Division also coordinated the NWDA Annual Short Course and the NWDA Annual Conference Program each year. The two governance units also developed and administered a scholarship to recognize E.C. Condra, the UN-L C/S Division Dean and Director in the 1920s and 1930s, for his efforts at organizing and directing the early efforts of the NWDA (Seidel, 1993, p. 236; *Water Writes*, 1985 (August), p. 5; NWDA Annual Short Course Programs, 1979-1986; NWDA Annual Conference and Trade Show Programs, 1975-1986). The NGWA and the NWDA also had high collaboration levels as evidenced in their efforts to enact mandatory licensing requirements which began in the 1960s, continued throughout 1970s when voluntary NGWA certification began in 1976 and culminated in mandatory licensing in 1986 (NWDA Annual Conference and Trade Show Programs, 1970-1986).

Moderate collaboration levels existed between the NDWR GWD and the

NNRC, the UN-L C/S Division, the NDOH EHD and the NRDs. The NDWR GWD was heavily involved in the review and approval of proposed NRD Groundwater Control Areas in conjunction with the NNRC (Aucoin, 1984, pp. 69-73; Flowerday & Herring, 1993, p. 181; Gaul, 1993, p. 221). Furthermore, these governance units also worked to develop a comprehensive State Water Plan that was spearheaded by the NNRC (Flowerday & Herrin, 1993, pp. 184-185; UN-L C/S Division, 1981).

6.2.2a 1987-1994: Number of Governance Units

Nineteen governance units dispersed over four vertical governance levels were active at this time as shown in Figure 6.2. This included one local, three intra-regional, fourteen state and one national level horizontal governance units and are largely the same governance units that existed in the previous period except for the introduction of three new ones. The Water Well Standards and Contractor's Licensing Board (WWSCLB), created as part of the 1986 regulatory changes, was charged with the development of mandatory well construction standards and the on-going refinement of the well contractor licensing program. The Nebraska Rural Water Association (NRWA) also became involved in the process largely through its advocation for "pipeline solutions" on behalf of smaller rural water systems. In addition, the Nebraska Groundwater Foundation (NGWF) focused on public education activities and became quite active during this time frame. The Nebraska Cattlemen Association no longer affected the process and the Nebraska Department of Environmental Control changed its name in 1993 to the Nebraska Department of Environmental Quality (NDEQ) to better reflect its environmental mandate.

6.2.2b 1987-1994: Types of Linkages

Most linkages during this period remained the same except for some realignment that occurred in relation to the new governance units as shown in Table 6.5. The NWDA, for instance, continued its lobbying efforts as seen in its successful work in obtaining oral well driller licensing tests (Downey, 1994, p. 3; NWDA & NDHHS officials, interviews, 14, 16 November 2007). Education continued to form a large part of the NWDA's activities with the continuation of the Annual Short Course and its Annual Conference and Trade Show (NWDA Annual Short Course and the NWDA Annual Conference and Trade Show Programs, 1987-1994). In addition, specific licensing tutorials were developed and delivered throughout the state (*Water Writes*, 1991, pp. 6, 21).

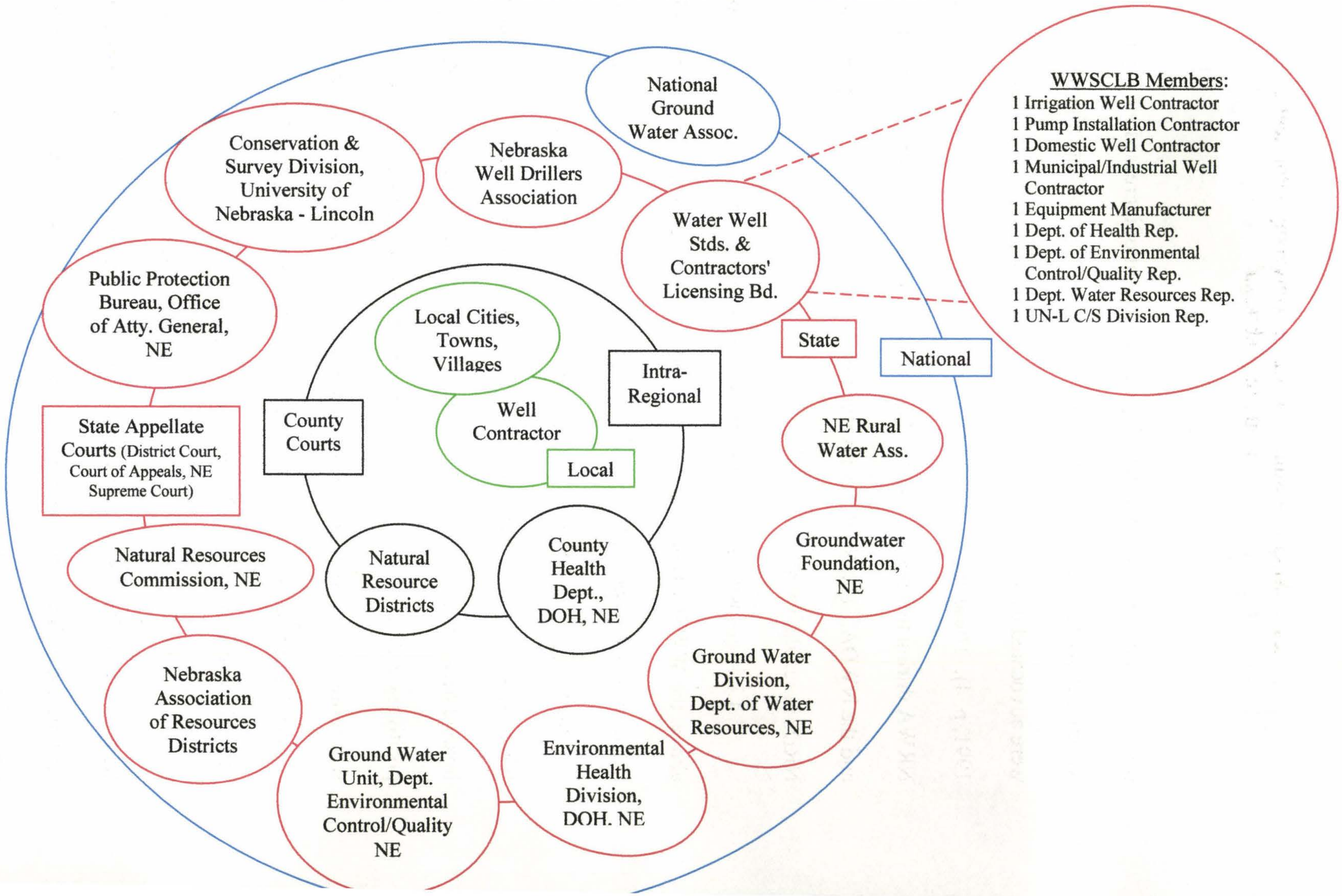
The NWDA's strategic linkages with the NDWR GWD, the NDEC/Q GWU and the NDOH EHD were largely transferred to the newly formed WWSCLB noted above. The WWSCLB was composed of nine members, five of which were appointed by the Governor and are industry related with the others being representatives from the main state agencies (see Figure 6.2; NE Laws 1986, LB 310, § 19). Strategic linkages between the NWDA and the UN-L C/S Division continued both through and outside of the WWSCLB. It was primarily through the WWSCLB that regulatory changes were done, however, note the continuation of the NWDA Annual Short Course and the Annual Convention and Trade Show (e.g. speakers) in which the UN-L C/S Division was heavily involved (NWDA Annual Short Course and the NWDA Annual Conference and Trade Show Programs, 1987-1994). Similarly, the NWDA continued to have a strategic linkage with the NGWA yet this strategic linkage was focused on the national arena and included yearly "Washington Fly-ins" to lobby national policy makers (e.g. *Water Writes*, 1993, p. 14; NWDA official, interview, 14 November 2007).

Other NWDA linkages largely remained the same with the exception of the linkage with the NRDs and the NARD where it became functionally neutral. This was due to various measures including the enactment of increased well spacing requirements and well installation moratoriums and the fact that "pipeline solutions" were advocated by some NRDs which would negatively impact well drillers (Merritt, 1991, p. 4). These "pipeline solutions" were also aggressively advanced by the NRWA during this period which led to the functionally negative linkage between it and the NWDA. The NARD is involved in this process through its representation of NRDs in regulatory affairs.

Linkages with the new governance units varied. In addition to those noted above, the WWSCLB had a functionally positive linkage with the County Health Departments, NRDs and the NARD. This is the result of the fact the standards developed by the WWSCLB directly improved the protection of groundwater sources which all three of the other governance units had a role in protecting. In contrast, the linkage between the WWSCLB and the NGWA was functionally neutral. Any positiveness derived in activity overlap in relation to education and licensing efforts was seriously eroded by the NGWA's refusal to address exam deficiencies (NWDA, Annual Short Course, 1999, 2000; NWDA, NDHHS EHD & UN-L C/S Division officials, interviews, 14, 16 November 2007).

The NGWF had functionally positive linkages with most governance units. Its groundwater education efforts such as its Children's Groundwater Festival and Groundwater Guardian Program raised public awareness in relation to groundwater protection. The NGWF also had a strategic linkage with the NWDA, the NDEC/Q GWU and the NDWR GWD in that all three have funded the NGWF (Seacrest, 1989,

Figure 6.2: Well Driller Governance Units, 1987-1994, NE



p. 18; NWDA, NGWF & NDNR officials, interviews, 14, 05, 15 November 2007). The NGWF did, however, have a functionally neutral linkage with both adjudication units due to their different core activities.

The NRWA had functionally positive linkages with most governance units except the previously discussed negative linkage with the NWDA. This general positiveness related to its core activities of aiding small rural public water systems to meet operation standards including the education and training of water and wastewater operators.

6.2.2c 1987-1994: Complementarity of Linkages

governance visions (goals)

The goals for each *new* governance unit are shown in Table 6.4 (see Table 6.2 for the goals of the existing governance units) and similarities in goals are summarized in Table 6.6. No changes in governance goals occurred in relation to the existing governance units. In relation to the new governance units, the NRWA had a low similarity in goals with most governance units due to its narrow mandate previously discussed. One exception to this pattern is the moderate similarity in goals the NRWA had with the NDOH EHD. This was due to the fact both were involved in educational activities in regards to water systems operators and to the licensing and operation of public water (drinking) systems.

The NGWF's goal similarities follow those described above for the NRWA. For instance, goal similarity was low between the NGWF and the NWDA, the NDEC/Q GWU, the UN-L C/S Division, the NDOH EHD and the WWSCLB due to the educational activities performed by each unit and/or the groundwater protection activities each performed. Note the lack of goal similarity between the NGWF and the NDWR GWD, the NNRC, the NARD, and the adjudication units. Simply put, these latter governance units had much larger and broader water, soil and overall natural resource planning functions and/or were chiefly concerned with a narrow and different mandate such as the adjudication of disputes.

Table 6.4: Goals of *New* Governance Units, Well Driller Regs., 1987-94, NE

Water Well Standards & Contractor's Licensing Board
• Advisory functions re development and administration of well construction standards & well contractor licensing for the protection of groundwater resources and public health.
NE Groundwater Foundation
• Educate and motivate people to care for/about groundwater; • Achieved through various programs (e.g. Children's Festival, Groundwater Guardians).
NE Rural Water Association
• Represent small water/wastewater systems in Nebraska (population <10,000); • Assist in regulatory compliance via various programs (e.g. technical/management help, training and seminars.

Goal similarities in relation to the WWSCLB varied. For instance, goal similarities were moderate between most members such as the NWDA, the NGWA and the NDOH EHD due to their overlap in well standards and contractor licensing. However, the similarity is not classified as high due to the fact each governance unit also had a broader mandate, such as the NWDA with its related advocacy work and educational activities. Interestingly, this pattern did not carry over to the other members of the WWSCLB, that is, the NDEC/Q GWU and the UN-L C/S Division, due to the fact the latter two governance units' much broader mandates such as the NDEC/Q GWU's responsibility for land and air resources and the UN-L C/S Division's geological and soils survey functions (see Tables 6.2 and 6.4).

***communication level** (meeting frequency, proposals, personal communication)*

Overall, no major changes in communication levels occurred during this time

Table 6.5: Linkage Types, Well Driller Regulatory Changes, 1987-1994, NE

	NW DA	DWR GW Div.	Nat. Res. Com	NG WA	DEC/Q GW Unit	UN-L C/S Div.	DOH En. Hth. Div.	DOH Cty. Hth.	N R D	NA RD	AG Off.	L. Gov't	Courts	WW SCL B	GW Fdn	NR WA
NWDA	-----	F+	F+	F+, S	F+	F+,S	F+	F+	Fn	Fn	F+/-	F+/-	F+/-	F+, S	F+, S	F-
DWR GWD	F+	-----	F+	Fn	F+	F+, S	F+	Fn	F+	F+	F+/-	Fn	F+/-	F+, S	F+, S	F+
Nat. Res. Comm.	F+	F+	-----	Fn	F+	F+, S	F+, S	F+	F+S	F+ S	F+/-	Fn	F+/-	F+	F+	F+
NGWA	F+, S	Fn	Fn	-----	Fn	F+	F+	F+	Fn	Fn	Fn	F+	Fn	Fn	F+	F+
DEC/Q GW Unit	F+	F+	F+	Fn	-----	F+, S	F+, S	F+	F-	F-	F+/-	Fn	F+/-	F+, S	F+	F+
UN-L C/S Division	F+, S	F+, S	F+, S	F+	F+, S	-----	F+, S	F+, S	F+	F+	Fn	F+	Fn	F+, S	F+, S	F+
DOH En. Hth.	F+	F+	F+, S	F+	F+, S	F+, S	-----	F+, S	F+	F+	F+	F+	F+/-	F+, S	F+	F+
DOH Cty. Hth.	F+	Fn	F+	F+	F+	F+, S	F+, S	-----	F+	F+	F+/-	F+	F+/-	F+	F+	F+
NRD	Fn	F+	F+, S	Fn	F+/-	F+	F+	F+	-----	F+, S	F+/-	F+	F+/-	F+	F+	F+
NARD	Fn	F+	F+, S	Fn	Fn	F+	F+	F+	F+ S	-----	F+/-	F+	F+/-	F+	F+	F+
AG Off.	F+/-	F+/-	F+/-	Fn	F+/-	Fn	F+	F+/-	F+/-	F+/-	-----	F+/-	F+/-	F+/-	Fn	F+/-
L. Gov't	F+	Fn	Fn	F+	Fn	F+	F+	F+	F+	F+	F+/-	-----	F+/-	F+/-	F+	F+
Courts	F+/-	F+/-	F+/-	Fn	F+/-	Fn	F+/-	F+/-	F+/-	F+/-	F+/-	F+/-	-----	F+/-	Fn	F+/-
WWSCLB	F+, S	F+	F+	Fn	F+, S	F+, S	F+, S	F+	F+	F+	F+/-	F+/-	F+/-	-----	F+	F+
GW Fdn	F+, S	F+	F+	F+	F+	F+	F+	F+	F+	F+	Fn	F+	Fn	F+	-----	F+
NRWA	F-	F+	F+	Fn	F+	F+	F+	F+	F+	F+	F+/-	F+/-	F+/-	F+	F+	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative;
Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

frame. However, the introduction of the WWSCLB did shift some communication patterns while the entry of the NGWF and the NRWA increased the complexity of communication. For instance, communication levels between the NDWR GWD and the NWDA, the NDEC/Q GWU, the UN-L C/S Division and the NDOH EHD were moderate in nature (formerly high) due to the fact much communication was channeled through the WWSCLB which met every other month for full day meetings (UN-L C/S Division & NDHHS officials, interviews, 16 November 2007).

The reduction in communication levels due to the WWSCLB did not materialize with all governance units such as the case between the NWDA and the NGWA, the UN-L C/S Division and the NDOH EHD. Communication levels between these governance units remained high as noted by the continued coordination of the NWDA Annual Short Course and Annual Convention and Trade Show programs by the UN-L C/S Division. The UN-L C/S Division staff also presented papers at the aforementioned events and continued to jointly administer, with the NWDA, the Condra Scholarship (NWDA Annual Short Course and Annual Convention and Trade Show Programs, 1987-1994). The NGWA participated in these events, the "Washington Fly-ins", provided updates to the NWDA, contributed articles to and placed ads in the NWDA's publication, *Water Writes* (NWDA Annual Meeting Minutes, 1991; Lehr, 1990, pp. 13, 22, 23; *Water Writes*, 1988, p. 14; *Water Writes*, 1993, p. 14; for ads see any issue of *Water Writes* 1987-1994). Similarly, the NWDA and NDOH EHD continued to have high communication levels during this time period as noted in educational activities related to licensing and in the administration of the exams (*Water Writes*, 1991, pp. 6, 21; Tremblay, 1989, p. 16, 1990, p. 7; Wentink, 1991, p. 6).

The NGWF had low communication levels with most governance units with two exceptions. The NGWF had high communication levels with the NWDA and with the NDEC/Q GWU as evidenced by the funding it obtained to facilitate the delivery of various educational programs previously discussed. Annual reports were given at the NWDA Annual Convention and Trade Shows and in NWDA's periodical and in NDEC/Q "Updates" (e.g. NWDA Annual Convention Program, 1993, 1994; Johnson, 1994, pp. 4-6). This level of activity was in addition to participation in various conferences in the state (NGWF official, interview, 05 November 2007).

frequency and type of collaboration

Collaboration levels were mixed for this time period as shown in Table 6.6. Note that the entry of the WWSCLB altered collaboration patterns between the NWDA and the NDWR GWU, between the NGWA and the UN-L C/S Division, and between the UN-L C/S Division and the NDOH EHD in that collaboration levels were lower and directed through the WWSCLB.

A similar effect did not happen with the other main governance units. In fact, collaboration levels increased between the NDWR GWD and the NNRC, the NDEC/Q GWU, the UN-L C/S Division and the NDOH EHD due to various factors including collaboration required for the update of the State's Water Plan, ongoing litigation in regards to the North Platte Decree and wellhead protection planning (Rundquist, 1993, pp. 210-211; NDEQ, 2001; NDNR & NDEC/Q officials,

Table 6.6: Linkage Complementarity Summary, 1987-1994, Well Driller Regs, NE.

	NW DA	DWR GW Div.	Nat. Res. Com	NG WA	DEC/Q GW Unit	UN-L C/S Div.	DOH En. Hth. Div.	DOH Cty. Hth.	N R D	NA RD	AG Off.	L. Gov't	Courts	WWS CLB	GW Fdn	NR W A
Governance Vision (goals)																
NWDA	-----	Mod	Low	Mod	Mod	Mod	Mod	Low	Low	Low	Low	Low	Low	Mod	Low	Low
DWR GWD	Mod	-----	High	Low	Mod	Mod	Mod	Low	Mod	Low	Low	Low	Low	Low	-nil-	Low
Nat. Res. Comm.	Low	High	-----	Low	Mod	Mod	Low	Low	High	Mod	Low	Low	Low	Low	-nil-	Low
NGWA	Mod	Low	Low	-----	Low	Low	Low	Low	Low	Low	-nil-	Low	-nil-	Mod	Mod	Low
DEC/Q GW Unit	Mod	Mod	Mod	Low	-----	Mod	Low	Low	Mod	Low	Low	Low	Low	Low	Low	Low
UN-L C/S Division	Mod	Mod	Mod	Low	Mod	-----	Low	Low	Mod	Low	-nil-	Low	-nil-	Low	Low	Low
DOH EHD	Mod	Mod	Low	Low	Low	Low	-----	High	Low	Low	Mod	Low	Low	Mod	Low	Mod
DOH Cty. Hth.	Low	Low	Low	Low	Low	Low	High	-----	Low	Low	Low	Mod	Low	Low	Low	Low
NRD	Low	Mod	High	Low	Mod	Mod	Low	Low	-----	High	Low	Low	Low	Low	Low	Low
NARD	Low	Low	Mod	Low	Low	Low	Low	Low	High	-----	Low	Low	Low	Low	-nil-	Low
AG Off.	Low	Low	Low	-nil-	Low	-nil-	Mod	Low	Low	Low	-----	Low	High	Mod	-nil-	-nil-
L. Gov't	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	-----	Low	Low	Low	Low
Courts	Low	Low	Low	-nil-	Low	-nil-	Low	Low	Low	Low	High	Low	-----	Low	-nil-	-nil-
WWSCLB	Mod	Low	Low	Mod	Low	Low	Mod	Low	Low	Low	Mod	Low	Low	-----	Low	Low
GW Fdn	Low	-nil-	-nil-	Mod	Low	Low	Low	Low	Low	-nil-	-nil-	Low	-nil-	Low	-----	Low
NRWA	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	-nil-	Low	-nil-	Low	Low	-----
Communication Level (Meetings, Proposals, Personal Communication)																
NWDA	-----	Mod	Low	H	Low	High	High	Low	Low	Low	Low	Low	Low	High	Mod	Low
DWR GWD	Mod	-----	Mod	Low	Mod	Mod	Mod	Low	Low	Low	Low	Low	Low	Mod	Low	Low
Nat. Res. Comm.	Low	Mod	-----	Low	Mod	High	Mod	Low	Mod	Mod	Low	Low	Low	Low	Low	Low
NGWA	High	Low	Low	-----	Low	High	High	Low	Low	Low	-nil-	-nil-	-nil-	Mod	Low	Low
DEC/Q GW Unit	Low	Mod	Mod	Low	-----	High	High	Low	Mod	Low	Low	Mod	Low	High	Mod	Low
UN-L C/S Division	High	Mod	High	H	High	-----	High	Low	Low	Low	Low	Low	Low	High	Mod	Low
DOH EHD	High	Mod	Mod	H	High	High	-----	High	Low	Low	Low	Low	Low	High	Low	High

Table 6.6: Linkage Complementarity Summary, 1987-1994, Well Driller Regs, NE (cont'd).

	NW DA	DWR GW Div.	Nat. Res. Com	NG WA	DEC/Q GW Unit	UN-L C/S Div.	DOH En. Hth. Div.	DOH Cty. Hth.	N R D	NA RD	AG Off.	L. Gov't	Courts	WW SCL B	GW Fdn	NR W A
Communication Level (Meetings, Proposals, Personal Communication) (cont'd)																
DOH Cty. Hth.	Low	Low	Low	Low	Low	Low	High	-----	Mod	Low	-nil-	Low	-nil-	Low	Low	Low
NRD	Low	Low	Mod	Low	Mod	Low	Low	Mod	-----	High	Low	Mod	-nil-	Low	Low	Low
NARD	Low	Low	Mod	Low	Low	Low	Low	Low	High	-----	Low	Low	-nil-	Low	Low	Low
AG Off.	Low	Low	Low	-nil-	Low	Low	Low	-nil-	Low	Low	-----	Low	Low	Low	-nil-	Low
L. Gov't	Low	Low	Low	-nil-	Mod	Low	Low	Low	Mod	Low	Low	-----	Low	-nil-	Low	Low
Courts	Low	Low	Low	-nil-	Low	Low	Low	-nil-	-nil-	-nil-	Low	Low	-----	-nil-	-nil-	Low
WWSCLB	High	Mod	Low	Mod	High	High	High	Low	Low	Low	Low	-nil-	-nil-	-----	Low	-nil-
GW Fdn	Mod	Low	Low	Low	Mod	Mod	Low	Low	Low	Low	-nil-	Low	-nil-	Low	-----	Low
NRWA	Low	Low	Low	Low	Low	Low	High	Low	Low	Low	Low	Low	Low	-nil-	Low	-----
Frequency and Type of Collaboration																
NWDA	-----	Low	Low	H	Low	High	High	Low	Low	-nil-	-nil-	-nil-	-nil-	High	Mod	-nil-
DWR GWD	Low	-----	High	-nil-	High	High	Low	Low	Mod	-nil-	-nil-	Low	-nil-	Low	Low	Low
Nat. Res. Comm.	Low	High	-----	-nil-	High	High	Low	Low	Mod	Mod	-nil-	Low	-nil-	-nil-	Low	Low
NGWA	High	-nil-	-nil-	-----	-nil-	-nil-	Low	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	Low	-nil-	-nil-
DEC/Q GW Unit	Low	High	High	-nil-	-----	High	High	Low	Mod	Low	Low	Low	-nil-	Low	Mod	Low
UN-L C/S Division	High	High	High	-nil-	High	-----	Low	Low	Mod	Low	-nil-	Low	-nil-	High	High	Low
DOH EHD	High	Low	Low	Low	High	Low	-----	High	Low	-nil-	Low	Low	-nil-	High	Low	High
DOH Cty. Hth.	Low	Low	Low	-nil-	Low	Low	High	-----	Low	-nil-	-nil-	Low	-nil-	-nil-	Low	Low
NRD	Low	Mod	Mod	-nil-	Mod	Mod	Low	Low	-----	High	-nil-	Low	-nil-	-nil-	Low	Low
NARD	-nil-	-nil-	Mod	-nil-	Low	Low	-nil-	-nil-	High	-----	-nil-	-nil-	-nil-	-nil-	Low	-nil-
AG Off.	-nil-	-nil-	-nil-	-nil-	Low	-nil-	Low	-nil-	-nil-	-nil-	-----	-nil-	-nil-	-nil-	-nil-	-nil-
L. Gov't	-nil-	Low	Low	-nil-	Low	Low	Low	Low	Low	-nil-	-nil-	-----	-nil-	-nil-	Low	Low
Courts	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-----	-nil-	-nil-	-nil-
WWSCLB	High	Low	-nil-	Low	Low	High	High	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-----	-nil-	-nil-
GW Fdn	Mod	Low	Low	-nil-	Mod	High	Low	Low	Low	Low	-nil-	Low	-nil-	-nil-	-----	Low
NRWA	-nil-	Low	Low	-nil-	Low	Low	High	Low	Low	-nil-	-nil-	Low	-nil-	-nil-	Low	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

interviews, 15, 14 November 2007). Similar events are also at the root of increased collaboration between the NNRC, the UN-L C/S Division, the NDEC/Q GW and the NDOH EHD.

Other notable collaborative efforts existed in relation to the entry of new governance units. In particular, collaboration between the NGWF and the NWDA and the NDEC/Q GWU was moderate due to both of the latter's involvement in the funding, planning and delivering of the NGWF's educational activities such as the Children's Water Festival (Seacrest, 1989, p. 18). Also, a high level of collaboration between the NGWF and the UN-L C/S Division existed in terms of broad governance issues in the NGWF's early years and the fact that some faculty members have periodically sat on the NGWF's Technical Advisory Committee which continues to this day (NGWF, n.d.-a; NWDA, NDEC/Q, NGWF & UN-L C/S Division officials, interviews, 14, 14, 05, 16 November 2007). Little collaboration existed between the NRWA and most governance units except for the NDOH EHD which is classified as "high" due to the long association the two have had in relation to public water supply systems for system design, water quality testing and licensing of operators (NDHHS EHD & NDEC/Q officials, interviews, 14, 16 November 2007).

6.2.3a 1998-2004: Number of Governance Units

Little change occurred in the number of governance units during this time period as shown in Figure 6.3. Overall, nineteen governance units were active at this time dispersed over four vertical governance levels. This included one local, four intra-regional, thirteen state and one national level horizontal governance units. These were the *same* governance units as in the previous period except for one notable change. The NNRC and the NDWR merged in 2000 to become the Nebraska Department of Natural Resources (NDNR). Little in terms of their functions changed except that the planning functions of the two were merged. The NNRC continued to operate within the NDNR as a separate unit for the administration of state funding programs such as the Water Well Decommissioning Fund. Field Offices for the NDNR also became active in the process in terms of facilitating well registrations. The only other change occurred with the NDOH which became the Nebraska Department of Health and Human Services (NDHHS) in 1998 though the change did not affect the Environmental Health Division's (EHD) functions.

6.2.3b 1998-2004: Types of Linkages

Few changes occurred in relation to linkage types, shown in Table 6.7, largely due to the continuation of functions by the same governance units. There are, however, two exceptions. First, the functional linkage between the NGWA and the WWSCLB became functionally negative due to the NGWA's refusal to update their exams to reflect current industry knowledge. The fact that there were increasingly significant economic costs associated with the NGWA exams did not help matters and led members of the WWSCLB to spend "a lot of time and money both as a unit and independently of the WWSCLB" to write their own set of licensing exams and institute mechanisms for their yearly review (NWDA & NDHHS EHD officials, interviews, 14, 16 November 2007).

Second, the newly formed NDNR brought NDNR Field Offices into the regulatory mix. The Field Offices were largely responsible for carrying out the broad water and natural resource activities of the NDNR at the regional level. In essence, well contractors could file well registrations (until 2002 when electronic filing was instituted) and/or make inquiries with their regional offices. Linkages between the NDNR Field Offices and the other governance units mirrored the linkages the NDNR GWD had with the same said governance units with a few exceptions. The NDNR Field Offices had a functionally neutral linkage with the NGWA due to its lack of involvement in regulatory changes yet were still functionally linked since the Field Offices carried out some groundwater functions such as well registration aspects. Similarly, the NDNR Field Offices had a functionally neutral linkage with the NARD due to the scope of each unit's mandate.

6.2.3c 1998-2004: Complementarity of Linkages

***governance visions** (goals)*

The goals of the governance units remained the same as in the previous periods (shown in Tables 6.2 and 6.4). The goals for the <u>*new*</u> governance units are shown in Table 6.8 and similarities in Table 6.9 below. Only changes in goal similarities related to the NDNR are discussed since no changes in similarities

Figure 6.3: Well Driller Governance Units, 1998-2004, NE

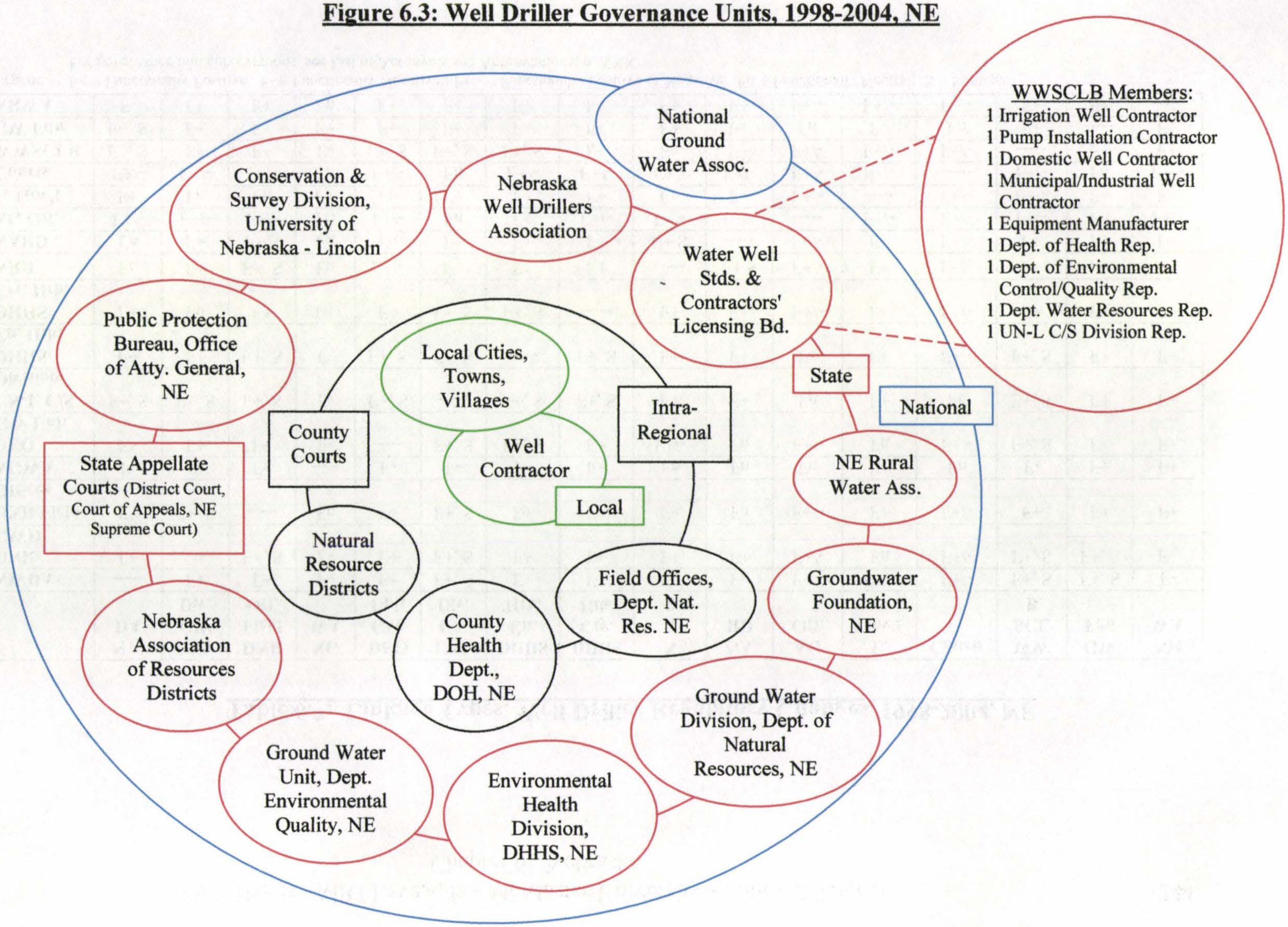


Table 6.7: Linkage Types, Well Driller Regulatory Changes, 1998-2004, NE

	NW DA	DNR GW Div.	DNR Field Off.	NG WA	DEQ GW Unit	UNL C/S Div.	DHHS En. Hth.	DHHS Cty. Hth.	N R D	NA RD	AG Off.	L. Gov't	Courts	WW SCL B	GW Fdn	NR WA
NWDA	-----	F+	F+	F-	F+	F+, S	F+	F+	Fn	Fn	F+/-	F+/-	F+/-	F+, S	F+, S	F-
DNR GWD	F+	-----	F+, S	F-	F+	F+, S	F+	F+	F+	F+	F+/-	Fn	F+/-	F+, S	F+, S	F+
DNR Field Offices	F+	F+, S	-----	Fn	F+	F+, S	F+	F+	F+	Fn	F+/-	F+	F+/-	F+	F+	F+
NGWA	F-	F-	Fn	-----	F-	F-	F-	F+	Fn	Fn	Fn	F+	Fn	F-	F+	F+
DEQ GW Unit	F+	F+	F+	F-	-----	F+, S	F+, S	F+	F+/-	Fn	F+/-	Fn	F+/-	F+, S	F+	F+
UN-L C/S Division	F+, S	F+, S	F+, S	F-	F+, S	-----	F+, S	F+, S	F+	F+	Fn	F+	Fn	F+, S	F+	F+
DHHS En. Hth.	F+	F+	F+, S	F-	F+, S	F+, S	-----	F+, S	F+	F+	F+	F+	F+/-	F+, S	F+	F+
DHHS Cty. Hth.	F+	Fn	F+	F+	F+	F+, S	F+, S	-----	F+	F+	F+/-	F+	F+/-	F+	F+	F+
NRD	Fn	F+	F+, S	Fn	F+/-	F+	F+	F+	-----	F+ S	F+/-	F+	F+/-	F+	F+	F+
NARD	Fn	F+	F+,S	Fn	Fn	F+	F+	F+	F+ S	-----	F+/-	F+	F+/-	F+	F+	F+
AG Off.	F+/-	F+/-	F+/-	Fn	F+/-	Fn	F+	F+/-	F+/-	F+/-	-----	F+/-	F+/-	F+/-	Fn	F+/-
L. Gov't	F+	Fn	Fn	F+	Fn	F+	F+	F+	F+	F+	F+/-	-----	F+/-	F+/-	F+	F+
Courts	F+/-	F+/-	F+/-	Fn	F+/-	Fn	F+/-	F+/-	F+/-	F+/-	F+/-	F+/-	-----	F+/-	Fn	F+/-
WWSCLB	F+, S	F+	F+	F-	F+, S	F+, S	F+, S	F+	F+	F+	F+/-	F+/-	F+/-	-----	F+	F+
GW Fdn	F+, S	F+	F+	F+	F+	F+	F+	F+	F+	F+	Fn	F+	Fn	F+	-----	F+
NRWA	F-	F+	F+	Fn	F+	F+	F+	F+	F+	F+	F+/-	F+/-	F+/-	F+	F+	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. XXX.

occurred in relation to the other governance units.

Similarities in goals for the NDNR Field Offices largely mirrored those of the NDNR with a few exceptions. The NDNR Field Offices had no similarities in goals with the NGWA due to the fact each governance unit performed very different functions. The NGWA's mandate focused on educational and advocacy work related to water well contractors and professionals while the NDNR Field Offices were concerned about policy implementation "on the ground" which included water rights administration. The NDNR GWD also had a low similarity in goals with the NARD largely due to its lack of advocacy work and broad policy implementation mandate. Similarly, goal similarities between the NDNR GWD and the NDEC/Q GWU were low due to the broad and different mandates each governance unit had. The NDNR Field Offices were primarily concerned with various water rights administration issues which included groundwater while the NDEQ GWU was focused on water quality and protection activities which included water quality standards.

Table 6.8: Goals of *New* Governance Units, Well Driller Regs., 1998-2004, NE.

NE Department of Natural Resources Groundwater Unit
• Contribute to the Department's mandate of natural resources planning which includes groundwater management and related data (e.g. water well database).
NE Department of Natural Resources Field Offices
• Contribute to the delivery of the NDNR's main programs including well registrations, surface water administration, dam inspections, peroration of stream gauging.

***communication level** (meeting frequency, proposals, personal communication)*

Communication patterns were mixed during this time frame as shown in Table 6.9. For instance, the NGWA's refusal to update its exams and address examination fees was a large factor in decreased communication levels and in the nature of the communication with the WWSCLB. As one official noted, there was little reason to discuss the matter with the NGWA given their intransigence on the issue and the need existed to "get on with it" and develop a new and more relevant set of exams (NWDA official, interview, 14 November 2007). Decreased NGWA communication levels were also seen in their lack of regular participation in the NWDA's Annual Short Course and the NWDA's Annual Convention and Trade Show (NWDA Annual Short Course Programs, NWDA Annual Convention and Trade Show Programs and NWDA Annual Meeting Minutes, 1995-2004). This suggests a "distancing" or "cooling" in relations between governance units. Interestingly, this "distancing" did not transpire to relations between the NWDA and the NGWA's national advocacy work with many NWDA members participating in the "Washington Fly-ins", no doubt, in large part, due to the fact the NWDA's Executive Director happened to Chair the NGWA's Government Affairs committee at the time (NWDA, Annual Meeting Minutes, 1998).

Communication levels remained high between the NWDA, the UN-L C/S Division, the WWSCLB and the NDHHS EHD. This is evidenced, in addition to the need to develop new examinations, in the numerous educational talks and events held at the NWDA Annual Short Course which regularly featured individuals from the NDHHS and from the WWSCLB (e.g. NWDA, Annual Short course, 1998, 2000). Furthermore, the WWSCLB attended the yearly NWDA Annual Convention and Trade Show and provided the industry with program updates (e.g. NWDA Annual Convention and Short Course, 1997-2004). Communication was also facilitated between the governance units through *Water Writes*, the NWDA's publication, with

Table 6.9 Linkage Complementarity Summary, 1998-2004, Well Driller Regs, NE.

	NW DA	DNR GW Div.	DNR Field Off.	NG WA	DEQ GW Unit	UN-L C/S Div.	DHHS En. Hth.	DHHS Cty. Hth.	N R D	NA RD	AG Off.	L. Gov't	Courts	WW SCL B	GW Fdn	NR WA
Governance Vision (goals)																
NWDA	-----	Mod	Low	Mod	Mod	Mod	Mod	Low	Low	Low	Low	Low	Low	Mod	Low	Low
DNR GWD	Mod	-----	High	Low	Mod	Mod	Mod	Low	Mod	Low	Low	Low	Low	Low	-nil-	Low
DNR Field Offices	Low	High	-----	-nil-	Low	Mod	Low	Low	High	Low	Low	Low	Low	Low	-nil-	Low
NGWA	Mod	Low	Low	-----	Low	Low	Low	Low	Low	Low	-nil-	Low	-nil-	Mod	Mod	Low
DEQ GWU	Mod	Mod	Mod	Low	-----	Mod	Low	Low	Mod	Low	Low	Low	Low	Low	Low	Low
UN-L C/S Division	Mod	Mod	Mod	Low	Mod	-----	Low	Low	Mod	Low	-nil-	Low	-nil-	Low	Low	Low
DHHS En. Hth.	Mod	Mod	Low	Low	Low	Low	-----	High	Low	Low	Mod	Low	Low	Mod	Low	Mod
DHHS Cty. Hth.	Low	Low	Low	Low	Low	Low	High	-----	Low	Low	Low	Mod	Low	Low	Low	Low
NRD	Low	Mod	High	Low	Mod	Mod	Low	Low	-----	High	Low	Low	Low	Low	Low	Low
NARD	Low	Low	Mod	Low	Low	Low	Low	Low	High	-----	Low	Low	Low	Low	-nil-	Low
AG Off.	Low	Low	Low	-nil-	Low	-nil-	Mod	Low	Low	Low	-----	Low	High	Mod	-nil-	-nil-
L. Gov't	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	-----	Low	Low	Low	Low
Courts	Low	Low	Low	-nil-	Low	-nil-	Low	Low	Low	Low	High	Low	-----	Low	-nil-	-nil-
WWSCLB	Mod	Low	Low	Mod	Low	Low	Mod	Low	Low	Low	Mod	Low	Low	-----	Low	Low
GW Fdn	Low	-nil-	-nil-	Mod	Low	Low	Low	Low	Low	-nil-	-nil-	Low	-nil-	Low	-----	Low
NRWA	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	-nil-	Low	-nil-	Low	Low	-----
Communication Level (Meetings, Proposals, Personal Communication)																
NWDA	-----	Mod	Low	Mod	Low	High	High	Low	Low	Low	Low	Low	-nil-	High	Mod	Low
DNR GWD	Mod	-----	High	Low	High	High	High	Low	High	Low	Low	Low	Low	Mod	Low	Low
DNR Field Offices	Low	High	-----	-nil-	Low	Low	Low	Low	High	Low	Low	Low	-nil-	-nil-	Low	Low
NGWA	Mod	Low	-nil-	-----	-nil-	Low	Low	-nil-	Low	-nil-	-nil-	-nil-	-nil-	Mod	Low	Low
DEQ GWU	Low	High	Low	-nil-	-----	High	High	Low	Mod	Low	Low	Low	Low	High	Mod	Low
UN-L C/S Division	High	High	Low	Low	High	-----	High	Low	Low	Low	Low	Low	Low	High	Low	Low
DHHS En. Hth.	High	High	Low	Low	High	High	-----	High	Mod	Low	Low	Low	Low	High	Low	High
DHHS Cty. Hth.	Low	Low	Low	-nil-	Low	Low	High	-----	Mod	-nil-	-nil-	Low	-nil-	Low	Low	Low

Table 6.9 Linkage Complementarity Summary, 1998-2004, Well Driller Regs, NE (cont'd)

	NW DA	DNR GW Div.	DNR Field Off.	NG WA	DEQ GW Unit	UN-L C/S Div.	DHHS En. Hth.	DHHS Cty. Hth.	N R D	NA RD	AG Off.	L. Gov't	Courts	WW SCL B	GW Fdn	NR WA
Communication Level (Meetings, Proposals, Personal Communication) (cont'd)																
NRD	Low	High	High	Low	Mod	Low	Mod	Mod	-----	High	Low	Mod	-nil-	Low	Low	Low
NARD	Low	Low	Low	-nil-	Low	Low	Low	-nil-	High	-----	Low	Low	-nil-	Low	Low	Low
AG Off.	Low	Low	Low	-nil-	Low	Low	Low	-nil-	Low	Low	-----	Low	Low	Low	-nil-	Low
L. Gov't	Low	Low	Low	-nil-	Low	Low	Low	Low	Mod	Low	Low	-----	Low	-nil-	Low	Low
Courts	-nil-	Low	-nil-	-nil-	Low	Low	Low	-nil-	-nil-	-nil-	Low	Low	-----	-nil-	-nil-	Low
WWSCLB	High	Mod	-nil-	Mod	High	High	High	Low	Low	Low	Low	-nil-	-nil-	-----	Low	-nil-
GW Fdn	Mod	Low	Low	Low	Mod	Low	Low	Low	Low	Low	-nil-	Low	-nil-	Low	-----	Low
NRWA	Low	Low	Low	Low	Low	Low	High	Low	Low	Low	Low	Low	Low	-nil-	Low	-----
Frequency and Type of Collaboration																
NWDA	-----	Mod	Low	Mod	Low	High	High	Low	Low	-nil-	Low	Low	-nil-	High	Mod	-nil-
DNR GWD	Mod	-----	High	-nil-	High	High	Mod	Low	Mod	Low	Mod	Low	-nil-	Mod	Low	Low
DNR Field Offices	Low	High	-----	-nil-	Low	Low	Low	Low	High	Low	Low	Low	-nil-	-nil-	Low	Low
NGWA	Mod	-nil-	-nil-	-----	-nil-	Low	Low	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	Low	-nil-	-nil-
DEQ GWU	Low	High	Low	-nil-	-----	High	High	Low	Mod	Low	Low	Low	-nil-	Low	Mod	Low
UN-L C/S Division	High	High	Low	Low	High	-----	Mod	Low	Mod	Low	-nil-	Low	-nil-	High	Low	Low
DHHS En. Hth.	High	Mod	Low	Low	High	Mod	-----	High	Low	-nil-	Low	Low	-nil-	High	Low	High
DHHS Cty . Hth.	Low	Low	Low	-nil-	Low	Low	High	-----	Low	-nil-	-nil-	Low	-nil-	-nil-	Low	Low
NRD	Low	Mod	High	-nil-	Mod	Mod	Low	Low	-----	High	-nil-	Low	-nil-	-nil-	Low	Low
NARD	-nil-	Low	Low	-nil-	Low	Low	-nil-	-nil-	High	-----	-nil-	-nil-	-nil-	-nil-	Low	-nil-
AG Off.	Low	Mod	Low	-nil-	Low	-nil-	Low	-nil-	-nil-	-nil-	-----	-nil-	-nil-	-nil-	-nil-	-nil-
L. Gov't	Low	Low	Low	-nil-	Low	Low	Low	Low	Low	-nil-	-nil-	-----	-nil-	-nil-	Low	Low
Courts	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-----	-nil-	-nil-	-nil-
WWSCLB	High	Mod	-nil-	Low	Low	High	High	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-----	-nil-	-nil-
GW Fdn	Mod	Low	Low	-nil-	Mod	Low	Low	Low	Low	Low	-nil-	Low	-nil-	-nil-	-----	Low
NRWA	-nil-	Low	Low	-nil-	Low	Low	High	Low	Low	-nil-	-nil-	Low	-nil-	-nil-	Low	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

the NDHHS EHD providing regular updates, and through *Well Bits,* the NDHHS EHD's new industry publication (Christopherson, 1998, p. 10, 1999, p. 7, 2003, pp. 3-4, 2004, p. 4, 16; Hansmeyre, 2003, p. 12; Sizer, 2003, p. 3; Byrd, 2004, p. 1-2). Lines of communication between these governance units were "open", well used and the parties respected each other.

High communication patterns among the main governance units can also be traced through the aforementioned conferences and via participation in other projects such as the review of NRD Groundwater Management Plans, participation in the Lower Platte River Corridor Alliance, the Platte River Cooperative Hydrology Study, digitalized soil surveys, the North Platte River Settlement and litigation underway in regards to the Republican River Basin between Kansas and Nebraska (*Nebraska Resources*, 1999, pp. 3-4, 2001, p. 4, 2002, p. 1; Gaul, 1999, 1; Vanek, 2003, p. 4; NDNR, n.d.-a; Cookson, 2000, p. 4).

frequency and type of collaboration

The preceding discussion is revealing for it details many collaborative efforts that took place during the time frame. In fact, collaborative efforts largely mirrored communication levels as shown in Table 6.9 with high levels of collaboration between the main governance units through various projects noted above.

Other collaborative efforts included the Children's Groundwater Festival spearheaded by the NGWF previously discussed. The NWDA and the NDHHS EHD collaborated to resolve water well issues and the NWDA continued to collaborate with the UN-L C/S Division in many projects including the annual Condra

Scholarship (Merritt, 2002, pp. 10-11; *Water Writes*, Convention 1998, p. 12; for the Condra Scholarship, see *Water Writes* 1998-2004). One significant collaborative project between the NWDA, the UN-L C/S Division, the NDHHS EHD and the NDEQ GWU was participation in the Nebraska Grout Task Force which examined and documented the poor aging and endurance properties of bentonite grout on the continued proper sealing of water wells (Chistopherson, 2003 (Summer), pp. 1-2; UN-L C/S Division & NDHHS EHD officials, interviews, 16 November 2007).

6.2.4 Preliminary Findings: Well Drilling Regulations and Organizational Environment

The organizational environment surrounding the evolution of well drilling legislative and regulatory changes in Nebraska has been examined over three time frames. In terms of policy changes, licensing requirements were enacted in 1986 (t-1) for well and/or pump contractors and supervisors which included the need to take and pass certification exams and the need to continually upgrade their skills (12 CEUs per three years). Over the next two successive time frames, licensing classifications (i.e. more categories) and requirements (e.g. 18 CEUs/three years) were added including exam refinement through the development of their own state exams.

The aforementioned policy instrument changes in the latter two time periods occurred largely through the WWSCLB which was established with the 1986 legislative changes. The WWSCLB, comprised of five industry and four agency representatives, was also charged with the initial promulgation and continual revision of mandatory well construction standards and the recommendation of enforcement actions to be taken for non-compliance. A close working relationship among the

WWSCLB members existed, especially between the NWDA and the UN-L C/S Division which dates back to the 1920s. This pattern of close working relationships is one that is repeated in relation to water takings as the next section reveals.

6.3 Water Takings Independent Variable Summary

The effects of nested institutional arrangements on water takings, specifically, water transfer, irrigation, municipal and industrial permits, are examined over three time frames: 1980-1987, 1991-1999, post-2000, with the associated legislative and regulatory changes shown in Appendix VIII.

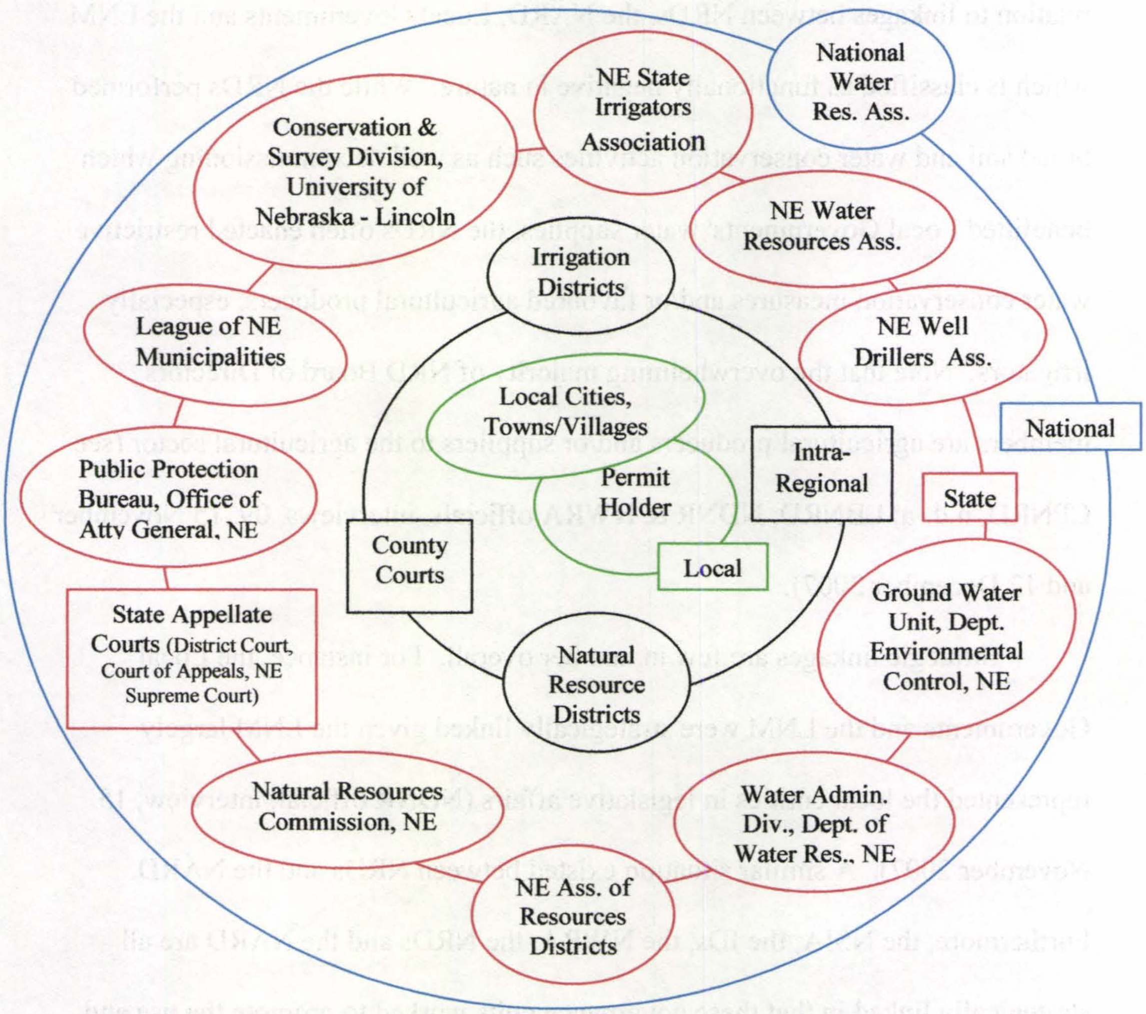
6.3.1a 1980-1987: Number of Governance Units

As Figure 6.4 illustrates, eighteen governance units dispersed over four vertical governance levels were active at this time. This included one local, three intra-regional, thirteen state and one national level horizontal governance units.

6.3.1b 1980-1987: Types of Linkages

Water takings linkages between governance units are summarized in Table 6.10. Most linkages were functionally positive such as the ones between the NDWR Water Administration Division (WAD), the NNRC, the NDEC GWU, the UN-L C/S Division, the Nebraska State Irrigation Association (NSIA) and Irrigation Districts (IDs). This was due to the significant role each governance unit performed in relation to water planning and environmental protection. For instance, the NDWR WAD was responsible for the administration of water rights and natural resource planning. The NNRC had broader water and soil planning functions including spearheading the State's Soil and Water Conservation Strategy in conjunction with the other governance units. Likewise, the NDEC GWU had a broad environmental protection role which included hydrogeologic reviews. The UN-L C/S Division was also functionally and positively linked in that its research provided much of the scientific data for the planning activities. Similarly, both the NSIA and IDs had broad water planning activities in terms of either the delivery of irrigation water to farmers or in terms of planning new resource projects.

Figure 6.4: Water Takings Governance Units, 1980-1987, NE



Exceptions to the above pattern existed. For instance, linkages between Local Governments, the League of Nebraska Municipalities (LNM) and the NSIA, the Nebraska Water Resources Association (NWRA), the NRDs and the NARD were functionally negative due to the emphasis on irrigation development by the NSIA and the NWRA, water which Local Governments desired for future growth. A similar result did not occur in relation to the IDs, Local Governments and the LNM due to the fact many of the IDs also produced power which the municipalities purchased for use, hence, the functionally neutral linkage. The same situation largely occurred in relation to linkages between NRDs, the NARD, Local Governments and the LNM which is classified as functionally negative in nature. While the NRDs performed broad soil and water conservation activities such as well decommissioning which benefitted Local Governments' water supplies, the NRDs often enacted restrictive water conservation measures and/or favoured agricultural producers, especially irrigators. Note that the overwhelming majority of NRD Board of Directors' members are agricultural producers and/or suppliers to the agricultural sector (see CPNRD, n.d.-a; LBNRD, NDNR & NWRA officials, interviews, 09, 15 November and 12 December 2007).

Strategic linkages are few in number overall. For instance, the Local Governments and the LNM were strategically linked given the LNM largely represented the local entities in legislative affairs (NDNR official, interview, 15 November 2007). A similar situation existed between NRDs and the NARD. Furthermore, the NSIA, the IDs, the NWRA, the NRDs and the NARD are all strategically linked in that these governance units worked to promote the use and development of irrigation and/or worked to ensure favourable agricultural policies to maximize irrigation activities. The aforementioned composition of NRD Board of Directors was repeated with the NWRA, yet the strategic linkage was much more complex in that, as one official noted, "a number of NRD Managers sit on and have always sat on both the Board of Directors of both the NWRA and the NSIA" (NWRA official, interview, 12 December 2007). Perhaps most important was the strategic relationship between the NDWR WAD and the NSIA where both worked closely together to obtain passage of the Groundwater Management Act in 1982 which increased the powers of NRDs to enact regulations governing groundwater. Also note the strategic linkage between the NWRA and the National Water Resources Association (NaWRA) which was directed towards national water policy advocacy efforts (NWRA official, interview, 12 December 2007).

Table 6.10: Linkage Types, Water Takings Regulatory Changes, 1980-1987, NE

	N W DA	DWR WA Div.	Nat. Res. Com	DEC GW Unit	NS IA	Irr. Dis.	UNL C/S Div.	NE Wat RA	Nat Wat. RA	N R D	NA RD	AG Off.	L. Go v't	Cou rts	L N M
NWDA	---	F+	F+	F+	F+	F n	F+	F+	F+	F n	F n	F+/-	F+/-	F+/-	Fn
DWR WADiv	F+	-----	F+	F+	F+ S	F+	F+	F+	F+	F+/-	F+/ -	F+/-	Fn	F+/-	F+/ -
NatRes Comm.	F+	F+	-----	F+	F+	F+	F+, S	F+	F+	F+	F+	F+/-	Fn	F+/-	Fn
DEC GWU	F+	F+	F+	-----	F+	F+	F+, S	F+/-	F+/ -	F+	F+	Fn	Fn	Fn	Fn
NSIA	F+	F+S	F+	F+	---	F+S	F+S	F+S	F+	F+S	F+S	F+/-	F-	F+/-	F-
Irr.Dis.	Fn	F+	F+	F+	F+S	-----	F+	F+	F+	F+S	F+S	F+/-	Fn	F+/-	Fn
UN-L C/SDiv	F+	F+	F+, S	F+, S	F+, S	F+	-----	F+	F+	F+	F+	Fn	Fn	Fn	Fn
NeWat. R.A.	F+	F+	F+	F+/-	F+, S	F+	F+	-----	F+ S	F+	F+ S	F+/-	F-	F+/-	F-
NatWat R.A.	F+	F+	F+	F+/-	F+	F+	F+	F+, S	---	Fn	Fn	F+/-	Fn	F+/-	Fn
NRD	Fn	F+/-	F+	F+	F+S	F+S	F+	F+	Fn	---	F+S	F+/-	F+/-	F+/-	F-
NARD	Fn	F+/-	F+	F+	F+S	F+S	F+	F+S	Fn	F+ S	---	F+/-	F+/-	F+/-	F-
AGOff.	F+/-	F+/-	F+/-	Fn	F+/-	F+/-	Fn	F+/-	F+/-	F+/-	F+/-	-----	F+/-	F+/-	F+/-
L.Gov't	F+/-	Fn	Fn	Fn	F-	Fn	Fn	F-	Fn	F+/-	F+/-	F+/-	----	F+/-	F+S
Courts	F+/-	F+/-	F+/-	Fn	F+/-	F+/-	Fn	F+/-	F+/-	F+/-	F+/-	F+/-	F+/-	---	F+/-
LNM	Fn	F+/-	Fn	Fn	F-	Fn	Fn	F-	Fn	F-	F-	F+/-	F+S	F+/-	---

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative;
Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

6.3.1c 1980-1987: Complementarity of Linkages

governance vision (goals)

The goals of the governance units are listed in Table 6.11 and similarities are summarized in Table 6.12. High goal similarities existed between the NSIA, the NWRA and the IDs due to their shared focus on irrigation development and management. Moderate goal similarities also occurred between the NSIA, IDs, the NWRA and the NRDs and the NARD. All of these governance units had slightly different mandates yet all were "certainly on the same page in terms of the resource's management" (NWRA official, interview, 12 December 2007). High goal similarities existed in relation to the NRDs and the NARD, the two adjudicatory bodies, and Local Governments and the LNM (see Table 6.12). Again, this is not surprising since, for instance, Local Governments provided many services to their citizens including the provision of drinking water which the LNM aided, in terms of technical assistance and/or as a liaison with state agencies. Also of note were the high goal similarities between the NNRC and the NDWR WAD largely due to their respective yet overlapping functions in regards to water.

communication level (meetings, proposals, personal communication)

Communication levels varied greatly during this time frame as shown in Table 6.12. High communication levels were experienced between governance units that were closely related such as between the NRDs and the NARD. The NARD kept the NRDs informed of proposed legislative changes on a daily or weekly basis and worked with them to develop suitable responses as previously discussed. This was in addition to the monthly NARD Board of Directors meetings (Little Blue NRD & NARD officials, interviews, 09, 12 November 2007). Note that NRD representatives are the Directors of the NARD (NARD, n.d.-b). Yearly NARD Legislative and Annual Conferences also facilitated communication between the parties. Of note were the Legislative Conferences which offered an opportunity to strategize and take

Table 6.11: Goals of Governance Units, Water Takings, 1980-1987, NE

Nebraska Well Drillers Association
• Promote common business interest of drilling of water wells and related services including development of publications, trade-shows, educational material; development of principals of uniformity/cooperation among well contractors; organization/ promotion of legislative activity.
NE Department Water Resources Water Administration Division
• Effective management of NE's water resources via administration of water rights and natural resources planning/assistance (e.g. stream gauging, engineering, planning).
NE Natural Resources Commission
• Promote resource development and conservation for soil and water resources; • Aid in State planning via development of State Soil & Water Conservation Strategy and provide assistance to NRDs re water resources planning; • Facilitate coordination, cooperation between governance units.
NE Department of Environmental Control Groundwater Unit
• Contribute to NDEC's overall goals of protecting water, land, air resources; • Specific functions relate to improving and protecting quality of NE's waters including groundwater quality standards setting, hydrogeologic reviews, remedial oversight.
NE State Irrigation Association
• Represent irrigation projects and their water user constituents - advocacy work; • Work with other groups interested in supporting irrigation activities in NE; • Educate members and public re irrigation via conferences, workshops, and meetings; • Encourage scientific and technical research, wise and beneficial use of the water resources.
Irrigation Districts
• Manage/provide irrigation water and public power to its members.
University of Nebraska - Lincoln Conservation & Survey Division
• Research, service, data collection related to State's geology, hydrology, and soils (includes taking inventory of quality and quantity of water resources).
NE Water Resources Association
• Promote irrigation (and water) development in NE.
National Water Resources Association
• Promote development of water resources; Protect rights/interests of states in their water resources; • Cooperate/assist national/state/local agencies re securing funding/approval for construction, operation, maintenance of water projects.
Natural Resource Districts
• Local government entities to regulate water and land use.
Nebraska Association of Resource Districts
• Unite, coordinate efforts of NRDs including administrative ones (e.g. training); • To represent NRDs in State lobbying efforts.
NE Attorney General's Office Public Protection Bureau
• Represent, advise State agencies/boards re natural resources, environment; • Enforcement of environmental laws, rules/regulations for State agencies.
Local Governments
• To promote, enhance, and foster a community's social and economic well-being.
Courts
• Adjudicate Disputes.
League of NE Municipalities - Utilities Section
• Provide assistance and input for members on issues related to municipal utilities and public works operations including electricity, drinking water, wastewater.

official positions on issues, as well as, coordinate their relationship with Senators.[46]

High communication levels also existed between the NSIA and the IDs, the NWRA, the NRDs and the NARD. The NSIA worked "hard" with these agencies to address changes such as modifications to transfer permits and NRD powers over permit issuance (Aucoin, 1984, pp. 79-81; NWRA official, interview, 12 December 2007). Meetings were held on a regular basis and at various events such as the combined NSIA and NWRA Annual Conference (NWDA & NWRA officials, interviews, 14 November and 12 December 2007). Note that high communication levels were also facilitated through membership in other organizations such as with irrigators who were the majority on NRD Board of Directors as previously discussed.

Other high communication levels included those found between the NDWR WAD, the NSIA, the NNRC and the NWDA. Changes to transfer permits and permits within groundwater control and/or management areas were primarily crafted between the NDWR WAD, the NARD and NRDs yet the NSIA played an important part in the process due to industry's vested interest in having sound water resources planning to ensure their long term viability (Little Blue NRD & NWRA officials, interviews, 09 November and 12 December 2007). The NNRC was part of the process given its broader natural resources planning functions (Aucoin, 1984, pp. 87-89). The NWDA was a minor actor in the process yet had a vested interest since most

[46]All Senators typically attended the yearly NARD Legislative Conferences where a reception and dinner was held with NRD/NARD Officials. After dinner, smaller "break out" groups were formed with the Senators to discuss particular issues after which local NRDs met in yet smaller groups with Senators from their area to pursue site specific issues. The practice continues to this day (Interviews with Officials from LBNRD and NARD, 09, 12 November 2007; see also any NARD Legislative Conference program).

of the irrigation occurring in the state at the time used groundwater (Dreeszen, 1993, p. 84). High communication levels also occurred as a result of the NWDA and the NSIA having the same Executive Director (NWDA official, interview, 14 November 2007).

Most other communication levels were low to non-existent. For instance, communication levels between the Attorney General's office and most governance units were low given its narrow legislative and regulatory powers. One exception was the introduction of industrial permits and the increase of NRD regulatory powers over permitting activities, which were difficult to achieve and challenged municipalities' ability to grow. The LNM was "heavily involved" in the aforementioned legislative changes causing it to have a moderate amount of communication with the NARD (Little Blue NRD official, interview, 12 December 2007). It should also be noted that communication levels between the main governance units were also facilitated through the many conferences held throughout the year in the state and discussed at length under well driller regulations.

type and frequency of collaboration

Collaboration levels were moderate to low during this period of time (see Table 6.12). For instance, moderate collaboration occurred between the UN-L C/S Division and most of the main governance units given the Division's role in the research of the state's soil and water resources and involvement in a number of projects that required their expertise such as for the administration of water rights and the development of Groundwater Management Plans for the NRDs. Similar moderate collaboration levels can be found between the NRDs, the NNRC and the NDEC

Table 6.12: Linkage Complementarity Summary, 1980-1987, Water Takings, NE.

	NWDA	DWR WA Div.	Nat. Res. Com	DEC GW Unit	NSIA	Irr. Dis.	UNL C/S Div.	NWRA	Nat. Wat. R.A.	NRD	NARD	AG Off.	L. Gov't	Courts	LNM
Governance Vision (Goals)															
NWDA	---	Low	Low	Low	Mod	Low	Low	Mod	Mod	Low	Low	Low	Low	Low	Low
DWR WA Div.	Low	-----	High	Mod	Mod	Mod	Mod	Mod	Low	Mod	Low	Low	Low	Low	Low
Nat. Res. Comm.	Low	High	-----	Mod	Mod	Mod	Mod	Mod	Low	High	Mod	Low	Low	Low	Low
DEC GW Unit	Low	Mod	Mod	-----	Low	Low	Mod	Low	Low	Mod	Low	Low	Low	Low	Low
NSIA	M	Mod	Mod	Low	-----	High	Low	High	High	Mod	Mod	Low	Low	Low	Low
Irr. Dis.	L	Mod	Mod	Low	High	-----	Low	High	High	Mod	Mod	Low	Low	Low	Low
UN-L C/S Div.	Low	Mod	Mod	Mod	Low	Low	-----	Low	Low	Mod	Low	-nil-	Low	-nil-	Low
NWRA	M	Mod	Mod	Low	High	High	Low	-----	High	Mod	Mod	-nil-	Low	-nil-	Low
NaWRA	M	Low	Low	Low	High	High	Low	High	-----	Mod	Mod	-nil-	Low	-nil-	Low
NRD	L	Mod	High	Mod	Mod	Mod	Mod	Mod	Mod	---	High	Low	Low	-nil-	Low
NARD	L	Low	Mod	Low	Mod	Mod	Low	Mod	Mod	High	---	Low	Low	-nil-	Mod
AG Off.	L	Low	Low	Low	Low	Low	-nil-	-nil-	-nil-	Low	Low	-----	Low	High	Low
L.Gov't	L	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	-----	-nil-	High
Courts	L	Low	Low	Low	Low	Low	-nil-	-nil-	-nil-	-nil-	-nil-	High	-nil-	---	-nil-
LNM	L	Low	Low	Low	Low	Low	Low	Low	Low	Low	Mod	Low	High	-nil-	-----
Communication Level (Meetings, Proposals, Personal Communication)															
NWDA	---	High	Low	High	High	Low	High	Low	Low	Low	Low	Low	Low	-nil-	Low
DWR WA Div.	High	-----	Low	High	High	Mod	High	Mod	Low	Mod	High	Low	Low	Low	Mod
Nat. Res. Comm.	Low	Low	-----	Low	High	Low	Low	Low	Low	Mod	Mod	Low	Low	Low	Low
DEC GW Unit	High	High	Low	-----	Low	Mod	High	Low	-nil-	Mod	Mod	Low	Low	Low	Low
NSIA	H	High	High	Low	-----	High	Mod	High	Low	High	Low	Low	Low	Low	Low
Irr. Dis.	L	Mod	Low	Mod	High	-----	Mod	High	Low	High	Low	Low	Low	Low	Low
UN-L C/S Div.	High	High	Low	High	Mod	Mod	-----	Low	Low	Low	Low	Low	Low	Low	Low
NWRA	L	Mod	Low	Low	High	High	Low	-----	Mod	High	Low	Low	Low	Low	Low

Table 6.12: Linkage Complementarity Summary, 1980-1987, Water Takings, NE (cont'd).

	NWDA	DWR WA Div.	Nat. Res. Com	DEC GW Unit	NSIA	Irr. Dis.	UNL C/S Div.	NWRA	Nat. Wat. R.A.	NRD	NARD	AG Off.	L. Gov't	Courts	LNM
Communication Level (Meetings, Proposals, Personal Communication) (cont'd)															
NaWRA	L	Low	Low	-nil-	Low	Low	Low	Mod	-----	Low	Low	-nil-	Low	-nil-	Low
NRD	L	Mod	Mod	Mod	High	High	Low	High	Low	---	High	Low	Mod	Low	Low
NARD	L	High	Mod	Mod	Low	Low	Low	Low	Low	High	---	Low	Low	Low	Mod
AG Off.	L	Low	Low	Low	Low	Low	Low	Low	-nil-	Low	Low	-----	Low	Low	Low
L. Gov't	L	Low	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	-----	Low	High
Courts	nil	Low	Low	Low	Low	Low	Low	Low	-nil-	Low	Low	Low	Low	---	Low
LNM	L	Mod	Low	Low	Low	Low	Low	Low	Low	Low	Mod	Low	High	Low	-----
Frequency and Type of Collaboration															
NWDA	---	Mod	Low	Low	Low	-nil-	High	Low	-nil-	Low	-nil-	-nil-	-nil-	-nil-	-nil-
DWR WA Div.	Mod	-----	Mod	Low	Mod	Low	Mod	Low	-nil-	Mod	-nil-	-nil-	Low	-nil-	-nil-
Nat. Res. Comm.	Low	Mod	-----	Mod	Low	Low	Mod	Low	-nil-	Mod	Mod	-nil-	Low	-nil-	-nil-
DEC GW Unit	Low	Low	Mod	-----	Low	Low	Mod	Low	-nil-	Mod	Low	-nil-	Low	-nil-	-nil-
NSIA	L	Mod	Low	Low	-----	Mod	Low	Mod	Low	Low	Low	-nil-	-nil-	-nil-	-nil-
Irr. Dis.	nil	Low	Low	Low	Mod	-----	Low	Low	Low	Low	Low	-nil-	Low	-nil-	Low
UN-L C/S Div.	High	Mod	Mod	Mod	Low	Low	-----	Low	-nil-	Mod	Low	-nil-	Low	-nil-	-nil-
NWRA	L	Low	Low	Low	Mod	Low	Low	-----	Low	Low	-nil-	-nil-	Low	-nil-	-nil-
NaWRA	nil	-nil-	-nil-	-nil-	Low	Low	-nil-	Low	-----	Low	Low	-nil-	-nil-	-nil-	-nil-
NRD	L	Mod	Mod	Mod	Low	Low	Mod	Low	Low	---	High	-nil-	Low	-nil-	-nil-
NARD	nil	-nil-	Mod	Low	Low	Low	Low	-nil-	Low	High	---	-nil-	-nil-	-nil-	-nil-
AG Off.	nil	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-----	-nil-	-nil-	-nil-
L. Gov't	nil	Low	Low	Low	-nil-	Low	Low	Low	-nil-	Low	-nil-	-nil-	-----	-nil-	High
Courts	nil	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	---	-nil-
LNM	nil	-nil-	-nil-	-nil-	-nil-	Low	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	High	-nil-	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil; For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

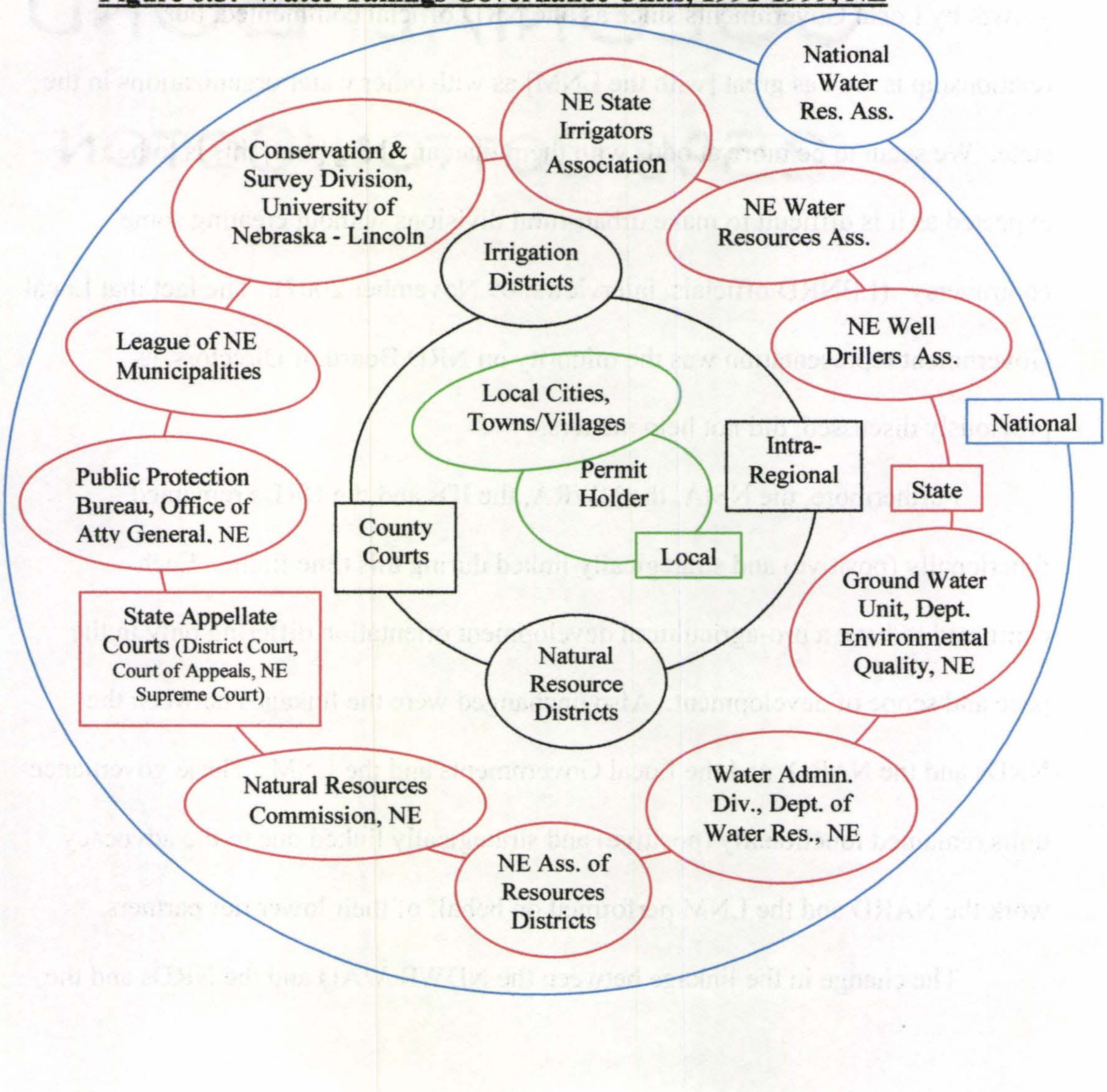
GWU in relation to the review of Groundwater Management Plans and the decommissioning of water wells among other things (e.g. Little Blue NRD, 1986; Goeke, 1983; Hanson, 1983; LBNRD & UN-L C/S Division officials, interviews, 09, 16 November 2007). Contributing to these moderate collaboration levels was the work done to organize and manage the many conferences held every year as noted by the joint efforts between the UN-L C/S Division and the NWDA and the NSIA and the NWRA previously discussed.

Collaboration between the adjudication units and the other governance units was non-existent which is not unusual given the narrow functions of the adjudication units. Furthermore, closely related governance units such as Local Governments and the LNM, the NRDs and the NARD had high levels of collaboration. This was due to their interrelated functions which drew on each other's resources. Other sporadic collaborative efforts existed that lends support to the low collaborative efforts between many of the governance units such as the proposed irrigation project in the Upper Big Blue NRD to extend the life of the local aquifers (Aucoin, 1984, pp. 97-98).

6.3.2a 1991-1999: Number of Governance Units

No changes occurred in governance units during this period as shown in Figure 6.5 though the Department of Environmental Control was renamed the Department of Environmental Quality to better reflect its broad environmental protection activities. As in the last period, eighteen governance units dispersed over four vertical governance levels were active at this time. This included one local, three intra-regional, thirteen state and one national level horizontal governance units.

Figure 6.5: Water Takings Governance Units, 1991-1999, NE



6.3.2b 1991-1999: Types of Linkages

Only one change in the linkages occurred during this time frame, which is discussed below (a linkage summary table is not repeated here due to the lack of changes that occurred). The LNM remained functionally and negatively linked to both the NRDs and the NARD due to the latter's increased powers in relation to permit issuance such as for industrial water withdrawal and for water well modifications. Both measures were seen to have a negative impact on economic growth by Local Governments since as one NRD official commented, our relationship is "not as great [with the LNM] as with other water organizations in the state. We seem to be more at odds with them than anything [and] this is to be expected as it is difficult to make urban-rural divisions without creating some controversy" (LBNRD officials, interviews, 09 November 2007). The fact that Local Government representation was the minority on NRD Board of Directors, as previously discussed, did not help matters.

Furthermore, the NSIA, the NWRA, the IDs and the NRDs remained functionally (positive) and strategically linked during this time frame. Each continued to have a pro-agricultural development orientation differing only in the pace and scope of development. Also unchanged were the linkages between the NRDs and the NARD, and the Local Governments and the LNM. These governance units remained functionally (positive) and strategically linked due to the advocacy work the NARD and the LNM performed on behalf of their lower tier partners.

The change in the linkage between the NDWR WAD and the NRDs and the

NARD to one that was functionally positive and strategic (the negative functionality largely disappeared) was significant. This was largely due to the fact that efforts at legislative change were directed at addressing deficiencies (e.g. own property industrial transfers) in existing legislation and not at trying to enact a new management program such as was the case with the previous industrial permits legislation (NDWR official, interview, 16 November 2007).

6.3.2c 1991-1999: Complementarity of Linkages

governance vision (goals)

Due to the fact no changes in goals for the governance units occurred for the current period, the reader is referred to Table 6.11 in the previous time frame to examine each governance unit's goals. The data and analysis of that data in section 6.3.1c above applies equally for this period and is not repeated here. Likewise, goal similarities are summarized in Table 6.12 in the previous section.

communication level (meetings, proposals, personal communication)

Communication levels decreased slightly for the main governance units while remaining virtually identical for the others during this period, as summarized in Table 6.13, and may be attributed to the refinement of the existing legislative framework rather than the introduction of a new element. The NDWR WAD had low communication levels with the NSIA, the IDs, the NWRA and the NARD (moderate). Few meetings were held on a yearly basis except with the NARD which continued to lead the push for legislative change. Rather, much more was accomplished through other activities such as the continued administration of water rights and larger planning activities which allowed ample opportunity to discuss permitting changes.

Communication levels between each of the NSIA, IDs, NWRA and the NRDs decreased due to the "funnelling" of communications through the NRDs and the NARD. Furthermore, most of the communication between the governance units was facilitated through cross membership; many NRD Managers sat on the Board of Directors of the other organizations and the majority of Directors on the individual NRD Boards continued to be from the agricultural community, namely irrigators, as previously discussed. Communication levels between the NSIA, the IDs and the NWRA largely remained the same which was also facilitated through cross membership, as well as, the yearly joint development of policy such as was the case between the NSIA and the NWRA (LBNRD & CPNRD officials, interviews, 09 November and 12 December 2007).

Also of note were the non-existent communication levels between the NaWRA and the NRDs and the NARD which reflected the NWRA's desire for an increased role in relation to these governance units. The NaWRA only became involved in state affairs at the discretion of the state association (NWRA; NaWRA official, interview, 12 December 2007). The continued "negative" relationship between many Local Governments and the NRDs who increased their regulatory powers in relation to both industrial permits and to control/management area water permits is also significant. It is this negative relationship between the two that contributed to increased communication levels between Local Governments and the LNM (LNM official, interview, 13 December 2007).

type and frequency of collaboration

Table 6.13: Linkage Complementarity Summary, 1991-1999, Water Takings, NE.

	N W DA	DWR WA Div.	Nat. Res. Com	DEC/ Q GW Unit	NS IA	Irr. Dis.	UNL C/S Div.	NE Wat. R.A.	Nat. Wat. R.A.	N R D	NA RD	AG Off.	L. Gov' t	Cou rts	L N M
Communication Level (Meetings, Proposals, Personal Communication)															
NWDA	---	High	Low	High	High	Low	High	Low	Low	Low	Low	Low	Low	-nil-	Low
DWR WA Div.	Hi gh	-----	Low	Mod	Low	Low	Mod	Low	-nil-	Mod	Mod	Low	Low	Low	Mod
Nat. Res. Comm.	Lo w	Low	-----	Low	Low	Low	Low	Low	-nil-	Mod	Mod	Low	Low	Low	Low
DEC/Q GW Unit	Hi gh	Mod	Low	-----	Low	Low	High	Low	-nil-	Mod	Mod	Low	Low	Low	Low
NSIA	H	Low	Low	Low	-----	High	Mod	High	Low	Mod	Low	Low	Low	Low	Low
Irr. Dis.	L	Low	Low	Low	High	-----	Mod	Mod	Low	Mod	Low	Low	Low	Low	Low
UN-L C/S Div.	Hi gh	Mod	Low	High	Mod	Mod	-----	Mod	Low	Low	Low	Low	Low	Low	Low
NE Wat. R. A.	Lo w	Low	Low	Low	High	Mod	Mod	-----	Mod	Mod	Low	Low	Low	Low	Low
Nat. Wat. R. A.	Lo w	-nil-	-nil-	-nil-	Low	Low	Low	Mod	-----	-nil-	-nil-	-nil-	Low	-nil-	Low
NRD	L	Mod	Mod	Mod	High	Mod	Low	Mod	-nil-	---	High	Low	Mod	Low	Mod
NARD	L	Mod	Mod	Mod	Low	Low	Low	Low	-nil-	High	---	Low	Low	Low	Mod
AG Off.	L	Low	Low	Low	Low	Low	Low	Low	-nil-	Low	Low	-----	Low	Low	Low
L. Gov't	L	Low	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	-----	Low	High
Courts	nil	Low	Low	Low	Low	Low	Low	Low	-nil-	Low	Low	Low	Low	---	Low
LNM	L	Mod	Low	Low	Low	Low	Low	Low	Low	Mod	Mod	Low	High	Low	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

Collaboration levels were unchanged for the period except for collaboration levels between the NDWR WAD and the NDEC/Q GWU discussed below (refer to Table 6.12 in the previous section). Overall collaboration levels were moderate to low. An increase in collaboration levels occurred between the NDWR WAD and the NDEQ GWU due to their continued role, for instance, in the review of Groundwater Management Area designations which increased significantly during the period and in other projects such as the Lower Platte River Corridor Alliance, which included other agencies such as the NNRC, NRDs and the UN-L C/S Division (NDEQ, 1998; *Nebraska Resources*, 1997, pp. 1-3; NDWR official (retired), interview, 16 November 2007). The NDEQ and the NRDs also collaborated in relation to enforcement proceedings in regards to environmental protection issues such as agricultural livestock waste (e.g. NDEQ, 1997).

Other collaboration levels remained unchanged. For instance, the NDWR WAD, the NNRC and the UN-L C/S Division continued to have moderate levels of collaboration as noted by their involvement in data integration and digitalizing projects for water well registrations and soil surveys (*Nebraska Resources*, 1999, pp. 1, 5; UN-L C/S Division & NDNR officials, interviews, 15, 16 November 2007). Each of the above governance units, as well as, the NDEC/Q GWU collaboration levels also increased due to their contributions to the development of both the WHP and SWA Programs and related protection plans (e.g. NDEC, 1991; NDEQ, 1999). Collaboration also continued between the governance units in relation to conference proceedings as previously noted.

6.3.3a Post-2000: Number of Governance Units

Nineteen governance units impacted water takings post-2000 as shown in Figure 6.6. This included four vertical governance levels and one local, three intra-regional, fourteen state and one national level horizontal governance units.

These are the same governance units that were present in the previous periods with the addition of the Nebraska Game and Parks Commission (NGPC) and the fact that the former NDWR and the NNRC were consolidated into one unit, the NDNR. The NGPC is charged with oversight, protection and maintenance functions in regards to the State's wildlife, fish, parks and outdoor recreation areas (NGPC, n.d.). Their entry into the permitting changes was largely a result of their participation in events that led to the passage of Legislative Bill (LB) 962 which addressed the hydrological connections between surface water and groundwater in 2004 (NDNR officials, interviews, 15 November 2007). The significant use of groundwater for irrigation led to decreased levels of surface water in rivers and streams much to the dismay of surface water irrigators (e.g. Bleed, 2006, p. 2; NDNR, 2003; NDEQ, 2005, pp. 3-4; UN-L C/S Division, 1998, pp. 32-34). The NGPC enters the equation since decreased river levels threaten the survival of plant and animal species, especially endangered species and, by 2005, endangered species restrictions in several of the State's river basins had been issued (NDNR, 2007). A potentially volatile conflict exists between irrigation interests, municipalities and both the NDNR and the NGPC since economic growth may be impacted. In effect, LB 962 mandated the consideration of adverse environmental and cumulative effects in permit applications and necessitated the need to develop Integrated Management Plans (NDNR, 2007).

Other changes of note included the formation of the Water Policy Task Force to investigate surface water and groundwater interactions and make recommendations to the Legislature which led to LB 962 above. Membership on the task force was broad with the majority of members being irrigators themselves as shown in Figure 6.6 (NDNR, June 2005; Water Policy Task Force, n.d.).

6.3.3b Post-2000: Types of Linkages

Water takings linkages between governance units are summarized in Table 6.14. Few linkage types changed as a result of the new governance units' entry and most of the changes that did occur involved the NDNR WAD. The functional element of the linkages between the NDNR and the NSIA, the IDs, the NWRA and the NWDA all became negative and/or positive (previously positive only) due to the issue of integrated management of surface water and groundwater. The NDNR, for instance, gained powers to declare basins overappropriated and/or fully appropriated which negatively affected water users in general but especially irrigators. It also rendered the relationship between the NDNR WAD and the NWDA functionally neutral due to the negative impact of moratoriums on well drilling. The erosion of the positive linkages was noted by one NDNR official who declared "everybody hates us but we are used to that now" (NDNR official, interview, 15 November 2007).

Linkages with the new governance units were mixed. The NGPC, for instance, had functionally negative linkages with most other governance units. This is not surprising given the needed environmental considerations for fish and wildlife and

Figure 6.6: Water Takings Governance Units, Post-2000, NE

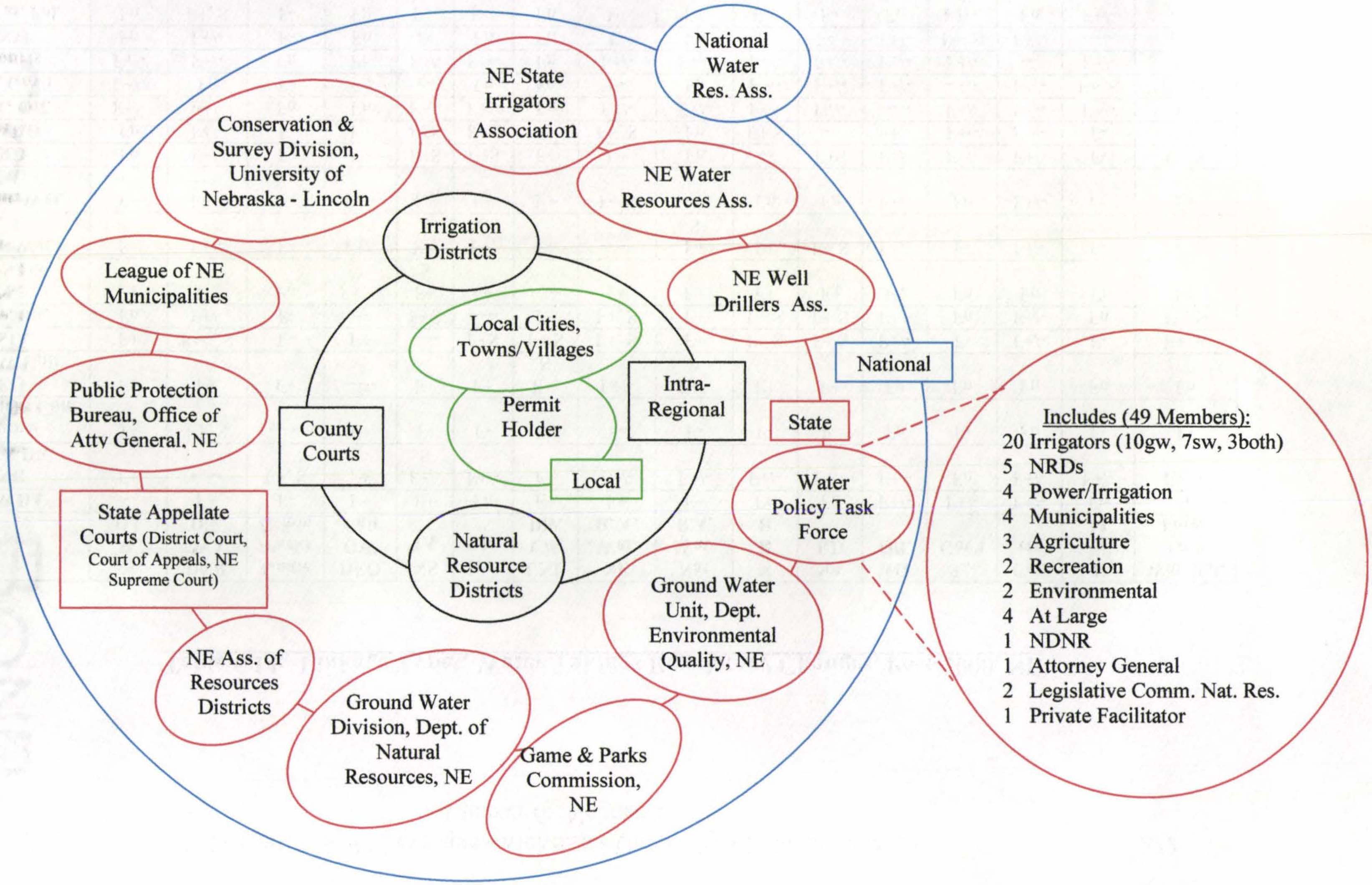


Table 6.14: Linkage Types, Water Takings Regulatory Changes, Post-2000, NE

	N W DA	DNR WA Div.	Game /Parks Comm	DEQ GW Unit	NS IA	Irr. Dis.	UNL C/S Div.	NE Wat. R. A.	Nat Wat. R.A.	N R D	NA RD	AG Off.	L. Gov't	Cou rts	L N M	Wat. Pol. Task Force
NWDA	---	F+	F-	F+	F+	Fn	F+	F+	F+	Fn	Fn	F+/-	F+/-	F+/-	Fn	Fn
DNR WA Div.	F+	-----	F+, S	F+	F+/- S	F+/-	F+	F+/-	F+/-	F+/-	F+/-	F+/-	Fn	F+/-	F+/-	F+, S
Game/ Parks Com	F-	F+, S	-----	F+	F-	F-	Fn	F-	F-	F-	F-	Fn	F-	Fn	F-	F-
DEQ GW Unit	F+	F+	F+	-----	F+	F+	F+, S	F+/-	F+/-	F+	F+	Fn	Fn	Fn	Fn	Fn
NSIA.	F+	F+/-, S	F-	F+	-----	F+S	F+ S	F+, S	F+	F+ S	F+ S	F+/-	F-	F+/-	F-	F+, S
Irr. Dis.	Fn	F+/-	F-	F+	F+S	-----	F+	F+, S	F+	F+ S	F+ S	F+/-	Fn	F+/-	Fn	F+, S
UN-L C/S Div.	F+	F+	Fn	F+, S	F+ S	F+	-----	F+	F+	F+	F+	Fn	Fn	Fn	Fn	Fn
NE Wat. R. A.	F+	F+/-	F-	F+/-	F+, S	F+, S	F+	-----	F+ S	F+	F+ S	F+/-	F-	F+/-	F-	F+
Nat. Wat. R. A.	F+	F+/-	F-	F+/-	F+	F+	F+	F+ S	---	Fn	Fn	F+/-	Fn	F+/-	Fn	F+
NRD	Fn	F+/-	F-	F+	F+S	F+S	F+	F+	Fn	---	F+S	F+/-	F+/-	F+/-	F-	F+, S
NARD	Fn	F+/-	F-	F+	F+S	F+S	F+	F+, S	Fn	F+ S	---	F+/-	F+/-	F+/-	F-	F+
AG Off.	F+/-	F+/-	Fn	Fn	F+/-	F+/-	Fn	F+/-	F+/-	F+/-	F+/-	-----	F+/-	F+/-	F+/-	Fn
L. Gov't	F+/-	Fn	F-	Fn	F-	Fn	Fn	F-	Fn	F+/-	F+/-	F+/-	-----	F+/-	F+, S	F+/-,S
Courts	F+/-	F+/-	Fn	Fn	F+/-	F+/-	Fn	F+/-	F+/-	F+/-	F+/-	F+/-	F+/-	---	F+/-	Fn
LNM	Fn	F+/-	F-	Fn	F-	Fn	Fn	F-	Fn	F-	F-	F+/-	F+, S	F+/-	-----	F+/-
Wat. Pol. Task Force	Fn	F+, S	F-	Fn	F+, S	F+, S	Fn	F+	F+	F+, S	F+	Fn	F+/-, S	Fn	F+/-	-----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

especially endangered species such as the pallid sturgeon; to ensure adequate stream flow necessarily meant the specific allocation of water for environmental purposes (NDNR, n.d.-a; Gaul, 1999, p. 1). Most water organizations, such as the NSIA, IDs, the NRDs, and municipalities questioned such allocations and argued that it limited economic growth. This is not necessarily so since provisions were included for growth as long as any new water requirements were offset by the retirement of other water uses (NDNR officials, interviews, 15 November 2007). The NGPC also had a functionally positive relationship with the NDNR WAD and the NDEQ GWD given its similar broad environmental planning activities. The linkage between the NDNR WAD and the NGPC was also strategic in that the NGPC had to be consulted for environmental considerations in regards to endangered species (NDNR official, interview, 15 November 2007). The NGPC also had a functionally positive linkage with the UN-L C/S Division given the latter's fish and wildlife stewardship activities and the University's research interests (e.g. Ress, 2000; Snook, 2001; Swigle, 2003).

The linkage between the WPTF and other governance units was mixed. For instance, functionally positive and strategic linkages existed between them and the NDNR WAD, the NSIA, the IDs, the NWRA and Local Governments. This was both due to representation on the WPTF and its work towards a solution to the problem of groundwater withdrawals depleting streamflows. However, note should also be made of the functionally negative relationship between the WPTF and the NGPC largely due to the high representation of irrigators on the WPTF (almost half) and the fact the NGPC had no seat at the table. Linkages between the WPTF and most other governance units were functionally neutral owing to similar activities that neither contributed positively and/or negatively to the issues at hand. This can be seen in the linkage between the WPTF and the Attorney General's Office and in the linkage with the UN-L C/S Division.

6.3.3c Post-2000: Complementarity of Linkages

governance vision (goals)

The goals of each new governance unit are shown in table 6.15 (refer to Table 6.11 for the goals of the existing governance units) and similarities in goals are summarized in Table 6.16. Changes in governance vision similarities occurred in relation to the introduction of the new governance units. Goal similarities between the NGPC and the major water user interests, that is, the NWDA, the NSIA, the IDs, the NWRA and the NaWRA were non-existent. The NGPC goals were centered on wildlife protection and enhancement while the major water users' goals largely centred on the further development of the state's water resources.

Table 6.15: Goals of *New* Governance Units, Water Takings, Post-2000, NE

NE Game and Parks Commission
• Stewardship of NE's fish, wildlife, park and outdoor recreation resources; • Achieved through various programs including administration of endangered species legislation.
Water Policy Task Force
• Advisory body to legislature re integrated management of surface water and groundwater; • Study issue and make recommendations for a course of action to follow.

Other goal similarities between the NGPC and the other governance units were low. For instance, the NDEQ's focus on groundwater planning, remediation, and standards had little similarity to the NGPC's fish and wildlife focus other than the NGPC protection activities depended on having an adequate supply of good quality water including groundwater to keep streams flowing sufficiently. The same situation applied in relation to the NDNR WAD and the NGPC in that the former had a narrower focus on water allocation and administration. While permit reviewing functions contribute to a moderate goal similarity, the actual similarity is classified as "low" due to the fact permit issues were but one part of a much broader goal structure for each governance unit.

Goal similarities in relation to the WPTF are mixed. A moderate goal similarity existed between it and the NRD, the NARD, the NSIA, the IDs and the NDEQ GWU. The main issue in relation to the WPTF was how to proceed in light of the negative effects groundwater pumping was having on stream flows which was a groundwater planning function. Note, however, the high goal similarity between the NDNR WAD and the WPTF due to the NDNR's role in water rights administration. How much should groundwater pumping be restricted to allow for environmental protection and to give surface water users (e.g. irrigators) the ability to exercise their water rights? These were basic water rights issues and it was hoped that the examination of the issue through the WPTF would help diffuse the volatility of the situation (NDNR official, interview, 15 November 2007). Other goal similarities between the WPTF and other governance units were typically low due to either broader and/or simply different mandates.

communication level (meetings, proposals, personal communication)

Communication levels increased between the main governance units and were mixed overall in regards to the two new governance units as illustrated in Table 6.16. The NGPC, for instance, had moderate communication levels with the NDNR WAD, the NDEQ GWU and the NRDs as indicated in the requirement by NDNR to consult with them on water permit applications and NRD Groundwater Management Plans, environmental rehabilitation issues and the establishment and maintenance of several outdoor recreation projects (France, 2001, p. 1; Zimmerman, 2007, p. 3; NDEQ & NDNR officials, interviews, 14, 15 November 2007). Low communication levels existed between the NGPC and most other governance units such as the UN-L C/S Division where communication was largely geared towards either water rights issues or the securing of new or upgrading of existing water supplies and sewage systems at NGPC managed State parks (UN-L C/S Division official, interview, 16 November 2007). The NGPC also had low communication levels with the WPTF with no official representation on the task force though it did present its concerns to WPTF (e.g. Gabelhouse, 2002).

In regards to other governance units, the WPTF had moderate or high communication levels with most of them. For instance, the NDNR, the NRDs, the NARD and the Attorney General's Office all had high communication levels with the WPTF. Each governance unit had direct membership in the task force which, as of 2006, had met a total of sixteen times as a full body with the Executive Committee having met twenty five times between 2002-2005 (WPTF, n.d.; WPTF, 2002-2007) which was in addition to the many informal discussions held outside of the meetings (NDNR & LNM officials, interviews, 15 November and 13 December 2007 respectively). The NSIA, IDs, the NWRA and the LNM all had moderate communication levels with the WPTF as evidenced by the fact that none of these governance bodies had direct membership in the task force. However, these associations were indirectly represented since twenty irrigators were members of the WPTF. In short, cross membership facilitated many of the communication exchanges. The situation is similar with the LNM in that it had the power to suggest five representatives for membership, including one for itself, on the WPTF and also had the opportunity to formally present its concerns (Volger, 2002, p. 1; Huggenberger, 2002).

High communication levels also existed between the Attorney General's Office in relation to the NDNR WAD and the LNM. This was largely a result of the extensive involvement in the writing of legislation brought on by the work in the WPTF, as well as, the continued heavy involvement in litigation activities (e.g. North Platte Settlement) previously discussed. The three governance units were also intimately involved in legislative revisions that exempted municipalities until 2026 from having to comply with groundwater withdrawal restrictions in areas that were deemed fully and/or overappropriated under certain conditions (Diers, 2006, p. 2; LNM official, inteview, 13 December 2007).

The NDNR WAD had high communication levels with most governance units given the fact that most changes centered on its core governance functions of water rights administration. In addition to the above communication levels and projects, the NDNR WAD was also involved with the UN-L C/S Division in the review of groundwater and integrated management plans in conjunction with the NRDs. This was in addition to its participation in the Lower Platte River Corridor Alliance and the

Platte River Cooperative Hydrology Study (COHYST) previously discussed (Gaul, 1999, p. 1; Williamson, 1999, pp. 3-4). Communication levels in regards to the NDNR were also facilitated with most governance units through its quarterly publication *Nebraska Resources* which serves as a conduit between it, the public and other agencies by providing updates on various activities the NDNR and its partners are involved in (see any issue of *Nebraska Resources*). All conferences and communication patterns, previously discussed, continued throughout this time frame.

type and frequency of collaboration

Collaboration levels remained largely unchanged for the period as shown in Table 6.16 and any changes largely reflected the addition of the new governance units. High collaboration levels existed between the NDNR WAD and the UN-L C/S Division, the NRDs, the NARD, the Attorney General's Office and the WPTF. This is seen in, for instance, the joint review of Groundwater and Integrated Management Plans, the participation in the Lower Platte River Corridor Alliance and the digitalization of soil surveys (*Nebraska Resources*, 2004, pp. 1-5; Gaul, 1999, p. 1; Williamson, 1999, pp. 3-4; France, 2001, p. 5; Vanek, 2003, p. 4; Starr, 2005, p. 1). Note that the NRDs were a party to all of these collaborative efforts, in the Platte River Cooperative Hydrology Study (COHYST) and in the administration of the Republican River Litigation Settlement (Starr, 2005, p. 1; Gaul, 1999, p. 1). This is in addition to the active participation of the NDNR and the NRDs in the WPTF.

Collaboration levels between the NGPC and the other governance units were low to non-existent except in relation to the UN-L C/S Division and the NRDs. This

Table 6.16: Linkage Complementarity Summary, Post-2000, Water Takings, NE.

	N W DA	DNR WA Div.	Game /Parks Com.	DEQ GW Unit	NS IA	Irr. Dis.	UNL C/S Div.	NE Wat. R.A.	Nat Wat R.A.	N R D	NA RD	AG Off.	L. Govt	Cou rts	L N M	Wat.Pol. Task Force
Governance Vision (Goals)																
NWDA	-----	Low	-nil-	Low	Mod	Low	Low	Mod	Mod	Low	Low	Low	Low	Low	Low	Low
DNRWADiv	Low	-----	Low	Mod	Mod	Mod	Mod	Mod	Low	Mod	Low	Low	Low	Low	Low	High
Game /Parks Com.	-nil-	Low	-----	Mod	-nil-	-nil-	Low	-nil-	-nil-	Low	Low	Low	-nil-	-nil-	-nil-	Low
DEQGWU	Low	Mod	Mod	-----	Low	Low	Mod	Low	Low	Mod	Low	Low	Low	Low	Low	Mod
NSIA	Mod	Mod	-nil-	Low	-----	High	Low	High	High	Mod	Mod	Low	Low	Low	Low	Mod
Irr. Dis.	Low	Mod	-nil-	Low	High	-----	Low	High	High	Mod	Mod	Low	Low	Low	Low	Mod
UN-L C/S Div.	Low	Mod	Low	Mod	Low	Low	-----	Low	Low	Mod	Low	-nil-	Low	-nil-	Low	Low
NEWat R.A.	Mod	Mod	-nil-	Low	High	High	Low	-----	High	Mod	Mod	-nil-	Low	-nil-	Low	Low
NatWatR.A.	Mod	Low	-nil-	Low	High	High	Low	High	-----	Mod	Mod	-nil-	Low	-nil-	Low	Low
NRD	L	Mod	Low	Mod	Mod	Mod	Mod	Mod	Mod	-----	High	Low	Low	-nil-	Low	Mod
NARD	L	Low	Low	Low	Mod	Mod	Low	Mod	Mod	High	-----	Low	Low	-nil-	Mod	Mod
AG Off.	Low	Low	Low	Low	Low	Low	-nil-	-nil-	-nil-	Low	Low	-----	Low	High	Low	Low
L. Gov't	Low	Low	-nil-	Low	Low	Low	Low	Low	Low	Low	Low	Low	-----	-nil-	High	Low
Courts	L	Low	-nil-	Low	Low	Low	-nil-	-nil-	-nil-	-nil-	-nil-	High	-nil-	-----	-nil-	-nil-
LNM	Low	Low	-nil-	Low	Low	Low	Low	Low	Low	Low	Mod	Low	High	-nil-	-----	Low
Wat. Pol. Task Force	Low	High	Low	Mod	Mod	Mod	Low	Low	Low	Mod	Mod	Low	Low	-nil-	Low	-----
Communication Level (Meetings, Proposals, Personal Communication)																
NWDA	-----	High	Low	High	High	Low	High	Low	Low	Low	Low	Low	Low	-nil-	Low	Low
DNRWADiv	High	-----	Mod	High	High	High	High	Mod	Low	High	High	High	Mod	Mod	High	High
Game /Parks Com.	Low	Mod	-----	Mod	Low	Low	Low	Low	-nil-	Mod	Low	Low	Low	-nil-	Low	Low
DEQGWU	High	High	Mod	-----	Low	Mod	High	Low	-nil-	Mod	Mod	Low	Low	Low	High	Low
NSIA	High	High	Low	Low	-----	High	Mod	High	Low	High	Low	Mod	Low	-nil-	Low	Mod
Irr. Dis.	Low	High	Low	Mod	High	-----	Mod	High	Low	High	Low	Mod	Low	Low	Low	Mod
UN-L C/S Div.	High	High	Low	High	Mod	Mod	-----	Mod	Low	High	Mod	Low	Low	Low	Low	Low
NEWat R.A.	Low	Mod	Low	Low	High	High	Mod	-----	Mod	Mod	Low	Low	Low	Low	Low	Mod

Table 6.16: Linkage Complementarity Summary, Post-2000, Water Takings, NE (cont'd).

	N W DA	DNR WA Div.	Game /Parks Com.	DEQ GW Unit	NS IA	Irr. Dis.	UNL C/S Div.	NE Wat. R.A.	Nat Wat R.A.	N R D	NA RD	AG Off.	L. Govt	Cou rts	L N M	Wat.Ppl. Task Force
Communication Level (Meetings, Proposals, Personal Communication) (cont'd)																
NatWatR.A.	Low	Low	-nil-	-nil-	Low	Low	Low	Mod	-----	Low	Low	-nil-	Low	-nil-	Low	-nil-
NRD	L	High	Mod	Mod	H	High	High	Mod	Low	-----	High	Low	Mod	Low	High	High
NARD	L	High	Low	Mod	Low	Low	Mod	Low	Low	High	-----	Low	Low	Low	High	High
AG Off.	Low	High	Low	Low	Mod	Mod	Low	Low	-nil-	Low	Low	-----	Mod	Low	High	High
L. Gov't	Low	Mod	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Mod	-----	Low	High	High
Courts	nil	Mod	-nil-	Low	-nil-	Low	Low	Low	-nil-	Low	Low	Low	Low	-----	Low	-nil-
LNM	Low	High	Low	High	Low	Low	Low	Low	Low	High	High	High	High	Low	-----	High
Wat. Pol. Task Force	Low	High	Low	Low	Mod	Mod	Low	Mod	-nil-	High	High	High	High	-nil-	High	-----
Frequency and Type of Collaboration																
NWDA	-----	Low	-nil-	Low	Low	-nil-	High	Low	-nil-	Low	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-
DNRWAD	Low	-----	Mod	Mod	Mod	Low	High	Low	-nil-	High	High	High	Low	Mod	Low	High
Game /Parks Com.	-nil-	Mod	-----	Low	Low	Low	Mod	Low	-nil-	Mod	-nil-	-nil-	Low	-nil-	-nil-	Low
DEQGWU	Low	Mod	Low	-----	Low	Low	Mod	Low	-nil-	High	High	-nil-	Low	-nil-	-nil-	Low
NSIA	Low	Mod	Low	Low	-----	Mod	Low	Mod	Low	Low	Low	-nil-	-nil-	-nil-	-nil-	Low
Irr. Dis.	-nil-	Low	Low	Low	Mod	-----	Low	Low	-nil-	Low	Low	-nil-	Low	-nil-	Low	Low
UN-L C/S Div.	High	High	Mod	Mod	Low	Low	-----	Low	-nil-	Mod	Low	-nil-	Low	-nil-	-nil-	Low
NEWat R.A.	Low	Low	Low	Low	Mod	Low	Low	-----	Low	Low	-nil-	-nil-	Low	-nil-	-nil-	Low
NatWatR.A.	-nil-	-nil-	-nil-	-nil-	Low	-nil-	-nil-	Low	-----	Low	-nil-	-nil-	-nil-	-nil-	-nil-	Low
NRD	L	High	Mod	High	Low	Low	Mod	Low	Low	-----	High	Mod	Low	-nil-	Low	Mod
NARD	-nil-	High	-nil-	High	Low	Low	Low	-nil-	-nil-	High	-----	Mod	-nil-	-nil-	Low	Low
AG Off.	-nil-	High	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	Mod	Mod	-----	-nil-	-nil-	Mod	Mod
L. Gov't	-nil-	Low	Low	Low	-nil-	Low	Low	Low	-nil-	Low	-nil-	-nil-	-----	-nil-	High	Mod
Courts	-nil-	Mod	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-nil-	-----	-nil-	-nil-
LNM	-nil-	Low	-nil-	-nil-	-nil-	Low	-nil-	-nil-	-nil-	Low	Low	Mod	High	-nil-	-----	Low
WPTF	-nil-	High	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Mod	Mod	-nil-	Low	-----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

was due to their participation in water rights issues involving the Platte and Republican Rivers, work in the Lower Platte River Corridor Alliance and in outdoor recreation projects (e.g. Lone Star Recreation Project; Zimmerman, 2007, p. 3).

Other collaboration levels were mixed. For instance, collaboration levels were high between the NRDs, the NARD and the NDEQ GWU due to their involvement in wellhead protection and source water protection planning (to be discussed in the next section), as well as, in monitoring and reporting on the state's groundwater quality on a yearly basis (NDEQ, 1991, 1999, 2005). Collaboration levels between the courts and all governance units were non-existent except for with the NDNR WAD due to litigation previously discussed. Similarly, the NaWRA had little involvement in the state during this period as the state branch, the NWRA, was leading most activities (NaWRA official, interview, 12 December 2007).

6.3.4 Preliminary Findings: Water Takings and Organizational Environment

Statewide water takings legislation and regulations have long existed in Nebraska and its continued evolution has been traced from 1980 to 2007. Most of the changes that occurred were in terms of policy instrument settings (with the exception of industrial water permits). For instance, changes in groundwater transfer permits included greater specificity in its application (i.e. which states permits applied to) in the first time frame to the delegation of regulatory powers for groundwater transportation and in permit considerations (e.g. interstate compacts, environmental effects) in subsequent time periods. A similar situation occurred for municipal water permits in regards to greater specificity in public notification procedures. Moreover and of note is the delegation of permit application evaluations and reviews to the NRDs which included increased NRD powers to enact more restrictive groundwater regulations through the establishment of Groundwater Management Areas.

The organizational environment surrounding water takings legislative and regulatory changes reveals a dense network of inter-organizational activity. Of significance were the roles the NDWR (the NDNR in the last time frame) and the NRDs had throughout all time frames in the lead up to and implementation of the policy changes. Similarly, the UN-L C/S Division, the NNRC and the NDEC/Q each had large and important supportive roles in either the provision of scientific information, the assessment of permit applications and/or infrastructure provision (e.g. data management). These bi-lateral relationships gave way to a multilateral one in the last time frame with the creation of the Water Policy Task Force to address, among other things, the need to endogenize environmental considerations in permit applications (e.g. for endangered species). This pattern of using multilateral forums to address controversial issues is not new to Nebraskans as the examination of source protection planning reveals in the next section.

6.4 Source Water Protection Independent Variable Summary

The effects of nested institutional arrangements on source protection activities are examined from 1986-94. The number of governance units, linkage types and complementarity of linkages are assessed to reveal their effects on the type, frequency and magnitude of groundwater policy change.

6.4.1a 1986-1994: Number of Governance Units

Eighteen governance units, as shown in Figure 6.7, were active at this time. This included five vertical governance units (local, intra-regional, state, inter-regional, national) and one local, three intra-regional, nine state, one inter-regional and four national level horizontal governance units.

6.4.1b 1986-1994: Types of Linkages

Two processes were at work simultaneously during this time frame; the first in relation to the 1986 Safe Drinking Water Act (SDWA) changes which, among other things, initiated state wellhead protection programs and was largely a federal endeavour, and the second being the actual creation of state wellhead protection programs and local wellhead protection plans (WHPPs) which occurred at the state and local levels. The two processes overlapped and linkage types are summarized in Table 6.17. Federal level linkages were identical to those for New York and are not repeated here though the reader is referred to Section 5.4.1b for an overview.

Other federally related linkages were mixed. The USEPA DWD had functionally positive and strategic linkages with the USEPA Region 7 Office due to the fact EPA programs were delivered through its regional offices. The USEPA

DWD also had functionally positive linkages with the NDEC GWU, the NDWR GWD and the NDOH EHD given their respective roles in wellhead protection, broader water planning issues and drinking water operations. The USEPA's Region 7 Office was functionally linked to the NDEC GWU and the NDOH EHD though whether the linkages were either positive or negative depended on the issue at hand. For instance, the NDEC GWU's WHP Program plan required the approval of the USEPA's Region 7 Office and that plan revisions were needed in the areas of vulnerability assessments and related ratings, as well as, the establishment of timelines and reporting mechanisms (NDEC GWU & USEPA Region 7 officials, interviews, 14, 02 November 2007).

Two other federally related linkages are noteworthy. First, USGS WRD was functionally (positive) linked to both the NDWR GWD and the UN-L C/S Division due to their joint research and monitoring activities including their stream gauging program which was ongoing throughout the time frame (NDWR Biennial Reports, 1986-1994; NDWR official (retired), interview, 16 November 2007). The second linkage to note was between the USDA NRCS and the NRDs which was functionally positive and strategic due to joint program delivery. In fact, NRCS staff are combined into the NRDs in Nebraska since separate conservation districts do not exist (Little Blue NRD & NARD officials, interviews, 09, 12 November 2007).

At the state level, the NDEC GWU, the designated lead agency for wellhead protection planning in the state, was functionally and strategically linked to the NDOH EHD and the NRWA. The strategic nature of the linkage is found in their

Figure 6.7: Source Water Protection Governance Units, 1986-1994, NE

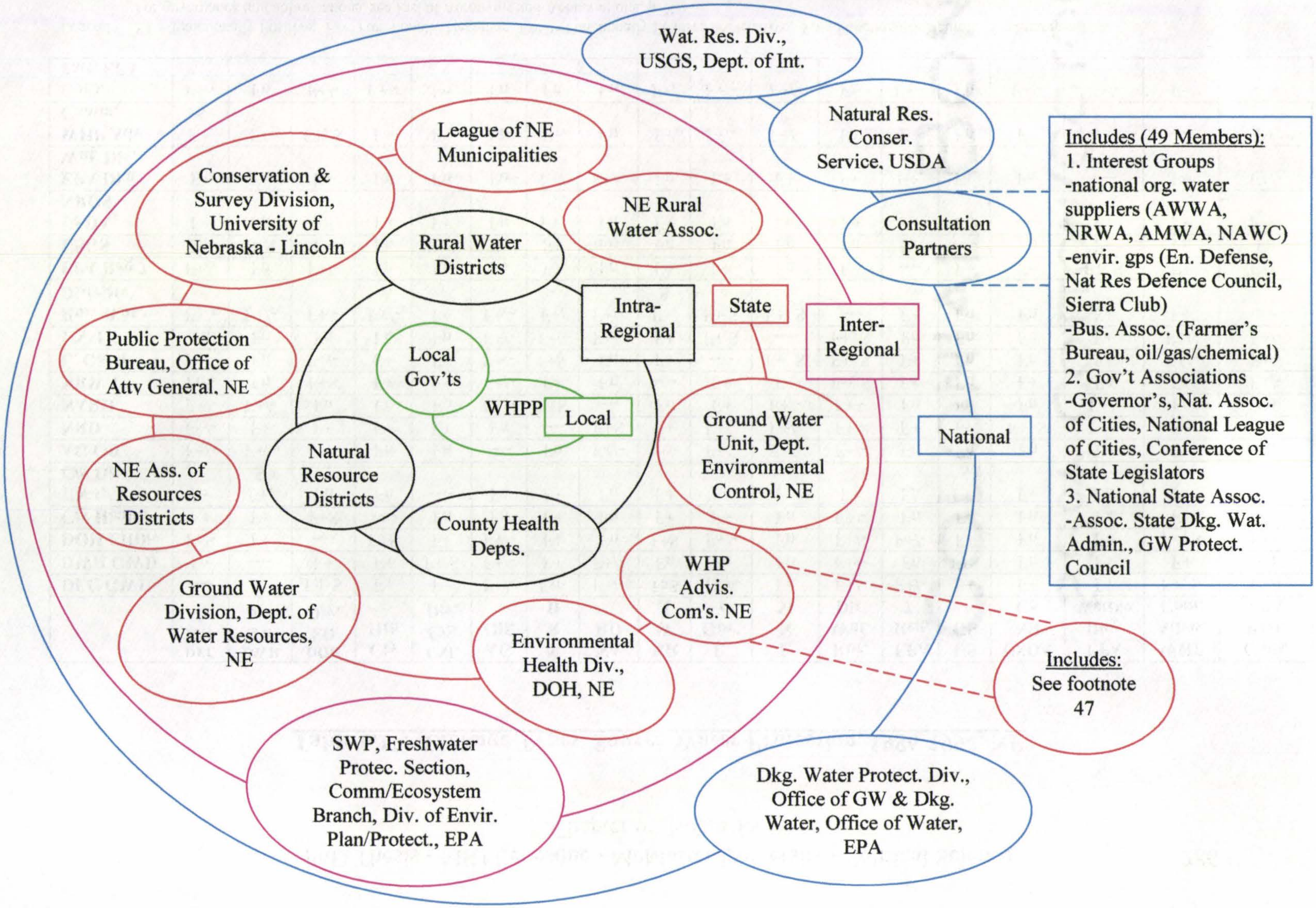


Table 6.17: Linkage Types, Source Water Protection, 1986-1994, NE

	DEC GW U	DWR GW Div.	DOH EH Div.	Cty Hth	UNL C/S Div.	AG Off.	N R D	NA RD	NR W A	L. Gov' t	L N M	Rur. Wat. Dis.	EPA Reg. 7	US GS	USDA NR CS	EPA Dkg. WatDiv	WHP Advis. Com.	Cons. Part. EPA
DEC GWU	----	F+	Fn, S	F+	F+	F+/-	F+/-	F+/-	FnS	F+/-	Fn	F+/-	F+/-	F+	F+	F+	F+, S	F+/-
DWR GWD	F+	----	F+	F+	F+ S	F+/-	F+	F+/-	Fn	Fn	Fn	F+/-	Fn	F+S	Fn	F+	F+	Fn
DOH EHDiv	FnS	F+	----	F+S	F+	F+/-	F+	Fn	F+S	F+/-	Fn	F+/-	F+/-	F+	Fn	F+	F+, S	F+/-
Cty Health	F+	F+	F+S	----	Fn	Fn	F+	Fn	F+	F+	Fn	F+/-	Fn	Fn	Fn	Fn	F+	F+/-
UN-L C/S Div.	F+	F+, S	Fn	Fn	----	Fn	F+	Fn	F+	Fn	Fn	F+	Fn	F+, S	F+	Fn	F+	Fn
AG Off.	F+/-	F+/-	F+/-	Fn	Fn	----	Fn	F+/-	F+/-	F+/-	F+/-	F+/-	Fn	Fn	Fn	Fn	Fn	Fn
NRD	F+/-	F+	F+	F+	F+	Fn	----	F+S	F+	F+/-	F+/-	F+/-	F+	F+	F+, S	F+/-	F+	Fn
NARD	F+/-	F+/-	Fn	Fn	Fn	F+/-	F+S	----	Fn	Fn	F+/-	F+/-	Fn	Fn	Fn	F+/-	Fn	Fn
NRWA	FnS	Fn	F+S	F+	F+	F+/-	F+	Fn	----	F+	F+	F+, S	F+	Fn	F+	Fn	F+	F+/-
L. Gov't	F+/-	Fn	F+/-	F+	Fn	F+/-	F+/-	Fn	F+	----	F+, S	F+, S	F+	Fn	Fn	F+	F+/-	F+/-
LNM	Fn	Fn	Fn	Fn	Fn	F+/-	F+/-	F+/-	F+	F+ S	----	F+, S	Fn	Fn	Fn	F+	F+/-	F+/-
Rur. Wat. Districts	F+/-	F+/-	F+/-	F+/-	F+	F+/-	F+/-	F+/-	F+, S	F+,S	F+, S	----	F+	Fn	Fn	F+	F+	F+
EPA Reg 7	F+/-	Fn	F+/-	Fn	Fn	Fn	F+	Fn	F+	F+	Fn	F+	----	F+	F+	F+, S	F+	F+/-
USGS	F+	F+S	F+	Fn	F+S	Fn	F+	Fn	Fn	Fn	Fn	Fn	F+	----	Fn	F+	Fn	Fn
USDA NRCS	F+	Fn	Fn	Fn	F+	Fn	F+, S	Fn	F+	Fn	Fn	Fn	F+	Fn	----	F+	F+	F+/-
EPA Dkg Wat. Div.	F+	F+	F+	Fn	Fn	Fn	F+/-	F+/-	Fn	F+	F+	F+	F+, S	F+	F+	----	F+	F+/-
WHP Adv Comm.	F+, S	F+	F+, S	F+	F+	Fn	F+	Fn	F+	F+/-	F+/-	F+	F+	Fn	F+	F+	----	F+
Cons. Part. EPA	F+/-	Fn	F+/-	F+/-	Fn	Fn	Fn	Fn	F+/-	F+/-	F+/-	F+	F+/-	Fn	F+/-	F+/-	F+	----

Legend: F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive or Negative; Fn = Functionally Neutral; S = Strategic
For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

close working relationship in both the crafting of the WHP Program and in the design of individual WHPPs for local communities. However, the functionality of the linkage was neutral due to "competitive" forces. For instance, while the NDOH had been entrusted with drinking water regulations long before the NDEC came along (thirty years), the NDEC was designated as the lead agency due to its broad environmental protection mandate which closely aligned with wellhead protection (NDEC GWU official, interview, 14 November 2007). Still, others maintain that the NDEC was designated as the lead agency largely for political reasons and point to the fact that the NDEC Director had a "close" working relationship with the Governor (NDOH EHD officials, interviews, 16 November 2007). While the NDEC and the NDOH had a "good working relationship", the positiveness of any functional linkage was eroded to one of neutrality. The NDOH, for instance, has never signed an interagency Memorandum Of Understanding (MOU) with the NDEC, in regards to wellhead protection planning, as outlined in the WHP Program plan, even though "many drafts have been sent to them" (NDEC, 1991, p. 6; NDEC official, interview, 14 November 2007). A similar situation is found with the functional linkage between the NDEC GWU and the NRWA. The NRWA had long worked with the NDOH in regards to the operation of public water supply systems and strongly opposed the NDEC's designation as program lead. NRWA officials went so far as to distribute "red flyers with the words "POWER GRAB!" in big print" to local entities to enlist their support in opposing the designation to no avail (NDEC official, interview, 14 November 2007). A neutral functional linkage developed as a result.

Other linkages were mixed. For instance, linkages between closely related governance units were, as expected, functionally positive and strategic such as the one between the NDOH EHD and the NDOH County Health Departments. This was due to the County Health Department's aid in delivering the NDOH's main programs such as in the education of local people regarding wellhead protection. The same situation applied to the NRDs and the NARD as seen in the fact that the NARD advocated on behalf of the NRDS in legislative matters (e.g. well decommissioning).

Many linkages were functional and positive or negative depending on the issue at hand. Such was the case for the linkage between Rural Water Districts and the NDEC GWU, the NDWR GWD and the NDOH EHD due to their different yet related groundwater functions. The NDEC GWU had broad groundwater protection (including wellhead protection) and remedial action functions, the NDOH EHD had oversight in regards to public water systems and drinking water standards, the NDWR GWD was involved in broader groundwater planning functions and well registrations among other things while Rural Water Districts were largely involved in the supply of public water. Depending on the issue, the decisions of each of the three former governance units could either positively and/or negatively affect the Rural Water Districts.

6.4.1c 1986-1994: Complementarity of Linkages

governance vision (goals)

The goals of each governance unit are listed in Table 6.18 and goal similarities are summarized in Table 6.19. Of note were the high similarities in goals between the governance units that developed the WHP program, that is, the NDEC

GWU, the USEPA Region 7 Office and the USEPA DWD, which reflected their respective duties in regards to both wellhead protection and broader environmental protection activities. At the state level, moderate similarities in goals existed between the NDEC GWU and the NDWR GWD, the NDOH EHD and the NRWA which reflected their core activities with the NDEC GWU being responsible for the development of the WHP Program and WHPPs. The NRWA worked "on the ground" with the NDEC GWU to devise local WHPPs, the NDOH aided in the development of the WHP program and broader communication with public water suppliers (NDEQ, 1991, p. 5) while the NDWR GWD was largely involved as a data provider (well locations via registrations). Also of note were the moderate goal similarities between the NDEC GWU and the UN-L C/S Division and the USGS in that the latter two were largely relied upon for scientific data provision and interpretation.

Other goal similarities were mixed. For instance, high goal similarities existed between governance units responsible for program delivery and/or advocacy across governance levels such as was the case between the NDOH EHD and the NDOH County Health Departments and between the NRDs and the NARD. A similar situation existed between the Local Governments and the LNM which represented the interests of the local entities in dealings with the many state agencies.

Two other points are worth mentioning. First, the NRWA had a moderate similarity in goals with the NDEC GWU and the NDOH EHD. This is significant due to NWRA's strong opposition to the NDEC GWU's designation as the lead agency. One questions this opposition since it appears the NWRA could easily have worked with the NDEC GWU which it eventually did. The second point involves the Rural Water Districts which had high similarities in goals with the NRWA due to their focus on the provision of drinking water supplies via public water suppliers yet had low similarities in goals with most other governance units largely a result of the Rural Water Districts' narrow mandate. This also applied to similarities in goals between the Rural Water Districts and the NRDs and Local Governments.

communication level (meetings, proposals, personal communication)

Communication levels were generally moderate to low during this period as shown in Table 6.19. Low communication levels existed between the DEC WHP Advisory Committees (WHPAC) and the other governance units except for the NDEC GWU and the NDOH EHD. The two WHPACs[47] only held five meetings overall though many more informal and subcommittee meetings did take place especially in regards to the latter two governance units (NDEC, 1991, p. 52; NDEC official, interview, 14 November 2007). Low communication levels involving the NDEC WHPACs extended to communications with the national Consultation Partners which largely reflected two separate processes in wellhead protection: national and state level program initiation. Other communication patterns with the national governance units are identical to that found for New York given the fact the overall WHP program was federally driven through changes to the federal Safe Drinking Water Act in 1986 (see Section 5.4.1c for further details).

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[47]Nebraska had a 19 member Technical Advisory Committee which included officials from the UN-L (5), NDOH, NNRC, LNM, NARD, USGS, USEPA and the NRWA. A Citizen's Advisory Committee included officials from 23 state organizations such as interest groups (e.g. NE Petroleum Council, NE Corn Growers Association), governance organizations (e.g. NE Association of County Officials) and from environmental groups (e.g. NE Wildlife Federation) (NDEC, 1991, p. 52-57).

Table 6.18: Goals of Governance Units, Source Water Protection, 1986-94, NE

NE Department of Environmental Control Groundwater Unit
• Contribute to NDEC's overall goals of protecting water, land, air resources; • Achieved through various programs including wellhead protection planning, groundwater quality standards setting, hydrogeologic reviews, remedial oversight.
NE Department Water Resources Ground Water Division
• Effective management of NE's water resources via administration of water rights and natural resources planning/assistance (e.g. stream gauging, engineering, planning, well registration).
NE Department of Health Environmental Health Division
• Contribute to Department's goals of promoting, protecting health/wellness of citizens; • Achieved via Public Health Assurance including water well standards and licensing.
NE Department of Health County Health Departments
• Improve, promote health of community including public education for well water issues.
University of Nebraska - Lincoln Conservation & Survey Division
• Research, service, data collection related to State's geology, hydrology, and soils.
NE Attorney General's Office Public Protection Bureau
• Represent, advise State agencies/boards re natural resources, environment; • Enforcement of environmental laws, rules/regulations for State agencies.
Natural Resource Districts
• Local government entities to regulate water and land use.
Nebraska Association of Resource Districts
• Unite, coordinate efforts of NRDs including administrative ones (e.g. training); • To represent NRDs in State lobbying efforts.
Nebraska Rural Water Association
• Represent small water/wastewater systems in NE (population <10,000); • Assist communities/systems comply with regulations; to protect public health and environment.
Local Governments
• To promote, enhance, and foster a community's social and economic well-being.
League of NE Municipalities - Utilities Section
• Provide assistance and input for members on issues related to municipal utilities and public works operations including electricity, drinking water, wastewater.
Rural Water Districts
• Operation, maintenance, and construction of public water supply systems including the production, acquisition, and distribution of water to the general public.
USEPA Region 7 Office
• Work to ensure clean air, pure water and better-protected land; compliance with environmental regulations and environmental stewardship; Achieved via various programs including WHPPs.
USGS (Dept. of Interior) Water Resources Division
• Provide water information that benefits the Nation's citizens (quantity/quality/location...).
USDA Natural Resources Conservation Service
• Provide leadership in a partnership effort with private land owners and managers to conserve their soil, water, and other natural resources through technical assistance based on sound science.
USEPA Drinking Water Division
• Ensure safe drinking water; restore/maintain watersheds, aquatic ecosystems to protect human health, support economic/recreational activities, provide healthy habitat for fish, plants, wildlife. • Achieved through various programs including WHPPs.
WHP Advisory Committees
• Assist in development of NE's WHP Program submittal to EPA.
Consultation Partners (National)
• Assist in development of legislative and regulatory framework (water).

At the state level, the NDEC GWU had high communication levels with both the NDOH EHD and the UN-L C/S Division. Though the NDEC GWU was the designated lead agency, it was nevertheless mandated to closely cooperate with the NDOH EHD given the latter's oversight functions for public water systems (State of Nebraska, 1990; NDEC GWU official, interview, 14 November 2007). The University was drawn upon for much of the needed hydrogeological information from which to develop the voluntary wellhead protection plans. Communication levels were also elevated due to other activities such as the review of NRD Groundwater Management Area designations and in the Lower Platte River Corridor Alliance (NDEQ, 1998; *Nebraska Resources*, 1997 (Summer), pp. 1-3; NDWR official, interview, 16 November 2007).

Other communication levels were mixed. For instance, while the development of local WHPPs was driven by the NDEC GWU, the NRWA was involved in drafting plans in relation to public water supply systems hence communication levels are classified as "moderate" (EPA, 1998; NDEC GWU, USEPA Region 7 Office & NRWA officials, interviews, 14, 02 November & 25 October 2007). Also note the moderate communication levels between the NDEC GWU and the NRDs which was largely due to other activities such as Groundwater Management Area designations and not WHP activities given the NRDs lack of interest in groundwater quality issues in part due to the lack associated funding (NDEC GWU & NARD officials, interviews, 14, 12 November 2007).

In comparison, "linked" governance units had high communication levels. This can be seen in communication levels between the NDOH EHD and the NDOH County Health Departments, between the NRDs and the NARDs, and between the

Local Governments and the LNM and is not surprising given the overlapping functions either in program delivery, training and/or advocacy performed by the various governance units.

Many communication levels between the governance units were low at the time given their lack of interaction. This can be seen in communication levels between the LNM and most governance units in question. The LNM, though part of consultation processes, were not "actively" engaged at the time. As one LNM official stated, we were "at the table more to be kept informed than anything" (LNM official, interview, 13 December 2007). A similar situation applies in regards to the Attorney General's Office and the Rural Water Districts in that while neither were directly involved in the crafting of the WHP Program or WHPPs, they were either consulted periodically and/or kept informed of events as they unfolded (NDEC GWU officials, interviews, 14, 15 November 2007). The above communication patterns between most governance units were also facilitated through the various conferences held in the state every year as previously discussed.

type and frequency of collaboration

Collaboration levels are shown in Table 6.19 and are characterized as generally "Low" to non-existent. The main exception involves collaboration levels between the NDEC GWU and most governance units given the fact the NDEC was the lead agency for WHPPs which were voluntary in nature. The NDEC GWU had high levels of collaboration with the NDWR GWD, the NDOH EHD, the UN-L C/S Division, the USEPA Region 7 Office and the USEPA DWD. Collaboration levels were high in relation to the first three governance units due to various factors including collaboration required for the update of the State's Water Plan, ongoing litigation in regards to the North Platte Decree and wellhead protection planning (Rundquist, 1993, pp. 210-211; NDEQ, 2001; NDEC & NDNR officials, interviews, 14, 15 November 2007). Collaboration levels were high between the NDEC GWU and the two USEPA Divisions due to the joint approval of the state's WHP Program and due to overlap in the many other USEPA directed programs where the NDEC was the lead agency for state implementation such as the National Pollutant Discharge Elimination System (NPDES) Program (NDEQ, n.d.; NDEC & USEPA officials, interviews, 14, 02 November 2007). Other collaboration levels involving the NDEC GWU were moderate in nature. This was the case in relation to Local Governments, the NRDs and the NRWA, for example, where their collaboration largely reflected the development of wellhead protection plans and broader environmental protection and planning issues such as the review of Groundwater Management Area designations previously discussed.

Most collaboration levels were, however, low in nature. Such was the case with the NDWR GWD and the NDOH EHD and most other governance units. For instance, the NDWR GWD and Local Governments collaborated mainly when a new water supply source was required which also involved the UN-L C/S Division in the process (UN-L C/S Division official, interview, 16 November 2007). The same situation applied in relation to Rural Water Districts.

Also of note were the low collaboration levels between most state, regional

Table 6.19: Linkage Complementarity Summary, Source Water Protection, 1986-1994, NE

	DEC GWU	DWR GW Div.	DOH EH Div.	Cty Hth	UNL C/S Div.	AG Off	NRD	NARD	NRWA	L. Gov't	LNM	Rur. Wat. Dis.	EPA Reg. 7	USGS	USDA NRCS	EPA Dkg. WatDiv	WHP Advis. Com.	Cons. Part EPA
Governance Vision (goals)																		
DEC GWU	----	Mod	Mod	L	Mod	L	M	L	M	L	Low	Low	H	M	Mod	High	Mod	Mod
DWR GWD	M	----	M	L	Mod	L	M	L	L	L	Low	Low	L	L	Low	Low	Low	Low
DOH EHDiv	Md	Mod	----	H	Low	L	L	L	M	L	Low	Mod	M	L	Low	Mod	Low	Low
Cty. Hth.	L	Low	High	----	Low	L	L	L	L	M	Low	Low	L	L	Low	Low	Low	Low
UN-L C/S Div.	Mod	Mod	Low	Low	----	nil	Low	Low	Low	Low	-nil-	Low	Low	High	Mod	Low	Low	-nil-
AG Off.	L	Low	Low	L	nil	----	L	L	nil	L	Low	-nil-	nil	nil	-nil-	-nil-	Low	Low
NRD	M	Mod	Low	L	Low	L	----	H	M	L	Low	Low	M	L	High	Mod	Mod	Low
NARD	L	Low	Low	L	Low	L	H	----	M	L	Mod	Low	L	nil	Mod	Low	Low	Low
NRWA	M	Low	Mod	L	Low	nil	M	M	----	L	Low	High	L	L	Mod	Low	Low	Low
L. Gov't	L	Low	Low	M	Low	L	L	L	L	----	High	Low	L	L	Mod	Low	Low	Low
LNM	L	Low	Low	L	nil	L	L	M	L	Hh	----	Low	nil	nil	-nil-	-nil-	-nil-	-nil-
RurWatDis.	L	Low	Mod	L	Low	nil	L	L	H	L	Low	----	L	L	Low	Low	Low	Low
EPA Reg 7	H	Low	Mod	L	Low	nil	M	L	L	L	nil	Low	----	M	Mod	High	Mod	Mod
USGS	M	Low	Low	L	H	nil	L	nil	L	L	nil	Low	M	----	Low	High	Low	Low
USDA NRCS	M	Low	Low	L	Mod	nil	H	M	M	M	nil	Low	M	L	----	Mod	Mod	Mod
EPA Dkg Wat. Div.	High	Low	Mod	Low	Low	nil	Mod	Low	Low	Low	nil	Low	High	High	Mod	----	Mod	Mod
DEC WHP Adv Comm.	Mod	Low	Low	Low	Low	Low	Mod	Low	Low	Low	nil	Low	Mod	Low	Mod	Mod	----	High
Cons. Part.	M	Low	Low	L	nil	L	L	L	L	L	nil	Low	M	L	Mod	Mod	High	----
Communication Level (Meetings, Proposals, Personal Communication)																		
DEC GWU	----	Mod	High	L	H	L	M	M	M	L	Low	Low	M	M	Low	Low	Mod	Low
DWR GWD	M	----	Mod	L	Mod	L	L	L	L	L	Low	Low	L	L	Low	nil	Low	Low
DOH EHDiv	H	Mod	----	H	Mod	L	L	L	M	L	Low	Mod	L	L	Low	nil	Mod	Low
Cty. Hth.	L	Low	High	----	Low	L	L	L	L	M	Low	Low	L	L	Low	Low	Low	Low
UN-L C/S Div.	High	Mod	Mod	Low	----	Low	Mod	Low	Low	Low	Low	Low	Low	High	Low	Low	Low	Low
AG Off.	L	Low	Low	L	Low	----	L	L	L	L	Low	Low	L	nil	-nil-	-nil-	Low	Low
NRD	M	L	L	L	M	L	----	H	L	M	Low	Low	nil	nil	High	-nil-	Mod	Low
NARD	M	L	L	L	L	L	H	----	L	L	Low	Low	L	nil	Mod	-nil-	Low	Low
NRWA	M	L	M	L	L	L	L	L	----	H	Low	Low	L	L	Low	-nil-	Low	Low
L. Gov't	L	Low	Low	M	Low	L	M	L	H	----	High	Mod	nil	L	Low	nil	Low	Low
LNM	L	Low	Low	L	Low	L	L	L	L	H	----	Low	nil	nil	nil	nil	nil	Low

Table 6.19: Linkage Complementarity Summary, Source Water Protection, 1986-1994, NE (cont'd)

	DEC GW U	DWR GW Div.	DOH EH Div.	Cty Hth	UNL C/S Div.	AG Off	N R D	NA RD	NR WA	L. Gov 't	L N M	Rur. Wat. Dis.	EPA Reg. 7	US GS	USDA NR CS	EPA Dkg. WatDiv	WHP Advis. Com.	Cons. Part EPA
Communication Level (Meetings, Proposals, Personal Communication) (cont'd)																		
RurWatDis.	Low	Low	Mod	L	Low	L	L	L	L	M	Low	----	L	L	Low	nil	Low	Low
EPA Reg 7	M	Low	Low	L	Low	L	nil	L	L	nil	nil	Low	----	L	Low	Mod	Low	Low
USGS	M	Low	Low	L	H	nil	nil	nil	L	Low	nil	Low	L	----	Low	Low	Low	Low
USDA NRCS	Low	Low	Low	L	Low	nil	H	M	L	Low	nil	Low	L	L	----	Low	Low	Low
EPA Dkg Wat. Div.	Low	nil	nil	Low	Low	nil	nil	nil	nil	nil	nil	nil	Mod	Low	Low	----	Low	Mod
DOH WHP Adv Comm.	Mod	Low	Mod	Low	Low	Low	Mod	Low	Low	Low	nil	Low	Low	Low	Low	Low	----	Low
Cons. Part.	Low	Low	Low	L	Low	L	L	L	L	Low	Low	Low	L	L	Low	Mod	Low	----
Frequency and Type of Collaboration																		
DEC GWU	----	H	High	L	H	nil	M	L	M	M	nil	Low	H	L	Low	High	Mod	Low
DWR GWD	H	----	Low	L	H	L	M	nil	L	Low	Low	Low	L	L	Low	nil	Low	nil
DOH EHDiv.	H	Low	----	H	Low	L	L	nil	L	Low	nil	Low	L	L	nil	nil	Low	nil
Cty. Hth.	Low	Low	High	----	Low	nil	L	nil	L	Low	Low	Low	nil	L	nil	nil	Low	nil
UN-L C/S Div.	High	High	Low	Low	----	nil	Mod	Low	Low	Low	Low	Low	Low	Low	nil	nil	Low	nil
AG. Off.	nil	Low	Low	nil	nil	----	nil	nil	nil	nil	nil	nil	L	nil	nil	nil	Low	nil
NRD	M	Mod	Low	L	Mod	nil	----	H	L	Low	nil	Low	L	L	High	nil	Low	nil
NARD	Low	nil	nil	nil	Low	nil	H	----	L	nil	nil	nil	nil	nil	Low	nil	Low	nil
NRWA	M	Low	Low	L	Low	nil	L	L	----	Low	Low	Low	L	L	Low	nil	Low	nil
L. Gov't	M	Low	Low	L	Low	nil	L	nil	L	----	Mod	Low	L	L	Low	nil	Low	Low
LNM	nil	Low	nil	L	Low	nil	nil	nil	L	M	----	nil	L	nil	nil	nil	Low	Low
RurWatDis.	Low	Low	Low	L	Low	nil	L	nil	L	Low	nil	----	L	L	Low	nil	Low	-nil-
EPA Reg 7	H	Low	Low	nil	Low	L	L	nil	L	Low	Low	Low	----	L	Low	Mod	Low	Low
USGS	Low	Low	Low	L	Low	nil	L	nil	L	Low	nil	Low	L	----	Low	Low	Low	Low
USDA NRCS	Low	Low	nil	nil	nil	nil	H	L	L	Low	nil	Low	L	L	----	Low	Low	Low
EPA Dkg Wat. Div.	High	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil-	nil	Mod	Low	Low	----	nil	Low
DEC WHP Adv Comm.	Mod	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	nil	----	Low
Cons. Part.	Low	nil	nil	nil	nil	nil	nil	nil	nil	Low	Low	-nil-	L	L	Low	Low	Low	----

Legend: L = Low; M, Mod = Moderate; H = High; n = nil; For governance unit abbreviations, see List of Acronyms and Abbreviations, p. X.

and local governance units and the USEPA Region 7 Office with only the NDEC GWU having high collaboration levels with the federal agency. This is not surprising given the fact the NDEC was the lead agency in relation to WHP planning, yet it is notable in relation to the NDOH EHD and its related functions for drinking water. However, as one NDOH EHD Official commented, it is more of a systematic process of reporting data to the USEPA than engaging in any significant collaborative efforts to address an issue (NDOH & USEPA officials, interviews, 16, 02 November 2007).

6.4.2 Preliminary Findings: Source Protection Planning and Organizational Environment

Like New York, source protection planning in Nebraska was federally driven. However, unlike New York, the basis for source protection planning through wellhead protection planning was underway for a few years prior to the federal initiatives which were realigned to encompass the federal initiative (e.g. timelines, reporting mechanisms). A diffuse organizational environment was present in source protection planning with many governance units involved. In particular, several advisory committees and consultation forums were utilized to initiate the legislative and regulatory changes which reflected the potential for much conflict given the core issues of property rights (e.g. limitations) involved in the process. Also of significance was the institutional rivalry, which continues to this day, between the NDEC/Q and the NDOH over who would become the lead agency with the NDEC/Q ultimately assuming responsibility.

6.5 Summary

Data in regards to legislative and regulatory changes related to Nebraska well drilling, water takings and source water protection was presented in this chapter. The data was presented in relation to the independent variables, that is, the number of governance units, the nature of the linkages (functional, strategic) and linkage complementarity. Generalizations about the patterns for the independent variables are briefly offered here to summarize the chapter's findings.

The examination of well drilling regulatory changes revealed an institutionally diverse institutional structure. A high number of governance units were involved in the process (17-19) spread over four vertical governance layers. A high number of functionally positive linkages existed over all three time frames and contributed to the ability to overcome resistance to regulatory changes which, while not high, was still substantive as noted in the number of functionally negative linkages. The fact the high number of functionally positive linkages, albeit of largely low complementarity, equalled or far outnumbered the functionally positive/negative and functionally neutral linkages is also important as is the high number of strategic linkages at the state level. This suggests that the lack of or a low linkage complementarity can be overcome for successful groundwater policy changes provided sufficient strategic and functionally positive linkages exist in low uncertainty areas.

A complex institutional structure is also evident in relation to water takings legislative and regulatory changes. A high number of governance units were also active (18-19) spread over four governance layers. A similar pattern of a high number of functionally positive and strategic linkages existed as did a substantive number of functionally negative linkages. However, the actual number of functionally positive linkages was consistently lower by a good margin (~20%) than the number of functionally positive/negative linkages. This is not unusual given the very function of permit evaluations automatically creates a "winner" (successful application) and/or a loser (unsuccessful application). In short, much hinges on permit decisions for whether a linkage is functionally positive or negative.

This complex and diffuse institutional structure was also present in relation to source protection planning. In particular, note the centrality of advisory committees and consultation partners to address a potentially highly contentious issue. It appears the multilateral forums were successful in diffusing tension between the many governance units which can be seen in the lack of functionally negative linkages. Furthermore, and consistent with well drilling regulatory changes, a high number of functionally positive and strategic (to a lesser extent) linkages existed and which far outnumbered the functionally positive/negative linkages.

The above results over the three policy areas suggest that in institutionally diffuse situations, that is, where authority is divided among many governance units operating at many vertical levels, a high level of functionally positive and strategic linkages is required for legislative and regulatory changes in low uncertainty areas. It also suggests that the use of multilateral forums for potentially divisive issues aids the process in giving voice to the various governance units and in facilitating an acceptable outcome. These generalizations and preliminary results are further analyzed in the next chapter, Chapter 7, along with the results for the previous two chapters, our data chapters for Ontario and New York.

Chapter Seven

Analysis

"what does it mean?"

7.1 Introduction

Common pool resource (CPR) theory has elaborated the importance of nested institutional arrangements (NIAs) in its contribution to the sustainable management of common pool resources. NIAs, that is, layered governance arrangements among and between many institutions operating at different levels, are but one of eight design principles of long enduring CPR institutions that have challenged the inevitability of the "tragedy of the commons". Exactly what role NIAs assume in the process is not detailed other than to note their presence and the flexibility they introduce in meeting various local resource needs. This dissertation addressed this deficiency by beginning the process of unravelling NIAs. It specifically examined the effects of NIAs on the type, frequency and magnitude of groundwater policy change under conditions of uncertainty to reveal clues for the development of a strategy for groundwater policy change.

This chapter examines and discusses the data results. While similarities in relation to the type, frequency and magnitude of policy changes exist, notable differences are evident in how the changes came about and in relation to effects introduced by diffuse authority between governance levels. Strengths such as the rigourousness of the research design and weaknesses in relation to generalizability are also examined in the chapter.

7.2 Policy Changes

Many similarities existed in relation to changes in policy goals, instruments and instrument settings as shown in Table 7.1 and are detailed below. Overall, few differences existed between policy changes in areas of low (NE) and high (ON, NY) uncertainty areas.

(a) ***policy goals***

- Changes in policy goals occur in relation to program introduction and/or expansion, are of large magnitude, and occur infrequently regardless of uncertainty levels.

Policy goals changed infrequently throughout all three jurisdictions and across all three programs (well driller regulations, water takings, source protection) in each jurisdiction. This is not surprising given the large magnitude a change in policy goals typically represents, which is akin to a paradigm change. Policy goals changed only when a new program was introduced and/or expanded. For instance, the introduction of well driller licensing regulations in New York and Nebraska (t-1) represented a change in policy goals and was a change of large magnitude given the lack of pre-existing programs. Note that this did not occur in Ontario over any of the three time frames since it had a pre-existing well driller licensing program in place. This pattern of changes in policy goals was repeated in relation to program introduction in regards

Table 7.1: Summary of Policy Changes

Well Driller Regulations

	Ontario			New York	Nebraska		
	t-1 1966-70	t-2 1980-84	t-3 2000-04	t-1 1996-06	t-1 1980-86	t-2 1987-94	t-3 1998-04
change type							
goals	---	---	---	✓	✓	---	---
instruments	---	---	---	✓	✓	✓	---
settings	✓	✓	✓	✓	✓	✓	✓
frequency							
goals	---	---	---	infreq (L)	infreq (L)	---	---
instruments	---	---	---	infreq (L)	infreq (L)	mod (M)	---
settings	infreq (L)	infreq (L)	infreq (L)	infreq (L)	freq (H)	freq (H)	freq (H)
magnitude							
goals	---	---	---	large (H)	large (H)	---	---
instruments	---	---	---	large (H)	mod (M)	mod (M)	---
settings	small (L)	small (L)	small (L)	small (L)	small (L)	small (L)	small (L)

Water Takings

	Ontario		New York	Nebraska		
	t-1 1958-64	t-2 1999-06	t-1 1985-91	t-1 1980-87	t-2 1991-99	t-3 2000-05
change type						
goals	✓	✓	✓	---	---	✓
instruments	✓	---	✓	---	---	---
settings	✓	✓	✓	✓	✓	✓
frequency						
goals	infreq (L)	infreq (L)	infreq (L)	---	---	infreq (L)
instruments	infreq (L)		infreq (L)			
settings	infreq (H)	freq (H)	infreq (L)	freq (H)	freq (H)	infreq (L)
magnitude						
goals	large (H)	large (H)	large (H)	---	---	large (H)
instruments	large (H)	---	large (H)	---	---	---
settings	small (L)	small (L)	small (L)	small(L)/ mod (M)	small (L)	small (L)

Source Protection

	Ontario	New York	Nebraska
	t-1 2002-06	t-1 1986-96	t-1 1986-94
change type			
goals	✓	✓	✓
instruments	✓	✓	✓
settings	✓	✓	✓
frequency			
goals	infreq (L)	infreq (L)	infreq (L)
instruments	infreq (L)	infreq (L)	infreq (L)
settings	mod (M)	mod (M))	mod (M)
magnitude			
goals	large (H)	large (H)	large (H)
instruments	med (M)	med (M)	med (M)
settings	small (L)	small (L)	small (L)

to both water takings (ON, NY) and source protection (all jurisdictions). The pattern was also repeated in relation to goal changes in existing programs as was the case in relation to Ontario (t-2) and Nebraska (t-3) where both were classified as large due to the expansion of water permit considerations to include environmental uses. As officials noted, the sharing of water with the environment, that is, leaving sufficient quantities of water to ensure the environment and its non-human inhabitants continued to flourish, represented a whole change in thinking with potentially serious implications for economic growth. This was even more acute in Nebraska in relation to endangered species (OMOE, NDNR & LBNRD officials, interviews, 09 March, 15 November and 09 November 2007).

A change in policy goals occurred infrequently, that is, greater than ten years in each case to occur. This was also as expected given the difficulty in changing policy goals and noted by the fact it took years for both NY and NE to institute a program of well driller licensing despite the fact each jurisdiction had been exploring such an idea for at least the previous twenty years. The situation is the same with water takings and source protection regulatory changes (see Chapters 5 and 6).

(b) ***policy instruments***

- Changes in policy instruments are largely dependent on context regardless of whether or not a change in policy goals occurs, except in cases when a program is introduced, are infrequent and are irrelevant of uncertainty levels.

Changes in policy instruments were few in nature and largely occurred in combination with a change in policy goals related to program introduction. Such was the case in all jurisdictions and in all programs across most time frames (13 of 16), and were as expected. To state the obvious, a change in policy goals related to program introduction also necessitates the introduction of a policy instrument to achieve the goals. The exceptions occurred in relation to existing programs. For instance, a change in policy goals in Nebraska related to water takings (t-3) did not include an accompanying change in policy instruments contrary to what many have argued should occur (see Hall, 1993). This was due to the fact that while policy goals for water permits in Nebraska were altered to include environmental considerations and inter-state compacts, the permitting system, a tax on water takings (economic instrument), remained unchanged.[48] Note a similar situation in Ontario (t-2) water takings regulatory changes. Likewise, while no change in relation to policy goals occurred in Nebraska well driller regulatory changes (t-2), a change in policy instruments nevertheless occurred. The regulation of well construction continued to be one of the main goals yet the regulations became mandatory (regulatory instrument) in the fall of 1988 when they had previously been voluntary (information instrument). This suggests that a change in policy instrument is largely dependent on context regardless of whether or not a change in policy goals has occurred except in cases when a program is introduced and is irrelevant of uncertainty levels.

Overall, policy instrument changes occurred infrequently regardless of the

[48]Note that discussions surrounded the need to include environmental considerations in the review of permit applications (goals) and not in changing the policy instrument in use. Furthermore, no new policy instrument was introduced.

level of uncertainty involved. This was largely due to the lack of changes in policy instruments across the regions and programs unrelated to program introduction. The one exception was related to a change in policy instruments in Nebraska well driller regulations (t-2) which is classified as moderate in nature as expected given the proximity of the changes in relation to the earlier time frame (t-1). Note that a change in policy instruments did not occur in relation to other programs after their introduction, yet the Nebraska (t-2) result is not unusual and largely reflected unfinished business from the previous time frame. At the time of the first regulatory changes (t-1, 1980-1986), agreement could not be reached on the details of the changes that affected well construction, but the governance units did agree to future terms of engagement through the delegation of such responsibility to a Water Well Standards and Contractor's Licensing Board (WWSCLB), an advisory body comprised of the affected bodies. It was this advisory body that worked out the particulars which led to binding regulations promulgated within a couple of years by the regulatory authorities.

(c) *policy instrument settings*

- Policy instrument setting changes are numerous, largely of small magnitude, and frequently occur in conditions of low uncertainty (NE) and infrequently in conditions of high uncertainty (ON, NY).
- Diffuse authority structures and/or the lack of funding decreases the frequency of instrument setting changes under conditions of low

uncertainty (NE) and increases the frequency of instrument setting changes under conditions of high uncertainty (ON, NY).

All jurisdictions and program areas incurred many policy instrument setting changes during all time frames. The magnitude of such changes were also small in nature in all sixteen time frames across the program areas with the exception of Nebraska water takings (t-1) where setting changes are classified as "small/moderate" due to the small nature of the setting changes (e.g. terminology clarifications, public notification procedural changes) yet with wider application to include industrial uses.

Changes to the frequency of policy instrument settings were mixed. Many more changes in instrument settings occurred when compared to changes in policy goals and instruments themselves. This, however, masked the frequency of changes within the individual time frames. As shown in Table 7.1, changes in policy instrument settings were frequent under conditions of low uncertainty (NE) and infrequent in conditions of high uncertainty (ON, NY) regardless of whether a program was introduced or not. This result applied to both well driller and water takings regulatory changes and likely reflects knowledge levels among governance units in areas of low uncertainty and their subsequent desire to address regulatory deficiencies. Nebraskans, for instance, are keenly aware of the economic value of groundwater and have a strong desire to address regulatory deficiencies as was expressed in interviews with most officials in Nebraska. One official noted that Nebraska lacked economically significant amounts of minerals and timber resources and, being land locked, had no shipping ports of significance. The Nebraska economy is largely based on agriculture which relies heavily on irrigation provided by the abundant groundwater resources of the Ogallala Aquifer (Interview with NARD official, 12 November 2007). This acute knowledge of the importance of groundwater to Nebraskans was also reiterated by a USEPA official who noted Nebraskans' eagerness to utilize all available tools to manage the groundwater resource (USEPA Region 7 official, interview, 02 November 2007).

An opposite situation existed in Ontario and New York. Note that groundwater was largely ignored in Ontario throughout the late 1970s, 1980s and 1990s. This is evidenced by the lack of emphasis on well inspections during this period and especially in the late 1980s and 1990s. The Walkerton water tragedy did renew focus on groundwater yet this was a mixed blessing. While much occurred in terms of research and operator training, it also brought increased pressure on municipalities to accept "pipeline solutions" since infrastructure improvement grants favoured surface water sources of water (OGWA officials, interviews, 25 September and 11 October 2006). The focus on groundwater in New York state has only lately received increased attention as noted by the late development of their regulatory framework.

One exception does exist to the above pattern in the frequency of policy instrument setting changes. The frequency of changes in water takings policy instrument settings that occurred in Nebraska (t-3) were infrequent in nature. This anomaly is more difficult to explain. It occurred in conjunction with a change in policy goals where environmental and interstate compacts now had to be considered in water permit applications. Attention may have been focused on the changes to the policy goals which was and remains controversial in the state. Furthermore, the situation may reflect a level of satisfaction with the general policy instrument settings in place at the time as noted by the lack of comment on the instruments and related settings by all interviewees.

Policy instrument setting changes related to source protection did not follow the above patterns and are moderate in nature regardless of the level of uncertainty. This reflected a more diffuse authority structure and related funding issues. Note that Source Protection Planning programs were mandated by the provincial government in Ontario and the federal government in the US yet few dollars were provided to develop related programs and implement actual WHP plans.[49] As such, the situation represents a tradeoff between implementation agencies who desire maximum flexibility (and, therefore, potentially frequent policy instrument setting changes) and governments who desire much less flexibility (infrequent policy instrument setting changes) yet want a high rate of program uptake. One Nebraskan official noted that while "hiccups" did occur in the state's WHP program plan formulation and approval, they were readily overcome in part due to the USEPA's desire to show progress in program implementation (NDEQ official, interview, 14 November 2007).

The preceding discussion revealed that few differences occurred in groundwater policy changes related to policy goals and policy instruments when comparing nested institutional arrangements operating under different levels of

[49]This problem continues to plague the Ontario situation.

uncertainty. Significant differences did occur in relation to policy instrument settings though these differences were negated when governance authority was divided between two or more vertical governance layers. These broad changes, however, masked the effects of the independent variables (number of governance units, type and complementarity of linkage), processes which are further considered in the next section.

7.3 Complexities Behind The Changes

NIAs matter. The last section documented little effect of NIAs on the type of policy changes. This section details the significant effects of NIAs on the processes behind the changes. These changes are summarized in Tables 7.2 and 7.3 and are discussed in terms of the number of governance units, the number and type of linkages and the complementarity of those linkages.

(a) *number of governance units*

- The number of governance units increases as uncertainty decreases with results less pronounced when authority is divided between two or more vertical levels of governance.

Low uncertainty levels increase the number of governance units. This suggests an increased number of potentially negatively affected parties becoming engaged in the policy process in order to protect their interests. This engagement is largely directed at the governance level possessing the authority to act. This was the case in all jurisdictions and in all programs and most pronounced in water takings. Ontario and New York, high uncertainty jurisdictions, had approximately half the number of governance units involved in the process when compared to Nebraska, a low uncertainty jurisdiction. The same pattern existed for the well driller regulations and source protection activities.

Note the importance of authority when it is divided between vertical governance levels. The increase in governance units in low uncertainty areas when compared to high uncertainty areas was much less pronounced, a pattern that was repeated across all jurisdictions. In relation to water takings, for instance, Conservation Authorities and the MNR Regional Offices in Ontario had by 1999-2006 (t-2) assumed some authority in permit issues in relation to low water responses and in high-use watershed determinations. This split authority from the provincial counterparts resulted in a higher number of governance units overall and decreased the gap with Nebraska, a low uncertainty area. In other words, the diffused authority structure ushered in by changes in 1999-2006 in Ontario resulted in a doubling of governance units (from 7 to 13) while the number of governance units in Nebraska (18-19) held steady over three time frames. It can be argued that the Nebraska governance structure is inflated due to its diffuse governance structure (when compared to Ontario t-1), that is, authority is dispersed between multiple vertical levels of governance (intra-regional, state) and multiple horizontal governance units at any one level. Yet note that the difference between Nebraska (low uncertainty area) and Ontario (t-2; high uncertainty area) was still approximately a third more governance units in Nebraska which is significant.

A similar pattern occurred in relation to well driller regulations and source

Table 7.2: Summary of Nested Institutional Arrangements

Well Driller Regulations																					
	Ontario									New York			Nebraska								
	t-1 1966-1970			t-2 1980-1984			t-3 2000-2004			t-1 1996-2006			t-1 1980-1986			t-2 1987-1994			t-3 1998-2004		
all	8			9			10			16			17			19			19		
vertical	3			3			3			4			4			4			4		
horizontal																					
local	2	F+	M	2	F+	L	2	F+	L	2	F+	L	1	F+	L	1	F+	L	1	F+	L
		F-	--		F-	M		F-	M		F-	--		F-	L		F-	L		F-	--
		F+/-	M		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	L
		Fn	--		Fn	--		Fn	M		Fn	L		Fn	L		Fn	L		Fn	L
		S	M		S	H		S	H		S	--		S	--		S	--		S	--
intra	0	F+	--	0	F+	--	0	F+	--	2	F+	M	3	F+	M	3	F+	L	4	F+	L
		F-	--		F-	--		F-	--		F-	--		F-	L		F-	L		F-	--
		F+/-	--		F+/-	--		F+/-	--		F+/-	L		F+/-	L		F+/-	L		F+/-	L
		Fn	--		Fn	--		Fn	--		Fn	L		Fn	L		Fn	L		Fn	L
		S	--		S	--		S	--		S	--		S	H		S	H		S	H
p/s	6	F+	M	7	F+	L	8	F+	M	9	F+	M	12	F+	M	14	F+	M	13	F+	M
		F-	--		F-	M		F-	M		F-	--		F-	L		F-	L		F-	L
		F+/-	M		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	L
		Fn	L		Fn	M		Fn	M		Fn	L		Fn	L		Fn	L		Fn	L
		S	M		S	H		S	H		S	H		S	M		S	M		S	M
inter	0	F+	--	0	F+	--	0	F+	--	0	F+	--	0	F+	--	0	F+	--	0	F+	--
		F-	--		F-	--		F-	--		F-	--		F-	--		F-	--		F-	--
		F+/-	--		F+/-	--		F+/-	--		F+/-	--		F+/-	--		F+/-	--		F+/-	--
		Fn	--		Fn	--		Fn	--		Fn	--		Fn	--		Fn	--		Fn	--
		S	--		S	--		S	--		S	--		S	--		S	--		S	--
national	1	F+	--	1	F+	--	1	F+	--	3	F+	M	1	F+	L	1	F+	L	1	F+	L
		F-	--		F-	--		F-	--		F-	--		F-	L		F-	L		F-	L
		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	--		F+/-	--		F+/-	--
		Fn	L		Fn	M		Fn	M		Fn	L		Fn	L		Fn	L		Fn	L
		S	M		S	--		S	--		S	H		S	M		S	--		S	--

Table 7.2: Summary of Nested Institutional Arrangements (cont'd)

Water Takings																		
	Ontario						New York			Nebraska								
	t-1 1958-1964			t-2 1999-2006			t-1 1985-1991			t-1 1980-1987			t-2 1991-1999			t-3 2000-2005		
all	7			13			8			18			18			19		
vertical	3			3			3			4			4			4		
horizontal local	1	F+	M	0	F+	--	0	F+	--	1	F+	H	1	F+	H	1	F+	H
		F-	--		F-	--		F-	--		F-	L		F-	L		F-	L
		F+/-	M		F+/-	--		F+/-	--		F+/-	L		F+/-	L		F+/-	L
		Fn	--		Fn	--		Fn	--		Fn	L		Fn	L		Fn	L
		S	H		S	--		S	--		S	H		S	H		S	H
intra	0	F+	--	3	F+	M	1	F+	--	3	F+	M	3	F+	M	3	F+	M
		F-	--		F-	--		F-	--		F-	L		F-	L		F-	L
		F+/-	--		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	L
		Fn	--		Fn	L		Fn	L		Fn	L		Fn	L		Fn	L
		S	--		S	M		S	--		S	M		S	M		S	M
p/s	5	F+	M	9	F+	M	6	F+	M	13	F+	M	13	F+	M	14	F+	M
		F-	--		F-	--		F-	--		F-	L		F-	L		F-	L
		F+/-	M		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	L
		Fn	L		Fn	L		Fn	L		Fn	L		Fn	L		Fn	L
		S	M		S	M		S	M		S	M		S	M		S	M
inter	0	F+	--	0	F+	--	0	F+	--	0	F+	--	0	F+	--	0	F+	--
		F-	--		F-	--		F-	--		F-	--		F-	--		F-	--
		F+/-	--		F+/-	--		F+/-	--		F+/-	--		F+/-	--		F+/-	--
		Fn	--		Fn	--		Fn	--		Fn	--		Fn	--		Fn	--
		S	--		S	--		S	--		S	--		S	--		S	--
national	1	F+	--	1	F+	--	1	F+	--	1	F+	L	1	F+	L	1	F+	L
		F-	--		F-	--		F-	--		F-	--		F-	L		F-	L
		F+/-	M		F+/-	L		F+/-	L		F+/-	L		F+/-	L		F+/-	L
		Fn	L		Fn	L		Fn	L		Fn	L		Fn	L		Fn	L
		S	L		S	--		S	--		S	M		S	M		S	M

Table 7.2: Summary of Nested Institutional Arrangements (cont'd)

Source Protection									
	Ontario			**New York**			**Nebraska**		
	t-1 2002-2006			t-1 1986-1996			t-1 1986-1994		
all	9			14			18		
vertical	2			5			5		
horizontal									
local	0	F+	--	1	F+	M	1	F+	M
		F-	--		F-	--		F-	--
		F+/-	--		F+/-	L		F+/-	L
		Fn	--		Fn	L		Fn	L
		S	--		S	H		S	M
intra	1	F+	H	3	F+	M	3	F+	M
		F-	--		F-	M		F-	--
		F+/-	L		F+/-	M		F+/-	L
		Fn	--		Fn	L		Fn	L
		S	H		S	H		S	M
p/s	8	F+	H	5	F+	M	9	F+	M
		F-	--		F-	M		F-	--
		F+/-	L		F+/-	L		F+/-	L
		Fn	--		Fn	L		Fn	L
		S	H		S	M		S	M
inter	0	F+	--	1	F+	M	1	F+	L
		F-	--		F-	--		F-	--
		F+/-	--		F+/-	M		F+/-	M
		Fn	--		Fn	M		Fn	L
		S	--		S	H		S	H
national	0	F+	--	4	F+	M	4	F+	L
		F-	--		F-	--		F-	--
		F+/-	--		F+/-	M		F+/-	L
		Fn	--		Fn	L		Fn	L
		S	--		S	H		S	M

Legend: F+=Functionally Positive; F-=Functionally Negative; F+/-=Functionally Positive/Negative; Fn=Functionally Neutral; S=Strategic L=Low; M, Mod=Moderate; H=High; n=nil

Table 7.3: NIA Ratios

Well Driller Regulations																					
	Ontario									New York			Nebraska								
	t-1 1966-1970			t-2 1980-1984			t-3 2000-2004			t-1 1996-2006			t-1 1980-1986			t-2 1987-1994			t-3 1998-2004		
horizontal	LT	#	R	LT	#	R	LT	#	R	LT	#	R	LT	#	R	LT	#	R	LT	#	R
local	F+	3	1.5	F+	2	1.0	F+	2	1.0	F+	3	1.5	F+	6	6.0	F+	8	8.0	F+	9	9.0
	F-	0	0	F-	4	2.0	F-	4	2.0	F-	0	0	F-	1	1.0	F-	1	1.0	F-	0	0
	F+/-	6	3.0	F+/-	9	4.5	F+/-	8	4.0	F+/-	10	5.0	F+/-	6	6.0	F+/-	7	7.0	F+/-	6	6.0
	Fn	0	0	Fn	0	0	Fn	3	1.5	Fn	12	6.0	Fn	3	3.0	Fn	3	3.0	Fn	3	3.0
	S	7	3.5	S	1	0.5	S	1	0.5	S	0	0	S	0	0	S	0	0	S	0	0
intra	F+	--	--	F+	--	--	F+	--	--	F+	2	1.0	F+	15	5.0	F+	21	7.0	F+	31	7.8
	F-	--	--	F-	--	--	F-	--	--	F-	0	0	F-	1	0.3	F-	1	0.3	F-	0	0
	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	11	5.5	F+/-	19	6.3	F+/-	21	7.0	F+/-	26	6.5
	Fn	--	--	Fn	--	--	Fn	--	--	Fn	12	6.0	Fn	5	1.7	Fn	6	2.0	Fn	8	2.0
	S	--	--	S	--	--	S	--	--	S	0	0	S	4	1.3	S	4	1.3	S	6	1.5
p/s	F+	3	0.5	F+	4	0.6	F+	5	0.6	F+	10	1.1	F+	36	3.0	F+	68	4.9	F+	56	4.3
	F-	0	0	F-	5	0.7	F-	4	0.5	F-	0	0	F-	8	0.7	F-	11	0.8	F-	7	0.5
	F+/-	6	1.0	F+/-	17	2.4	F+/-	17	2.1	F+/-	28	3.1	F+/-	40	3.3	F+/-	53	3.8	F+/-	33	2.5
	Fn	4	0.7	Fn	4	0.7	Fn	13	1.6	Fn	44	4.9	Fn	31	2.6	Fn	34	2.4	Fn	19	1.5
	S	7	1.2	S	1	0.2	S	2	0.3	S	5	0.6	S	18	1.5	S	20	1.4	S	19	1.5
inter	F+	--	--	F+	--	--	F+	--	--	F+	--	--	F+	--	--	F+	--	--	F+	--	--
	F-	--	--	F-	--	--	F-	--	--	F-	--	--	F-	--	--	F-	--	--	F-	--	--
	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	--	--
	Fn	--	--	Fn	--	--	Fn	--	--	Fn	--	--	Fn	--	--	Fn	--	--	Fn	--	--
	S	--	--	S	--	--	S	--	--	S	--	--	S	--	--	S	--	--	S	--	--
national	F+	0	0	F+	0	0	F+	0	0	F+	2	1.0	F+	5	5.0	F+	7	7.0	F+	4	4.0
	F-	0	0	F-	0	0	F-	0	0	F-	0	0	F-	1	1.0	F-	1	1.0	F-	6	6.0
	F+/-	2	2.0	F+/-	5	5.0	F+/-	5	5.0	F+/-	5	2.5	F+/-	0	0	F+/-	0	0	F+/-	0	0
	Fn	1	1.0	Fn	1	1.0	Fn	2	1.0	Fn	32	16	Fn	10	10.0	Fn	11	11.0	Fn	8	8.0
	S	2	2.0	S	0	0	S	0	0	S	3	1.5	S	3	3.0	S	3	3.0	S	0	0

Legend: LT = Linkage Type; # = Number of Linkages; R = Ratio (Number of Linkages ÷ Number of Governance Units at specified level (from Table 7.2))
F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive/Negative; Fn = Functionally Neutral; S = Strategic
L = Low; M, Mod = Moderate; H = High; n = nil

Table 7.3: NIA Ratios (cont'd)

Water Takings	Ontario						New York			Nebraska								
	t-1 1958-1964			t-2 1999-2006			t-1 1985-1991			t-1 1980-1987			t-2 1991-1999			t-3 2000-2005		
horizontal	LT	#	R	LT	#	R	LT	#	R	LT	#	R	LT	#	R	LT	#	R
local	F+	2	2.0	F+	--	--	F+	--	--	F+	1	1.0	F+	1	1.0	F+	1	1.0
	F-	0	0	F-	--	--	F-	--	--	F-	2	2.0	F-	2	2.0	F-	4	4.0
	F+/-	4	4.0	F+/-	--	--	F+/-	--	--	F+/-	7	7.0	F+/-	7	7.0	F+/-	7	7.0
	Fn	0	0	Fn	--	--	Fn	--	--	Fn	6	6.0	Fn	6	6.0	Fn	5	5.0
	S	1	1.0	S	--	--	S	--	--	S	1	1.0	S	1	1.0	S	1	1.0
intra	F+	--	--	F+	13	4.3	F+	0	0	F+	15	5.0	F+	16	5.3	F+	17	5.7
	F-	--	--	F-	0	0	F-	0	0	F-	1	0.3	F-	1	0.3	F-	3	1.0
	F+/-	--	--	F+/-	11	3.7	F+/-	2	2.0	F+/-	22	7.3	F+/-	21	7.0	F+/-	20	6.7
	Fn	--	--	Fn	9	3.0	Fn	3	3.0	Fn	7	2.3	Fn	7	2.3	Fn	9	3.0
	S	--	--	S	6	2.0	S	0	0	S	5	1.7	S	6	2.0	S	7	2.3
p/s	F+	3	0.6	F+	19	2.1	F+	3	0.5	F+	44	3.4	F+	46	3.5	F+	48	3.4
	F-	0	0	F-	0	0	F-	0	0	F-	5	0.4	F-	5	0.4	F-	6	0.4
	F+/-	3	0.6	F+/-	31	3.4	F+/-	11	1.8	F+/-	60	4.6	F+/-	58	4.5	F+/-	64	4.6
	Fn	4	1.3	Fn	22	2.4	Fn	16	2.7	Fn	22	1.7	Fn	22	1.7	Fn	33	2.4
	S	5	1.0	S	11	1.2	S	1	0.2	S	13	1.0	S	15	1.2	S	21	1.5
inter	F+	--	--	F+	--	--	F+	--	--	F+	--	--	F+	--	--	F+	--	--
	F-	--	--	F-	--	--	F-	--	--	F-	--	--	F-	--	--	F-	--	--
	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	--	--	F+/-	--	--
	Fn	--	--	Fn	--	--	Fn	--	--	Fn	--	--	Fn	--	--	Fn	--	--
	S	--	--	S	--	--	S	--	--	S	--	--	S	--	--	S	--	--
national	F+	0	0	F+	0	--	F+	0	0	F+	7	7.0	F+	7	7.0	F+	7	7.0
	F-	0	0	F-	0	--	F-	0	0	F-	0	0	F-	0	0	F-	1	0
	F+/-	1	1.0	F+/-	5	5.0	F+/-	2	2.0	F+/-	4	4.0	F+/-	4	4.0	F+/-	4	4.0
	Fn	1	1.0	Fn	4	4.0	Fn	3	3.0	Fn	4	4.0	Fn	4	4.0	Fn	4	4.0
	S	1	1.0	S	0	0	S	0	0	S	1	1.0	S	1	1.0	S	1	1.0

Legend: LT = Linkage Type; # = Number of Linkages; R = Ratio (Number of Linkages ÷ Number of Governance Units at specified level (from Table 7.2))
F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive/Negative; Fn = Functionally Neutral; S = Strategic
L = Low; M, Mod = Moderate; H = High; n = nil

Table 7.3: NIA Ratios (cont'd)

Source Protection									
	Ontario			New York			Nebraska		
	t-1 2002-2006			t-1 1986-1996			t-1 1986-1994		
horizontal	LT	#	R	LT	#	R	LT	#	R
local	F+	--	--	F+	5	5.0	F+	6	6.0
	F-	--	--	F-	0	0	F-	0	0
	F+/-	--	--	F+/-	3	3.0	F+/-	6	6.0
	Fn	--	--	Fn	5	5.0	Fn	5	5.0
	S	--	--	S	1	1.0	S	2	2.0
intra	F+	7	7.0	F+	18	6.0	F+	24	8.0
	F-	0	0	F-	1	0.3	F-	0	0
	F+/-	1	1.0	F+/-	3	1.0	F+/-	12	4.0
	Fn	0	0	Fn	14	4.7	Fn	10	3.3
	S	7	7.0	S	3	1.0	S	6	2.0
p/s	F+	31	3.9	F+	26	5.2	F+	46	5.1
	F-	0	0	F-	1	0.2	F-	0	0
	F+/-	3	0.4	F+/-	8	1.6	F+/-	28	3.1
	Fn	0	0	Fn	20	4.0	Fn	41	4.6
	S	29	3.6	S	4	0.8	S	12	1.3
inter	F+	--	--	F+	6	6.0	F+	8	8.0
	F-	--	--	F-	0	0	F-	0	0
	F+/-	--	--	F+/-	2	2.0	F+/-	3	3.0
	Fn	--	--	Fn	5	5.0	Fn	6	6.0
	S	--	--	S	1	1.0	S	1	1.0
national	F+	--	--	F+	18	4.5	F+	24	6.0
	F-	--	--	F-	0	0	F-	0	0
	F+/-	--	--	F+/-	11	2.3	F+/-	11	2.3
	Fn	--	--	Fn	17	4.3	Fn	27	6.8
	S	--	--	S	1	0.3	S	4	1.0

Legend: LT = Linkage Type; # = Number of Linkages; R = Ratio (Number of Linkages ÷ Number of Governance Units at specified level (from Table 7.2))
F+ = Functionally Positive; F- = Functionally Negative; F+/- = Functionally Positive/Negative; Fn = Functionally Neutral; S = Strategic
L = Low; M, Mod = Moderate; H = High; n = nil

protection. In well driller regulations, an approximate two to one difference existed in the number of governance units between Nebraska and Ontario while a much smaller increase in governance units existed in relation to New York and Nebraska (16 NY to 17-19 NE). This latter difference is not insignificant given the split horizontal authority for licensing enforcement that existed at the state level in New York where four enforcement governance units (not including the courts) existed. If these are controlled for, the difference becomes similar to that found in Ontario. Source water protection differences exhibit differences in governance unit numbers in relation to diffuse authority between vertical governance levels previously discussed.

(b) ***number and type of linkages***

- At the intra-regional and provincial/state levels, a higher ratio[50] of functionally positive (F+) linkages in low uncertainty areas exists, except when authority is divided between two of more vertical levels of governance.
- At the intra-regional and provincial/state levels, a higher ratio of functionally positive or negative (F+/-) linkages in low uncertainty areas exists regardless of diffused authority.
- Narrow interests (e.g. program area, regulatory changes) require a higher ratio of strategic linkages in low uncertainty areas at the intra-regional and provincial/state levels.

Much variation occurred in the number and type of linkages across the

[50]Ratio = Number of F+ linkages at a governance level divided by the number of governance units at that level for a jurisdiction in a particular time frame. See Table 7.2 for the number of governance units and Table 7.3 for other data and ratio results.

programs and time frames. As Table 7.3 illustrates, Nebraska, a low uncertainty area, had a higher ratio of functionally positive linkages to the number of governance units at the intra-regional and state levels except where authority was diffused. In relation to well driller regulations, Nebraska had a five to seven time higher functional positivity ratio at the intra-regional level and a three to four time higher functional positivity ratio at the state level when compared to Ontario and New York. In comparison, when authority was divided between the intra-regional and provincial/state levels in high uncertainty areas, the difference in the functional positivity ratio narrowed considerably. This can be seen in relation to water takings between Ontario (t-2) and Nebraska and in source protection between New York and Nebraska.

What does this mean? It suggests that the larger number of governance units in low uncertainty areas requires a high positive functionality ratio to achieve groundwater policy changes. Furthermore, to achieve similar groundwater policy changes in high uncertainty areas where authority is diffuse, the lower number of governance units found in these areas requires a similarly high positive functionality. In short, a positive functionality matters in relation to increased complexity in regards to governance numbers and diffused authority.

Less important but nonetheless notable is the higher ratio of F+/- linkages in low uncertainty areas regardless of diffuse authority at the intra-regional and provincial/state levels as shown in Table 7.3. This is likely a reflection of the fact that as uncertainty decreases any policy change decisions are likely to elicit a positive and or negative linkage, that is, there are likely to be more winners (positive linkages) and losers (negative linkages) due to resource limitations. In high uncertainty areas (ON, NY), it is unclear what the limitations of the resource are and, therefore, the F+/- ratio is lower.

Furthermore, strategic linkages matter in relation to program specificity. Broad program areas, such as was the case with source protection activities, elicited a high variance in strategic linkages with no discernable patterns evident. Water takings, a narrower program area since it affects fewer constituencies, showed a similar strategic linkage ratio between high and low uncertainty levels. In comparison, changes to well driller regulations which affected a very narrow constituency, well drillers, required a high ratio of strategic linkages in low uncertainty areas. This last result is surprising in that the same narrow benefits will accrue to the same constituency, well drillers, regardless of uncertainty levels. However, it may also reflect the fact that the benefits will unfairly advantage one party in low uncertainty areas to the disadvantage of others. Indeed, this was the case in Nebraska when well driller regulatory changes were undertaken (t-1). As officials noted, the most challenging part to the regulatory changes were the objections from others who were arguing the industry was "trying to protect themselves from outsiders" and that "this was not consumer protection" (UN-L C/S Division official, interview, 16 November 2007). In other words, the regulatory changes would provide an advantage to a narrow group in a low uncertainty area, such as Nebraska, yet it was unclear how much of an advantage the benefitting party may have received in high uncertainty areas (ON, NY).

(c) *linkage complementarity*

- A higher linkage complementarity is required in high uncertainty areas, except when authority is divided between two or more vertical levels of governance.

Linkage complementarity matters but not as much as CPR theory posits. The data for source protection and well driller regulations suggests that linkage complementarities need to be higher in areas of high uncertainty (see Table 7.2). For instance, in relation to source protection, both Ontario and New York had a higher linkage complementarity (albeit less robust for New York) among the intra-regional and provincial state levels when compared to Nebraska. Similarly, for well driller regulatory changes, linkage complementarities were higher for Ontario than Nebraska but not so between New York and Nebraska where they were virtually identical. This does not dispel the pattern, rather one must recall the multiple adjudication units (four) at the state level in New York which generally had a low complementarity with most other governance units (see Table 5.4 in Chapter 5). If these adjudication units are controlled for, complementarity levels increase for New York thus validating the finding. A similar situation existed in relation to water takings between the three jurisdictions though results are not as pronounced. It is also important to note that the necessity for higher linkage complementarity disappears when authority is diffused between two or more vertical governance levels. This can be seen in relation to water takings between Ontario (t-2) and Nebraska.

The results suggest that governance units in high uncertainty areas need to work closely together when authority is concentrated at one governance level to achieve groundwater policy changes. Similarly, when authority is diffused among many vertical governance levels, governance units can afford a lower complementarity at one level if venues are available elsewhere to address policy change. It also reflects the limited level of resources available which are primarily invested at the main authority level except when that authority level is diffuse, then resources are divided between authority levels. How significant of a change is this given the lack of differences in changes in policies? It may add to the infrequency of policy instrument changes in low uncertainty areas. This also suggests an additional challenge for governance units in high uncertainty areas to overcome when authority is concentrated at one governance level.

7.4 Other Notable Changes

Four other notable changes were found and are as follows:

- Local level governance units are largely inactive in the process regardless of uncertainty levels (Note that Natural Resource Districts, Conservation Authorities and the like are classified as intra-regional governance units. See text pp 314-316 for clarification.).
- Intra-regional level governance units are active in the process in areas of low uncertainty.

- A few national level governance units are involved in the process in a supportive role even when they are the initiators of groundwater policy changes.
- A shift from bi-lateral to multilateral relationships occurs for controversial issues that affect a broad range of interests.

The lack of local level governance units involved in the process was surprising given their emphasis in the CPR literature (e.g. Ostrom, 1990; Rose, 2002). Over the sixteen time frames covered in this dissertation, only seventeen local governance units were identified as part of the policy process and all but one were local governments. This suggests cause for concern given their importance in the sustainable management of CPRs, yet a more nuanced interpretation is required. Local governance units that may impact groundwater are many in number, such as local conservation groups, yet few possess authoritative powers over a particular groundwater aspect and/or may lack resources, human and financial, to be significantly involved in the process. Hence, the lack of local governance units is a concern yet this concern has to consider the level of intra-regional governance units involved in the process. With high intra-regional governance unit participation, concern over the lack of local involvement declines. Note that intra-regional governance units such as Natural Resource Districts (NRDs) with authority over more restrictive well spacing and water permits, for instance, were very active in Nebraska, the area of low uncertainty. Furthermore, the above finding is consistent regardless of authority fragmentation as shown by the comparison between well driller and water takings regulatory changes and challenges CPR theory's emphasis on local involvement in a CPR's management.

The above point however brings up the issue of what is considered local. Should locality be defined on municipal boundaries? If so, few groups would qualify. Rather, many local governance units spill over local municipal boundaries to include several municipal jurisdictions. Such is the case with Conservation Authorities in Ontario, Soil and Water Conservation Districts in New York and Natural Resource Districts in Nebraska. This dissertation has classified these types of governance units as intra-regional and when they are considered, a more complex picture emerges. For instance, there were thirty two intra-regional governance units identified overall as being active in the policy process. Combined with local governance units above, a robust involvement of lower tier governance units emerges, one that more closely aligns with CPR theory.

Why the need to divide up lower tiered governance units? This question is even more pertinent given the fact many officials interviewed referred to the intra-regional units as local entities such as "your local Conservation Authority" or "local Natural Resources Districts". The point is that nesting is popularly conceived in three vertical governance layers (local, provincial/state, national), yet NIAs are more complex than this. Important differences exist in relation to governance units operating at different levels such as levels of authority, membership and budgets. These are differences which may impact the groundwater policy change process differently. In order to tease out the effects of NIAs on the type, frequency and magnitude of groundwater policy change, a more robust depiction of NIAs is required which is the approach this dissertation has taken.

This same lack of involvement in groundwater policy changes is noted in relation to national governance units. Most national governance units identified related to the courts except for a few other groundwater institutions such as the National Ground Water Association (NGWA) and the USEPA. These governance units largely provided specific resources as was the case with the NGWA and their well driller certification programs. Similarly, national governance units' participation rates were low even when they were the initiators of a policy in question, such as was the case with source protection by the USEPA in both New York and Nebraska. Note that the USEPA's involvement was directed through their Regional Divisions (Region 2 and 7) who dealt directly with the states in question. This top down policy change process provided the opportunity for much conflict yet no conflict ensued largely due to the lack of funds for program implementation. For instance, national program demands were interpreted broadly and flexibly to ensure state level program uptake given the lack of funds attached with source water protection. Furthermore, both the inter-regional (USEPA Regional Offices) and national governance units (USEPA) of the program initially played a strong supportive role throughout the process (NDEQ, USEPA Region 2 & 7 Offices & NYDOH BWSM officials, interviews, 14 November 2007, 19 July, 02 November and 20 July 2007 respectively). This supportive role provided by upper tier governance units is consistent with CPR theory.

This lack of local and national involvement tended to disappear in relation to controversial issues that affected a broad range of interests. In these cases, bi-lateral relationships tended to be replaced with multilateral ones that also expanded to include a much more diverse group of interests. This can be seen in relation to source protection across all three jurisdictions where advisory committees with technical and implementation sub-committees were formed. The various governance units, that is, the main stakeholders which expanded to include diverse interests such as environmental groups and chemical manufacturing groups, were represented in these committees and were charged with plotting a course of action and/or program implementation. Decisions were made on a consensus basis in these committees to alleviate opposition. As one Nebraska Official noted, this did not mean that everyone left the room in complete agreement, rather it was a question of "what could each of us live with" (NDEQ official, interview, 24 November 2007). Once a course of action was arrived at, the existing governance units worked to ensure its legislative passage and implementation. In essence, there were two or more levels of linkages going on at the same time with all the main governance units represented in the multilateral processes, as well as, having separate linkages outside of these forums either to carry out related work in support of the advisory committees, for the implementation of advisory committee decisions and/or for existing other governance parameters related to other program dynamics. In short, the nature of the good in question accounts for much of the variation in local and national involvement.

A similar multilateral relationship occurred in Nebraska in relation to water takings. Note the formation of the Water Policy Task Force (WPTF) set up to examine the integrated management of surface water and groundwater which had implications for groundwater permits near streams and rivers. The potential changes largely pitted surface water and groundwater irrigators against each other since what one gained the other lost with further implications for municipalities and environmental groups among others (see Figure 6.6). The multilateral forum was established to determine a course of action that all parties could live with yet addressed the problem at hand and, similar to the source protection committees, linkages were both related to membership in the WPTF, in support of its work, as well as, to the continued work in relation to other programs. In short, the advisory committees added an extra governance unit to the nesting configuration that diffused potential conflicts between existing bi-lateral relationships between governance units by opening up the process to discussion and review. Each governance unit, one official noted, could walk away claiming some success in the process while deflecting blame to the advisory committees for problematic areas thus preserving the integrity of the bi-lateral relationships (NDNR officials, interviews, 15 November 2007).

7.5 Related Premises

This dissertation has specifically examined the effects of NIAs on the type, frequency and magnitude of groundwater policy change under different conditions of uncertainty to reveal clues for the development of a strategy of groundwater policy change. Some additional questions are now briefly examined.

(a) *Do different types of changes require different types of NIAs?*

This question arose early on in the dissertation and the data presented in Chapters 4, 5 and 6 for Ontario, New York and Nebraska respectively noted many groundwater policy changes that occurred in relation to policy goals, policy instruments and policy instrument settings. The evidence presented does not suggest that different types of NIAs are required for different types of changes in groundwater policy. Rather, it is important to note that similar changes in groundwater policy can occur in both high and low uncertainty conditions. Furthermore, it is not a question of whether a change in policy goals requires a particular type of NIA while a change in policy instruments requires a second NIA configuration. The question is more related to the process one goes through to achieve the changes in groundwater policy brought on by differing levels of uncertainty. The evidence presented shows that as uncertainty declines (e.g. an increase in knowledge related to groundwater's parameters, use and/or disuse), an increase in both horizontal governance units at different layers and in vertical governance layers occurs. Moreover, the frequency of policy instrument setting changes increases under conditions of low uncertainty when compared to conditions of high uncertainty though this difference in frequency is negated when governance authority is fragmented under conditions of high uncertainty. Similarly, functionality matters as do strategic linkages, the latter in relation to regulatory changes that concentrate benefits on the few. In short, similar changes can occur under both conditions of uncertainty but the process by which they are arrived at varies greatly.

(b) *The frequency and magnitude of policy change are expected to be greater in the*

Ogallala Aquifer due to the finite condition of the aquifer.

Yes and no. Indeed, the frequency of policy change increased in relation to the low uncertainty area, Nebraska, but this only applied to changes related to the settings of the policy instrument. This was clearly evident in relation to all three program areas. For instance, Nebraska underwent frequent changes in well driller licensing and well construction standards throughout all time periods. It was a matter of instituting a program to begin with then continually fine tuning the regulatory particulars. It may be the case where now that well established procedures are in place, future years will see fewer changes to policy instrument settings. This would not be unusual and would suggest a maturation of the regulatory framework, such as occurred in relation to water takings in Nebraska. Note that water permits had been established for years and instrument setting changes were frequent except in the last time period when changes became infrequent. This suggests that much "tinkering" had been done previously and a high level of satisfaction existed with the regulatory framework negating the need for many more instrument setting changes as noted in the description of clear lines of authority in water permit applications for the last period in question (t-3) by officials (NDNR officials, interviews, 15 November 2007).

In contrast, no discernable effects of NIAs on the magnitude of policy changes were found between high and low uncertainty areas. On the contrary, magnitude changes were very similar across the board. Why this was so is harder to answer and no firm conclusion is reached here. It may indicate a maturation of the groundwater regulatory framework in Nebraska negating the pressures placed on governance units to act in order "to get it right". In other words, governing authorities have achieved a system that seems to produce perceived satisfactory results thereby reducing pressures for significant changes. The situation may also reflect the high level of program initiation in the high uncertainty areas of Ontario and New York when compared to Nebraska, the low uncertainty area, due to the predictability in as

(c) *The frequency and magnitude of groundwater policy change is expected to be slower, less dramatic in jurisdictions where groundwater policy is concentrated at the provincial/state level (NY, ONT).*

This was not the case for reasons explained in the preceding query. This point was also predicated on the fact that authority would be concentrated at the provincial/state level. Concentrated authority had no bearing on the magnitude of changes in groundwater policy goals and instruments. Note the similarities in the frequency and magnitude of changes related to water takings in Nebraska (all time periods) where authority was diffused and in well driller regulations where authority was concentrated at the state level in Nebraska. Also note the change similarities (speed, magnitude) across the three jurisdictions for all programs. This emphasizes the more subtle processes leading to the changes such as linkage functionality, the relation between program specificity and strategic linkages, and linkage complementarities discussed above. However, concentrated authority does lead to less frequent changes in policy instrument settings as shown in the few changes that occurred in relation to well driller and water takings regulations in Ontario and New York.

(d) *Expected result overall: greater number of governance units functionally and complementarily linked will be found in areas of low uncertainty.*

This overall expected result needs to be modified to take into consideration the effects of diffuse authority structures between two or more vertical levels of governance. For instance, while a higher number of functionally positive governance units were found in low areas of uncertainty, the difference largely disappeared when authority was fragmented between two or more vertical levels of governance. The results also point out that a higher complementarity in linkages is required in areas of *higher* uncertainty contrary to what was predicted and that this result disappeared when authority was fragmented between two or more vertical levels of governance (see above discussion under linkage complementarity). The revised result should read as follows:

• In situations of concentrated authority (e.g. at one governance level), a greater number of governance units are linked functionally and positively yet have low levels of linkage complementarity and are found in low levels of uncertainty.

• In situations of fragmented authority (e.g. between two or more vertical governance levels), a greater number of governance units are found in areas of low uncertainty with no significant differences in functionally positive linkages or linkage complementarity.

7.6 What Does It Mean "On The Ground"?

A policy change puzzle was introduced in the introductory chapter (see pp. 25-27). It asked whether efforts to improve groundwater quality management should be directed at raising water withdrawal thresholds required for permits or registration (Option 1), instituting a water withdrawal permit or registration program in the first place (Option 2), and/or taxing metered water withdrawal consumption (Option 3). The choices reflected differences in the type, frequency and magnitude of groundwater policy change. What should one do?

The results in this dissertation provide some guidance to the selection of a course of action yet largely depend on available timelines and resources (human and economic). Changes to water withdrawal thresholds (Option 1, a change in policy instrument setting) would be the fastest possible change to occur but only in areas of low uncertainty. Moreover, if authority for water withdrawals is fragmented between at least two vertical governance levels, withdrawal changes would occur at the same frequency regardless of uncertainty levels given the fact diffuse authority structures slow down instrument setting changes in low uncertainty jurisdictions and have the opposite effect in high uncertainty jurisdictions.

Option 2 (a change in policy goals, instruments and instrument settings) and Option 3 (a change in policy instrument) are just as likely to occur as frequently regardless of authority structure and uncertainty levels. The important point here is where action needs to be directed. For instance, under a framework where authority is concentrated at one governance level, work will need to be done to increase the number of one's functionally positive linkages. This could mean a realignment of one's core activities with many of the other governance units and, in essence, becoming an intricate part of the governance web. Note that this may mean an increase in staffing levels which can strain financial resources thus potentially restricting one's ability to act and, therefore, contributing to the policy change process. The realignment could also be a lengthy process given institutional constraints and mandates, especially public sector ones.

The situation is different under a fragmented authority structure. Under such cases, resources need to be spread broadly across vertical governance layers and units. One is not necessarily better than the other and each has pitfalls. For instance, investing more heavily at one governance level may leave one wanting if program changes occur in such a way that one cannot respond fast enough or if one is also dependent on other governance units to fund part of their work as was the case with Rural Water Associations in both New York and Nebraska. Note that both receded quickly from source protection activities once funding levels from other governance units were cut. On the other hand, investing less but spreading that investment in activities over more vertical governance layers may render one's efforts ineffectual. In other words, the resources expended may be too few and spread too thinly to make a difference. Again, this is not to say that one option is better than the other, rather one should recognize the pitfalls of each and be able to adapt quickly when needed.

Similarly, the complementarity of the linkages one develops in order to achieve either Option 2 or Option 3 needs to be recognized and evaluated. A higher complementarity in linkages is required in areas of high uncertainty and concentrated authority structures (e.g. at one governance level). This difference is negated when authority structures are diffused over two or more vertical governance layers. This is important in identifying and directing where investments in collaborative efforts should be placed. Likewise, who benefits from a change in the regulatory structure is just as important. Benefits potentially bestowed on a narrow pool of constituents will require a higher level of strategic linkages in low uncertainty levels. No one wants to be "left out" or disadvantaged from a regulatory change that may or may be seen to unfairly advantage a competing interest. Hence, a higher level of investment is required in developing strategic linkages to overcome opposition and/or to ensure one's continued position.

As can be seen, any of Option 1, 2 or 3 can be instituted yet process matters and with careful attention to NIAs, uncertainty levels and authority structures, a better plan of action may be taken.

7.7 Strengths and Limitations of the Findings

Every piece of research has certain strengths and limitations and this dissertation is no exception. Strengths relate to both theoretical developments and the research design while weaknesses largely relate to generalizability. Note that a further potential weakness in terms of a data bias related to the more recent data did not materialize. Each of these points is discussed in the next few paragraphs.

From a theoretical perspective, the strengths of the dissertation's findings lie in the fact that they support how and when NIAs matter in the groundwater policy change process. A positive functionality matters but only in areas of low uncertainty and concentrated authority. In contrast, complementarity of linkages matters more in areas of high uncertainty and concentrated authority. Similarly, strategic linkages matter most in narrow regulatory changes which can potentially concentrate benefits on the few. The findings begin to stake out the broad parameters of a strategic framework for groundwater policy change, that is, how to move along the CPR tragedy-sustainability continuum in a heterogeneous society in relation to a large scale complex CPR, groundwater, given the need for NIAs. In short, it is possible to unravel what an NIA is from the various strands in the literature. Furthermore, as this thesis shows, it is also possible to develop linkages between NIAs and outcomes for particular situations (e.g. high uncertainty versus low uncertainty areas) in relation to specific common pool resources (e.g. groundwater).

This undoubtedly brings up questions of generalizability, a limitation of the dissertation. Note that the findings apply only to *one* type of CPR, groundwater. Similar work is needed in relation to other types of CPRs such as irrigation, forestry, fisheries and communications (e.g. internet) to determine the applicability of the results. Moreover, this work needs to be undertaken in areas where the CPR forms a less significant part of a community's activities. For instance, directly in relation to this study, work needs to be done in jurisdictions where the Ogallala Aquifer and the Great Lakes Basin do not form a significant part of the jurisdictions such as in Pennsylvania and Oklahoma. Likewise, work needs to be done in other first-world and non-first-world jurisdictions. Note that this dissertation was completed in first-world jurisdictions, Canada and the United States, and, even at that, a very limited segment of first-world countries, North America. This is an expansive research plan which is beyond the scope of a single dissertation, yet the need exists to recognize the limitations of the research findings' applicability.

Questions of generalizability aside, stock can be taken in the dissertation's findings due to the research design, a second strength of the dissertation. Chapter 3 detailed the research design used to ensure high validity, reliability and replicability levels. Validity assurances were gained by the fact that care was taken to accurately measure the independent variables which was relatively easy with the number of governance units and linkages yet proved more challenging in reference to the determination of linkage complementarity. A governance unit's governance vision (goals) alone was deemed insufficient as a measure as were collaboration levels. Note that collaboration levels do not capture the "active" nature of the complementarity which is important since it is an indicator of the level of interest and engagement. For these reasons, a threefold scale of linkage complementarity was undertaken that included governance visions, communication levels and collaboration levels which was then averaged to obtain a fuller measure of linkage complementarity.

A high reliability was ensured by following the same data collection procedures in all jurisdictions over all time frames. Legislative changes were first identified and grouped into time periods. This was followed by both a historical overview of groundwater management in all jurisdictions gleaned from secondary sources such as books and journals. It is these same materials that provided the framework that led to the legislative and regulatory changes. This material was supplemented by numerous primary documents such as meeting minutes and conference proceedings to more accurately depict the regulatory context. Multiple interviews with officials in all jurisdictions (see Appendix IX) then provided further insight to the connections between governance units, as well as, provided "colour" to the legislative and regulatory changes. Finally, the empirical chapters were sent to at least two interviewees in each jurisdiction for factual clarification and verification. The same process was systematically and methodically followed in all jurisdictions and results are shown in the Summary Tables in each of the empirical chapters.

Moreover, a high confidence level can be placed in the dissertation's findings due to the replicability of the results. Note that where possible multiple time periods were used to discern the effects of NIAs on the type, frequency and magnitude of groundwater policy change. Furthermore, the results were replicated over three dependent variables, well driller regulations, water takings and source protection, to further discern patterns of behaviour. In short, an expansive and complex research design was used to ensure a high confidence level in the findings. One weakness does exist in relation to replicability in that many of the comparisons are based on program initiations and are not "clean" comparisons of existing programs across all jurisdictions. This was expected given the fact jurisdictions are at different points in regulatory development, yet note that enough replicability exists to ensure a high confidence level in the results.

One issue that was a potential limitation turned out not to be so. Note that the research covered a significant period of time with well driller regulations covering the period from 1966-2006, water takings covering the period from 1958-2006 and source protection from 1986-2005. The question is whether the relatively recent regulatory changes that occurred in relation to source protection (Ontario), water takings (Ontario t-2, Nebraska t-3) and well driller regulations (Ontario t-3, New York, Nebraska t-3) biases the data set? This is possible since people may have a better recall of data, are readily available, and better documentation could exist. No biases were detected with the recent data. Evidence of this can be found in comparisons with other jurisdictions and/or other time periods within the same jurisdiction where data patterns remain constant. For instance, in regards to source protection, note that the Ontario complementarity patterns are similar to New York and higher than in Nebraska. In regards to water takings, note that patterns in Ontario (t-2) are different than in Ontario (t-1) and New York, yet the differences disappear when diffuse authority is considered, a pattern that is consistent with findings in Nebraska for all of its three time periods. Finally, in regards to well driller regulations, patterns in the data in Ontario (t-3) and Nebraska (t-3) are consistent with patterns in the two earlier time periods for each jurisdiction. Furthermore, while patterns for New York well driller regulatory changes are different, the difference is negated once the large number of adjudication units (exclusive of the courts) are controlled for as previously noted. In short, enough replication in the data occurs to dismiss the claim that a bias was introduced.

Even though the results do not support the claim that recent data is biased, the fact remains that people may have had a better recall of data, were readily available, and that better documentation would exist. How does one explain this apparent anomaly? If people did, indeed, have a better recall of data, they certainly did not provide such richness of detail during the interviews. Note that most of their answers were conservative in nature while they were "cagey" in response to other questions. This was perhaps best exemplified in the interview with one Ontario official where answers were vague and/or questions not answered (OMOE LWPB official, interview, 26 March 2007). Other officials were not as vague in their responses yet were conservative in their answers such as the case with Nebraska DHHS and NDNR officials. This conservativeness provided a more nuanced version of events not unlike one would find in talking to officials about regulatory changes that occurred long ago where they may have forgotten some particulars. Note that availability of people for recent data in terms of the fact that they exist and are easily reached does not mean they will grant an interview. Of the approximately one dozen interview requests that were declined, all but one of these were related to recent regulatory changes. As such, much more work was needed to contact others closely involved in the process to facilitate a full understanding of the regulatory change environment.

What about the documentation? Was better documentation not available for the recent regulatory changes? No, this was not the case. In fact, the opposite was true in that a period of time had to have passed before sufficient documentation was available for study. This can be seen in the excellent documentation of events in the earlier periods (especially Ontario and Nebraska) and the willingness of most current officials to search for more archival documents when requested. However, when it came to the more recent changes, primary documents and reports were much harder to obtain, officials were much more suspicious and agreed to document provisions often never "materialized". This also introduced an element of conservativeness in any data collected and contributed to the lack of bias in relation to recent regulatory changes.

7.8 Summary

This chapter has analyzed the data presented in the empirical chapters, that is, the dense web of NIAs that existed, on the type, frequency and magnitude of groundwater policy change. Briefly, it found no discernable differences between high and low uncertainty areas in relation to changes in policy goals and policy instruments. Policy instrument setting changes were, however, frequent in areas of low uncertainty though this difference was negated when authority was diffused between two or more governance layers. The number of governance units and the positive functionality of the linkages were both higher in areas of low uncertainty while linkage complementarity was higher in high uncertainty areas. The latter two differences disappear when authority was fragmented between two or more governance layers. Also note that strategic linkages matter for narrow regulatory changes that benefit a small target group but only in low uncertainty areas. Lastly, it highlighted the lack of engagement by local and national governance units and the introduction of multilateral forums for more controversial issues.

These findings were then related to several premises posited in the dissertation with the most important being that the greater number of governance units functionally and complementarily linked will be found in areas of low uncertainty. Given the above results, this premise needed to be modified to take into account differences introduced by diffuse authority. In situations of concentrated authority at one governance level, a greater number of governance units linked functionally and positively yet with low levels of complementarity were found in low levels of uncertainty. Note that these latter two differences disappeared when authority was fragmented between two or more vertical governance levels.

An elaborate example was worked through to gauge what the results meant "on the ground". It is not repeated here other than to say that while any of the options presented could be implemented, through the careful attention to NIAs, uncertainty levels and authority structures, a better plan of action may be taken.

The last section of the chapter discussed the strengths and limitations of the dissertation's findings. In particular, the theoretical strength lies in the fact that the findings support how and when NIAs matter in the groundwater policy change process though caution is warranted not to extend the results to other types of CPRs until further investigation is made. This does not detract from the significance of the dissertation's findings in relation to groundwater policy in heterogeneous communities. On the contrary, the rigourous research design ensured a high validity, reliability and, combined with several replications over time periods and programs, ensured a high confidence level in the results. Lastly, issues of bias in recent data never materialized as shown through replication levels among other factors.

Overall, nested institutional arrangements matter but not in terms of types of policy changes per se but rather how they are arrived at. In the quest to move to greater CPR sustainability, the results stake out broad parameters of a strategy for groundwater policy change.

Chapter Eight

Conclusion

"putting it together"

8.1 Introduction

The purpose of this dissertation was to discern the effects of nested institutional arrangements on groundwater policy change under different conditions of uncertainty. More broadly, it begins the process of unravelling nested institutional arrangements, a concept often referred to in the common pool resource (CPR) literature yet left theoretically underdeveloped. This chapter summarizes the research and discusses its theoretical contributions and policy implications. Some future research avenues are also briefly discussed.

8.2 Research Summary

Chapter 1 set the broad framework for the dissertation. In the desire to change public policy, one must decide on a course of action. In relation to groundwater, the level of uncertainty surrounding knowledge about the resource's movement, quantity, location and connections to surface water needs to be taken into consideration. In addition, groundwater's unique characteristics of excludability and subtractability render its management much more difficult and may lead to a "tragedy of the commons". Yet, institutional design principles have been elaborated that document the need for nested institutional arrangements for the sustainable management of CPRs such as groundwater.

Chapter 2 closely examined CPR theory to better understand the need for NIAs. Both the privatization of the commons through the assignment of property rights and binding contracts have been put forth as solutions to the problem of the "tragedy of the commons". Nested institutional arrangements, a concept central to both, have never been investigated in terms of its relationship to policy change, something that is needed to reach the sustainable management of groundwater. Note that the property rights literature tends to be preoccupied with the definition of rights, and the processes related to changes to the various rights. Similarly, the binding contracts literature tends to be focused on the identification and testing of institutional design principles, detailing the advantages and disadvantages of institutional arrangements and in noting the need for nested institutional arrangements.

Any course of action to change groundwater policy necessarily includes other stakeholders and begins within an existing institutional framework. Water takings legislative and regulatory changes in Nebraska during 2000-2005 (to include consideration of environmental effects of withdrawals including cumulative ones) serve as a good example. NRDs are the lead agency in the determination of water withdrawal permit applications (e.g. municipal, industrial).[51] However, the NDNR may be, and often is, consulted in the process. So are other agencies such as the NDEQ who have broad watershed protection functions, the UN-L C/S Division due

[51]The NDNR maintains authority over groundwater transfer permits.

to their hydrogeological expertise, and the NGPC due to their wildlife protection functions. Note that the legislative change impacts irrigators and municipalities since each group needs to obtain a permit before installation of a water well. As such, they were involved in the policy change process as was the NWDA since the proposed change in policy could negatively impact well drillers (i.e. harder to obtain permits so fewer wells installed). These governance units, and others, were also distributed at different levels of governance with most at the state level except for the NRDs who operate at the intra-regional level and Local Governments which operate at the local level. It is this plethora of stakeholders and institutional framework, a nested institutional arrangement at that, which CPR theory has deemed essential for a resource's sustainable management. Yet, how NIAs matter and how this information can be used to direct policy change towards greater sustainability is not investigated. That is, the need exists to examine the effects of nested institutional arrangements on groundwater policy change under different conditions of uncertainty in order to reveal clues for a strategy of groundwater policy change, something that is needed in order to move towards sustainable groundwater use. This is important because policymakers and stakeholders alike face many challenges in attempting to change groundwater policy including financial and technical (expertise, personnel) resources, as well as, operate within limited political timelines, all of which can be exacerbated by transaction costs. Knowledge of how NIAs affect the type, frequency and magnitude of policy change can aid in making effective use of limited resources and timelines while minimizing transaction costs. In other words, it explicates how individual action which is shaped and mediated by nested institutional arrangements affects the policy change process.

One approach in discerning the effects of NIAs on groundwater policy change was detailed in Chapter 3. A comparative case study was utilized comparing two jurisdictions in a high uncertainty area to one jurisdiction in a low uncertainty area. The strength of the methodology lies in its multiple points of measurement, sixteen overall, spread over three separate dependent variables. In essence, each observation point in each variable provided an opportunity for the discernment of the effects of NIAs on the type, frequency and magnitude of policy change. To facilitate this investigation, NIAs, the independent variable, were disaggregated into some of the constituent parts (based on the literature) and included the number of governance units, the number and type (functional, strategic) of linkages, as well as, their complementarity. It was these components that were used to examine actual groundwater policy changes related to well driller regulations, water takings, and source water protection in the Great Lakes Basin (Ontario, New York; high uncertainty) and the Ogallala Aquifer (Nebraska; low uncertainty).

The results for the governance units involved, the nature of the linkages between governance units and the complementarity of these linkages for each jurisdiction were presented in Chapters 4, 5 and 6, the empirical chapters. This data was re-analyzed in Chapter 7 to reveal the effects of NIAs on groundwater policy change. The results are summarized below in Table 8.1 and stress the importance of processes related to authority structures.

Table 8.1:

Effects of Nested Institutional Arrangements (NIAs) on Groundwater Policy Changes Under Conditions of High and Low Uncertainty

- Changes in policy goals occur in relation to program introduction and/or expansion, are of large magnitude, and occur infrequently regardless of uncertainty levels.
- Changes in policy instruments are largely dependent on context (local resource) regardless of whether or not a change in policy goals occurs, except in cases when a program is introduced, are infrequent and are irrelevant of uncertainty levels.
- Policy instrument setting changes are numerous, largely of small magnitude, and frequently occur in conditions of low uncertainty and infrequently in conditions of high uncertainty.
- Diffuse authority structures and/or the lack of funding decreases the frequency of instrument setting changes under conditions of low uncertainty and increases the frequency of instrument setting changes under conditions of high uncertainty.
- The number of governance units increases as uncertainty decreases with results less pronounced when authority is divided between two or more vertical levels of governance.
- At the intra-regional and provincial/state levels, a higher ratio of functionally positive (F+) linkages in low uncertainty areas exists, except when authority is divided between two of more vertical levels of governance.
- At the intra-regional and provincial/state levels, a higher ratio of functionally positive or negative (F+/-) linkages in low uncertainty areas exists regardless of diffused authority.
- Narrow interests (e.g. program area, regulatory changes) require a higher ratio of strategic linkages in low uncertainty areas at the intra-regional and provincial/state levels.
- A higher linkage complementarity is required in high uncertainty areas, except when authority is divided between two or more vertical levels of governance.
- Local level governance units are largely inactive in the process regardless of uncertainty levels.
- Intra-regional level governance units are active in the process in areas of low uncertainty.
- A few national level governance units are involved in the process in a supportive role even when they are the initiators of groundwater policy changes.
- A shift from bi-lateral to multilateral relationships occurs for controversial issues that affect a broad range of interests.

8.3 Contributions to CPR Theory

A number of contributions to CPR theory are made by this dissertation. First, a model for what constitutes an NIA is elaborated. Note that while CPR theory largely recognizes the need for NIAs, it nonetheless does not usually detail what constitutes an NIA. What does an NIA look like? At its core, what are the basic elements of an NIA? Answers to these types of questions are lacking on several fronts. For instance, the CPR literature largely construes an NIA in vertical terms, that is, governance units organized in multiple layers, yet it is silent on the horizontal governance units involved in the process. They are presumed to exist yet nothing takes stock of their complexity as part of nested institutional arrangements. This research explicitly recognizes this horizontality and assesses its contributions in NIAs to groundwater policy change.

The question arises of whether the number of vertical governance layers is more important than the number of horizontal governance units in groundwater policy change? No claim either way is supported by the results of this dissertation. Rather, one needs to take stock of the direction of the linkages in the process. For instance, the majority of functionally positive linkages at the intra-regional level are directed to the state level while the vast majority of these same functionally positive linkages at the state level are directed to other governance units at the state level in areas of high uncertainty. Note the different pattern in low uncertainty regimes where the majority of functionally positive linkages at the intra-regional level are directed to the state level. Also, functionally positive linkages at the state level are split between the state level and intra-regional levels in a ratio of two to one. That is, for every two functionally positive linkages with other governance units at the state level in low uncertainty areas, approximately one functionally positive linkage exists with the intra-regional level. The implications from this can be immediately seen. For instance, a governance unit at the intra-regional level needs to strive for functionally positive linkages with state level governance units regardless of uncertainty. State level governance units need to discriminate with whom they build functionally positive relationships, based on level of uncertainty to affect groundwater policy change.

This dissertation also develops a framework for what constitutes an NIA based on fundamental elements such as the number of governance units, the number and types of linkages and the complementarity of the linkages. Fundamentally, NIAs are about relationships between governance units and their collective effects on groundwater policy change. How are governance units connected and what is the nature of this connection? These factors are captured in the threefold model used in this dissertation developed from the CPR literature though never explicitly brought together.

Moreover, this dissertation details how NIAs matter in the groundwater policy change process. Noting the need for NIAs is one thing but unravelling how NIAs affect groundwater policy change is imperative in the desire to move towards the sustainable use of groundwater. From a broad perspective, a move towards greater sustainability means a change in groundwater policy. In most situations, some institutional framework exists which means we are at some point along the tragedy-sustainability continuum. The question is: How do we move towards a fuller development of the other institutional design principles that contribute to the sustainable use of groundwater? What course of action may be followed and how does one plan a course of action in relation to the other existing governance units? Thus further research on different configurations of NIAs is needed across different common pools.

The above results across varying levels of uncertainty suggest three broad considerations in terms of policy changes, processes and authority structures. Uncertainty matters, but to varying degrees. In terms of policy changes, no discernable differences exist between uncertainty levels in changes to policy goals and/or policy instruments. Uncertainty matters in terms of the frequency of changes to policy instrument settings with frequent changes occurring in areas of low uncertainty while infrequent changes occurred in areas of high uncertainty. These differences disappear when authority structures are diffused between two of more vertical governance layers. Similarly, the need for positive functionality between governance units in low uncertainty areas disappears when authority structures are diffused between two or more vertical governance layers. Strategic linkages are also more important in regards to regulatory changes with potentially concentrated benefits in low uncertainty areas. Lastly, linkage complementarity matters in high uncertainty areas though that also disappears under conditions of diffuse authority structures between two or more vertical governance units. These results provide some theoretical guidance for the study of groundwater policy changes under different conditions of uncertainty.

Broadly stated, this dissertation helps advance our understanding of how nested institutional arrangements affect the policy change process in the quest to move towards sustainable resource use. Chapter 2 reviewed CPR theory to reveal the centrality of NIAs in proposed solutions to the problem of "the tragedy of the commons"—property rights assignment and/or binding contracts. However, neither solution examines the effects of NIAs in relation to the type, frequency and magnitude of CPR policy change. In other words, CPR theory provides some solutions to the "tragedy of the commons" but not a "plan of action" or conceptual "map" of how to achieve them.

Strategies are needed on how to address CPR policy change. Furthermore, any such changes will be rooted in individual actions (whether through groups or not), yet these actions will be shaped and mediated by existing nested institutional arrangements. CPR theory, rooted in the public choice approach, integrates these elements, including transaction costs, yet remains somewhat static in explanatory power. That is, it needs to be extended to better account for the repetitive nature of real life situations (e.g. interactions) to capture the effects of commitment and trust.

One approach, detailed in this dissertation, is to cast policy changes broadly in terms of their type, frequency and magnitude and to measure the effects of NIAs on changes in these characteristics (on the underlying groundwater property rights, e.g. access, withdrawal) over at least a decade or more. Lastly, the examination of repeated changes (e.g. multiple decades) in the same or related property rights (e.g. withdrawal) reveals patterns of groundwater policy changes. The examination of cases (different jurisdictions) under varying conditions of uncertainty is further revealing since it is based on conditions facing many current policymakers and stakeholders.

This dissertation extends CPR theory by staking out the broad parameters of a strategy for how to achieve NIAs, that is, changes in groundwater policy (a move towards sustainable resource use via Ostrom's eight institutional design principles). It does so by measuring the effects of NIAs on changes in groundwater policy. Simply put, it provides a framework for how to explain changes in public policy, that is, how rules evolve over time by measuring how changes in rules, as driven by individuals, are mediated by nested institutional arrangements.

CPR theory is also advanced through this dissertation's contribution to the small but growing body of CPR literature on large scale complex resources in heterogeneous populations (e.g. Sproule-Jones, 2002).

8.4 Contributions to Policy Change Theory

The dissertation's results also contribute to the policy change literature, specifically, Hall's (1993) policy change framework. According to Hall, a change in policy goals necessitates a change in policy instruments and the instrument's settings. The results herein counter this claim. Note that while a change in policy goals occurred for both Ontario (t-2; high uncertainty) and Nebraska (t-3; low uncertainty) with regard to water takings, no associated change occurred in the policy instrument though instrument settings were changed in both cases. This suggests that theory needs a finer gradation in policy changes, one that discriminates between the initial introduction of a policy and related program compared to changes in policy goals with an existing program.

8.5 Policy Implications

At a practical level, this dissertation contributes to a better understanding of groundwater governance frameworks in three jurisdictions: Ontario, New York and Nebraska. This is important not only in the expansion of the study of governance frameworks but in the fact that the chosen jurisdictions are rarely studied in the literature which largely focuses on the American Southwest (e.g. Heikkila, 2001). Moreover, the dissertation specifically details the relationships among the stakeholders, the "glue" in this process, and how they aid or hinder groundwater policy changes. It is the clues revealed from this process that form a basis for strategizing groundwater policy change. As the example in Chapter 7 provided, stakeholders are faced with various options in deciding what and where to place their efforts in addressing regulatory deficiencies. The results may provide guidance to the crafting of a better plan of action.

8.6 Next Steps

A number of related research issues emanate for this dissertation and provide fertile ground for future work. The first is the question of whether the results hold for other types of CPRs. Investigation into forestry, fisheries and communications is needed to determine how extensively the results can be applied. For instance, fisheries possess different attributes highlighted by the fact that fish are highly mobile which may present different clues for affecting policy change. This line of inquiry would also be consistent with public choice theory. Recall that it outlines that the nature of the good, that is, the degree to which goods are subtractable and excludable, affects the institutional arrangements devised to manage the good and an individual's preferences towards the good (Sproule-Jones, 1982, 1996).

Second, investigation needs to be made of groundwater policy change in non-North American settings to further clarify the groundwater policy change process. This would include both Western and non-Western, first and third world counties and, in particular, non-federal countries. Differences may exist that may help clarify and/or expand on the findings of this dissertation.

Third, additional research is needed to clarify Hall's policy change framework. Research over more programs and that specifically looks at the relationship between changes in goals, instruments and settings is required to either reaffirm or refute this dissertation's findings. That is, changes in policy goals do not necessitate changes in policy instruments. This is important since it may streamline the policy change process for those desiring change, especially in consideration of how proposed changes are framed.

8.7 Summary

This chapter has provided a summary of the dissertation and its findings in relation to both its theoretical contributions and policy implications. The dissertation set out to discern the effects of nested institutional arrangement on the type, frequency, and magnitude of groundwater policy change in varying conditions of uncertainty. Numerous clues were revealed and note should be made of the limited effects of NIAs on policy changes. More important is the process by which changes are arrived at which is mediated by diffuse authority structures. Theoretically, the findings further develop CPR theory through the consideration of horizontal governance units in the equation, the development of an NIA framework and the discernment of *how* NIAs matter. That is, it provides a framework for how to explain changes in common pool resource policy related to groundwater, that is, how rules evolve over time by measuring how changes in rules, as driven by individuals, are mediated by nested institutional arrangements.

References

Abbott, R. (2004, Spring). Skaneateles Lake Watershed Composting Toilet Project. *Small Flows Quarterly*, 5(2), 32-39.

Advisory Committee on Watershed-based Source Protection Planning. (2003, April). Protecting Ontario's Drinking Water: Toward a Watershed-based Source Protection Planning Framework. *Final Report.*

Agency for Toxic Substances Disease Registry. (2002, September). *TocFAQs for DDT, DDE, and DDD.* Retrieved 22 February 2007, from http://www.atsdr.cdc.gov/tfacts35.html

Aggarwal, V. K. (1998). Reconciling Multiple Institutions: Bargaining, Linkages, and Nesting. In V. K. Aggarwal (Ed.), *Institutional Designs for a Complex World: Bargaining, Linkages, and Nesting* (1-32). Ithaca: Cornell University Press.

Agriculture and Agri-Food Canada and OMAFRA. (2003). *Best Management Practices: Water Wells.* Ottawa: Queen's Printer.

Alder, J., & Ward, T. (2001). Australia's Oceans Policy: Sink or Swim? *Journal of Environment and Development*, 10(3), 266-289.

Argyres, N. S., & Liebeskind, J. P. (1999, Jan.). Contractual Commitments, Bargaining Power, and Governance Inseparability: Incorporating History into Transaction Cost Theory. *The Academy of Management Review*, 24(1), 49-63.

Ashworth, W. (2006). *Ogallala Blue: Water and Life on the High Plains*. Vermont: The Countryman Press.

Aucoin, J. (1984). *Water in Nebraska.* Lincoln: University of Nebraska Press.

Bates, S. (2002, January). General Meeting Minutes, October 27 2001. *Holetalk*, 4-8.

Bates, S. (2004, Summer). General Meeting Minutes - April 17, 2004. *Holetalk*, 4-5.

Bates, S. (2005, Spring). General Meeting Minutes - January 19, 2005. *Holetalk*, 4-5.

Bates, T. (2007-a, Winter). From the President. *Holetalk*, 3.

Bates, T. (2007-b, Summer). From the President. *Holetalk*, 3.

Beaulieu, M. S. (2003). The expansion of large livestock farms between 1991 and 2000. *Vista on the Agri-Food Industry and the Farm Community* Cat. No. 21-004XIE Retrieved 23 May 2006, from http://64.233.161.104/search?q=cache: UDm5zE_xdA4J:dsp-psd.tpsgc.gc.ca/Collection/Statcan/21-004-X/21-004-XIE2003104.pdf+farm+expansion+ontario&hl=en&ct=clnk&cd=29

Berkes, F. (2002). Cross-Scale Institutional Linkages: Perspectives for the Bottom Up. In E. Ostrom, T. Dietz, N. Dolsak, P. C. Stern, S. Stonich & E. U. Weber (Ed.), *The Drama of the Commons* (pp. 293-322), Washington, D.C.: National Academy Press.

Berney, F. (2002-2003, Winter). NRD/DEQ Liaison — A New Era in Coordination, Communication. *NDEQ Environmental Update*. Retrieved 03 October 2007, from http://www.deq.state.ne.us/Newslett.nsf/1e49230d2053f96506256ca700793df6/e2ca0ace5d62714706256ca70075c885?OpenDocument.

Bleed, A. S. (1993). Climate and Hydrology. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (pp. 45-62), Lincoln: Conservation and Survey Division, University of Nebraska.

Bleed, A. & Patterson, R. K. (2006, February). Groundwater Pumping and Streamflow. *Factsheet*. Lincoln: NDNR.

Blomquist, W. (1991). Exploring State Differences in groundwater policy Adoptions, 1980-1989. *Publius: The Journal of Federalism*, 21, 101-115.

Blomquist, W. (1992). *Dividing the Waters: Governing Groundwater in Southern California*. Ithaca: ICS Press.

Blomquist, W., Schlager, E. & Heikkila, T. (2004). *Common Waters: Diverging Streams*. Washington, D.C.: Resources for the Future.

Boyd, D. R. (2003). *Unnatural Law: Rethinking Canadian Environmental Law and Policy*. Vancouver: UBC Press.

Boyd, H. (2005, Spring). From the President. *Holetalk*, 3.

Bray, D. B. (2000, 31 May-04 June). Adaptive Management, Organizations and Common Property Management: Perspectives from the Community Forests of Quintana Roo, Mexico. Paper presented at the 8th Conference of the International Association for Study of Common Property. Bloomington, U.S.A..

Brook, M. (2004, 9-13 August). Cross-scale Linkages among Forest Management Institutions in the Miskitu Commons. Paper presented at 10th Conference of the International Association for the Study of Common Property, Oaxaca, Mexico.

Brunckhorst, D. & Coop, P. (1999, July). Environmental and Resource Governance Under the Influence. Paper given to the International Conference on Society and Resource Management, Brisbane.

Brunckhorst, D. & Reeve, I. (2006, July). A Geography of Place: principles and application for defining 'eco-civic' resource governance regions. *Australian Geographer*, 37(2), 147-166.

Brunckhorst, D., Coop, P. & Reeve, I. (2006). 'Eco-civic' optimisation: A nested framework for planning and managing landscapes. *Landscape and Urban Planning*, 75, 265-281.

Buchanan, J. H. & Tullock, G. (1962). *The Calculus of Consent: Logical Foundations of Constitutional Democracy*. Ann Arbor: University of Michigan Press.

Buck, S. J. (1989). Multijurisdictional Resources. In F. Berkes (Ed.), *Common Property Resources* (pp. 127-147), London: Belhaven Press.

Burt, S. (1990, Mar.). Canadian Women's Groups in the 1980s: Organizational Development and Policy Influence. *Canadian Public Policy*, 16(1), 17-28.

Byrd, N. (2004, Summer). Changes. *Well Bits*, 1-2.

Campbell, J. L. (1998). Institutional analysis and the role of ideas in political economy. *Theory and Society*, 27, 377-409.

Canter, L. W., Knox, R. C. & Fairchild, D. M. (1987). *Ground Water Quality Protection*. Chelsea, MI: Lewis Publishers Inc..

Carson, R. (1962). *Silent Spring*. Boston: Houghton Mifflin.

Cayuga County SWCD. (2006). *2005 Annual Report*.

Celico, F., Musilli, I. & Naclerio, G. (2004). The impacts of pasture-and manure-spreading on microbial groundwater quality in carbonate aquifers. *Environmental Geology*, 46, 233-236.

Central New York Regional Planning and Development Board. (2002). *Water Resources Management Program*. Retrieved 15 July 2007, from http://www.cnyrpdb.org/docs/environmental/regional_coop_&_collab.pdf

Central Platte Natural Resources District. (n.d.-a). Board of Directors. Retrieved 12 December 2007, from http://www.cpnrd.org/Board%20Members.htm

Christopherson, T. (1998, Spring/Summer). Minimum standards for water well pump installations. *Water Writes*, 10.

Christopherson, T. (1999, Convention). Grouting questions answered. *Water Writes*, 7.

Christopherson, T. (2003, Summer). Water Well Standards Program Role in Task Force Study. *Water Writes*, 1-2.

Christopherson, T. (2003, Fall). Water Well Construction Concerns. *Well Bits*, 4-5.

Christopherson, T. (2004, Summer). Changes at the Water Well Standards Program. *Water Writes*, 4, 16.

Citizen's Environmental Coalition and Sierra Club. (2005). The Wasting of New York State: Factory Farms and Public Health. Retrieved 22 May 2006, from www.cectoxic.org/WastingRuralNY.pdf

Coase, R. (1937). The Nature of the Firm. *Economica*, 4(16), 386-405.

Conservation Ontario. (2007). *2006 Annual Report*. Alliston: Conservation Ontario.

Conservation Ontario. (n.d.). *About Us*. Retrieved 19 February 2007, from http://www.conservation-ontario.on.ca/index.html

Conservation Ontario. (n.d.). Conservation Symposium Emphasizes Action! *Media Release*. Retrieved 19 August 2007, from http://www.conservation-ontario .on.ca/news/pdf/adlat_media.pdf

Cookson, D. D. (2000, Winter). Update on Kansas V. Nebraska Litigation. *Nebraska Resources*, 4.

Coon, W. F. & Sheets, R. A. (2006). *Estimate of Ground Water in Storage in the Great Lakes Basin, United States, 2006*. USGS Scientific Investigations Report 2006– 5180. Reston, Virginia.

Council of Great Lakes Governors. (1985). *Great Lakes Charter*. Retrieved 15 November 2006, from http://www.mnr.gov.on.ca/mnr/water/greatlakes/index.html

Crawford, S. E. S. & Ostrom, E. (1995). A Grammar of Institutions. *American Political Science Review*, 89(3), 582-600.

Credit Valley Conservation Authority. (2004, Winter). A.D. Latornell Conservation Symposium 2003. *Bulletin*. Retrieved 17 July 2007, from http://www.creditvaleycons.com/bulletin/winter2004/index.html#latornell

Dahl, R. (1967). *Pluralist Democracy in the United States: Conflict and Consent*. Chicago: Rand McNally.

Dawson, R. M. (1970). *The Government of Canada* (5th ed.). (Revised by Norman Ward). Toronto: University of Toronto Press.

de Jong, G. & Nooteboom, B. (2000). *The Causal Structure of Long-Term Supply Relationships: An Empirical Test of a Generalized Transaction Cost Theory*. Boston: Kluwer Academic Publishers.

de Loë, R. & R. Kreutzwiser. (2007). Challenging the Status Quo: The Evolution of Water Governance in Canada. In K. Bakker (Ed.), *Eau Canada: The Future of Canada's Water* (pp.85-103), Vancouver: UBC Press.

Delaware River Basin Commission. (n.d.-a). Delaware River Basin Map. Retrieved 31 July 2007, from http://www.state.nj.us/drbc/maps/counties3.htm

Delaware River Basin Commission. (1961). *Delaware River Basin Compact*. New Jersey: DRBC. Retrieved 15 June 2007, from http://www.state.nj.us/drbc/regula.htm

Delaware River Basin Commission. (1961, as amended to 2006). *Water Code*. New Jersey: DRBC. Retrieved 15 June 2007, from http://www.state.nj.us/drbc/regula.htm

Delaware River Basin Commission. (2001). Amendment to the Delaware River Basin Commission's Water Code and Comprehensive Plan to Establish Water Usage Reporting Requirements (Final Rule). NO. 2001-8. Retrieved 17 June 2007, from http://www.state.nj.us/drbc/Res2001-8.htm

Dempsey, C. (2006, Winter). Notes from.... *Good Water News*, n.p. Retrieved 15 October 2006, from http://www.nerwa.org/gwnews/edart.htm.

Dickerson, B. (2005, June). Update on NYS Dept of Health Revised Proposed Rules on Water Well Construction. *Newsletter - New York State Council of Professional Geologists*, 10(3), 1-8.

Diers, A. (2006, June). Legislative Update. *Nebraska Resources*, 1-3.

Dietz, T., Dolšak, N., Ostrom, E., & Stern, P. C. (2002). The Drama of the Commons. In E. Ostrom, T. Dietz, N. Dolšak, P. C. Stern, S. Stonich, & E. U. Weber (Ed.), *The Drama of the Commons* (3-36), Washington, D.C.: National Academy Press.

Discover 903 Meetings. (2003, Winter). *The Source*, 8-14.

Downey, T. (1994, Fall). From the President. *Water Writes*, 3.

Downs, A. (1957). *An Economic Theory of Democracy*. Boston: Addison-Wesley Publishing Company.

Dreeszen, V. H. (1993). Water Availability and Use. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (82-106). Lincoln: Conservation and Survey Division, University of Nebraska.

Driscoll, F. G. (1986). *Groundwater and Wells* (2nd ed.). St. Paul, Minnesota: Johnson Filtration Systems Inc..

Duinker, P.N., Matakala, P. W. & Zhang, D. (1991). Community forestry and its implications for Northern Ontario. *The Forestry Chronicle*, 67(2), 131-135.

DuMars, C. T. & Minier, J. D. (2004). The Evolution of groundwater rights and groundwater management in New Mexico and the western United States. *Hydrogeology Journal*, 12, 40-51.

Dyer, J. H. & Chu, W. (2003, Jan.-Feb.). The Role of Trustworthiness in Reducing

Transaction Costs and Improving Performance: Empirical Evidence from the United States, Japan, and Korea. *Organization Science*, 14(1), 57-68.

Eisenhauer, D. E., Manbeck, D. M., & Stork, T. H. (1982, January). Potential for Ground Water Recharge with Seepage from Flood-Retarding Reservoirs in South Central Nebraska. *Journal of Soil and Water Conservation*, 37, 57-60.

Emel, J. L. & Brooks, E. (1988). Changes in Form and Function of Property Rights Institutions under Threatened Resource Scarcity. *Annals of the Association of American Geographers*, 78(2), 241-252.

Engberg, R. A. and R. F. Spalding. *Groundwater Quality Atlas of Nebraska*. Lincoln: Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, 1978.

Environment Canada. (2001). *Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada*. NWRI Scientific Assessment Report Series No. 1. Burlington, ON: National Water Research Institute.

Environmental Protection Agency. Office of Water. (1998). *Summary of State Biennial Reports of Wellhead Protection Program Progress - 1995-1997.*

Exner, M. (1993). The Occurrence of Nitrate Contamination in Nebraska. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (pp. 160-161). Lincoln: Conservation and Survey Division, University of Nebraska.

Fletcher, T.H. (2003). *From Love Canal to Environmental Justice*. Peterborough: Broadview Press.

Flowerday, C. A. & Herrin, S. J. (1993). Conservation Management and Environmental Protection. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (pp. 177-178). Lincoln: Conservation and Survey Division, University of Nebraska.

France, S. (2001, Summer). Water Administration Division – profile. *Nebraska Resources*, 1-4.

Freeze, R. A. & Cherry, J. A. (1979). *Groundwater*. New Jersey: Prentice Hall, Inc..

Gabelhouse, D. (2002, November). Recreational Considerations. *Presentation to the Water Policy Task Force*. Lincoln, NE. Retrieved 22 November 2007, from http://www.dnr.ne.gov/watertaskforce/docs/TFArchival_Presentations.html

Gamson, W. (1975). *The Strategy of Social Protest*. Homewood, Ill.: Dorsey Press.

Gaul, S. (1993). Politics and Policy. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (pp. 203-230). Lincoln: Conservation and Survey Division, University of Nebraska.

Gaul, S. (1999, Fall). Natural Resources Commission Involved in Diverse Platte River Efforts. *Nebraska Resources*, 1.

Geddes, Barbara. *Paradigms and Sand Castles: Theory Building and Research Design in Comparative Politics.* Ann Arbor: The University of Michigan Press, 2003.

Genesee/Finger Lakes Regional Planning Council. (n.d.). *Groundwater, Wellhead and Source Water Protection*. Retrieved 01 August 2007, from http://www.gflrpc.org/ProgramAreas/planning/WaterResources/GroundwaterProtection.htm

Genesee/Finger Lakes Regional Planning Council. (Yearly Issues). *Comprehensive EconomicDevelopment Strategy*. Retrieved 15 July 2007, from http://www.gflrpc.org/ProgramAreas/EconomicDevelopment/CEDS.htm

Genesee/Finger Lakes Regional Planning Council. (2004). *Genesee River Basin Action Strategy*. Retrieved 20 July 2007, from http://www.gflrpc.org/Publications/GenRiverActionStrategy.htm

Gianessi, L. P. & Marcelli, M. B. (2000). *Pesticide Use in US Crop Production in 1997 - National Summary Report*. Washington, D.C.: National Center for Food and Agricultural Policy. Retrieved 25 July 2007, from http://www.ncfap.org/ncfap/nationalsummary1997.pdf

Gillis, S. (2001, October 13). *A Speech by a Septic Dyspeptic*. Retrieved 19 March 2005, from http://www.foca.on.ca/Infobase/Environment/Septic/SepticDyspeptic.htm

Glennon, R. (2002). *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters*. Washington: Island Press.

Goeke, J. W. (1983). *Summary Report for the Twin Platte and Middle Republican Natural Resources Districts Groundwater Study* (OFR-33).

Goff, K. & Brown, D. R. (1981). *Ground Water Resources of the Thames River Basin*. Toronto: Ministry of the Environment.

Gordon, H. S. (1954). The Economic Theory of a Common-Property Resource: The Fishery. *The Journal of Political Economy*, 62(2), 124-142.

Grannemann, N.G., Hunt, R. J., Nicholas, J. R., Reilly, T.E., & Winter, T.C. (2000). *The Importance of Ground Water in the Great Lakes Region.* USGS Water-Resources Investigations Report 00–4008. Lansing, Michigan.

Gray, B. (1985). Conditions Facilitating Interorganizational Collaboration. *Human Relations*, 38(10), 911-936.

Great Lakes Charter Annex. (2001). Retrieved 15 November 2006, from http://www.mnr.gov.on.ca/mnr/water/greatlakes/index.html

Gulati, R. (1995, February). Does Familiarity Breed Trust? The Implications of Repeated Ties for Contractual Choice in Alliances. *The Academy of Management Journal*, 38(1), 85-112.

Gunderson, L. H. (2003). Adaptive dancing: interactions between social resilience and ecological crises. In F. Berkes, J. Colding & C. Folke *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change* (pp. 33-52). Cambridge: Cambridge University Press.

Hall, P. A. (1993, April). Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. *Comparative Politics*, 25, 275-296.

Hansen, W. L., Mitchell, N. J. & Drope, J. M. (2005). The Logic of Private and Collective Action. *American Journal of Political Science*, 49(1), 150-167.

Hansmeyer, D. (2003, Fall). Renew Your Well Driller/Pump Installation Licenses/Certificates Online!!!! *Well Bits*, 1.

Hanson, B. V. (1983). *Nitrate in the Groundwater of Pierce County, Summers 1980 and 1981, A Base Line Study*. (OFR-28). Lincoln: Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Hanson, B. R. & Trout, T. J. (2001). Irrigated Agriculture and Water Quality Impacts. In W. F. Ritter & A. Shirmohammadi (Ed.), *Agricultural Nonpoint Source Pollution: Watershed Management and Hydrology* (pp. 169-206). New York: Lewis Publishers.

Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.

Harrison, K. (1996, Reprint 2000). *Passing the Buck: Federalism and Canadian Environmental Policy*. Vancouver: UBC Press.

Harrison, K. (2002). Federal-Provincial Relations and the Environment: Unilateralism, Collaboration, and Rationalization. In D. L. VanNijnatten & R. Boardman (Ed.), *Canadian Environmental Policy: Context and Cases* (123-144). Don Mills: Oxford University Press.

Hart, J. (1986, May). Nebraska Takes Lead in Water Quality Protection. *Water Writes*, 8-10.

Hawk-Baldwin, J. L. (2000, July). Legislative Committee Report. *Holetalk*, 4.

Hawk-Baldwin, J. L. (2004, Summer). Legislative Update. *Holetalk*, 8.

Hawk-Baldwin, J. L. (2007, Winter). Legislative Update. *Holetalk*, 8.

Heclo, H. (1978). Issue Networks and Executive Establishment. In A. King (Ed.), *The New American Political System* (87-124). Washington: American Enterprise Institute for Public Policy Research.

Heclo, H. (1974). *Modern Social Politics in Britain and Sweden: From Relief to Income Maintenance*. New Haven: Yale University Press.

Heller, M. (2000). Empty Moscow Stores: A Cautionary Tale for Public Innovators. In C. Geisler & G. Daneker (Ed.), *Property and Values: Alternatives to Public and Private Ownership* (pp. 189-210). Washington, D.C.: Island Press.

Heikkila, T. (2004). Institutional Boundaries and common-Pool Resource Management: A Comparative Analysis of Water Management Programs in California. *Journal of Policy Analysis and Management*, 23(1), 97-117.

Hess, C. & Ostrom, E. (2003, Winter/Spring). Ideas, Artifacts, and Facilities: Information as a Common-Pool Resource. *Law and Contemporary Problems*, 66. Retrieved 15 August 2005, from http://www.law.duke.edu/journals/lcp/articles/lcp66dWinerSpring2003p111.htm

Hess, C. & Ostrom, E. (2004). "Studying Scholarly Communication: Can Commons Research and the IAD Framework Help Illuminate Complex Dilemmas?" Presented at "The Commons in an Age of Global Transition: Challenges, Risks and Opportunities," the 10th Conference of the International Association for the Study of Common Property, Oaxaca, Mexico, August 9-13.

Hiscock, K. (2005). *Hydrogeology Principles and Practice*. Malden, MA: Blackwell Publishing.

Holetalk. 1998-2007.

Huggenberger, S. (2002, November). Municipal Water. *Presentation to the Water Policy Task Force*. Lincoln, NE. Retrieved 22 November 2007, from http://www.dnr.ne.gov/ watertaskforce/docs/TFArchival_Presentations.html

Jacobs, J., Guertin, J., & Herron, C. (2001). *MTBE: Effects on Soil and Groundwater Resource*. New York: Lewis Publishers.

Jacques, P. (2004). Introduction. In M. Brentwood & S. F. Robar (Ed.), *Managing Common Pool Groundwater Resources: An International Perspective* (pp. 3-6). Westport, CT: Praeger Publishers.

Johnson, C. (1994, Convention). NE Children's GW Festival. *Water Writes*, 4-6.

Johnston, L. (2006, April 7). The Limits on Privatizing the Commons. Paper presented at the Ethics, Security, and the Environment Panel, 14th Annual Illinois Conference for Students of Political Science. Retrieved 18 August

2007, from http://www.politicsandgovernment.ilstu.edu/current/conferences / archive/2006.shtml

Jordan, A. G. & Richardson, J. (1987). *Government and pressure groups in Britain.* Toronto: Oxford University Press.

Kidd, J. (2003, November 12). Expert Workshop on Managing Groundwater Resources in the Great Lakes Basin: Securing Our Future. *Meeting Report*. Toronto: Program on Water Issues, Munk Centre for International Studies.

King, G., Keohane, R. O., & Verba, S. (1994). *Designing Social Inquiry: Scientific Inference in Qualitative Research.* Princeton: Princeton University Press.

Knight, F. (1921). *Risk, Uncertainty, and Profit*. Boston, MA: Houghton Mifflin Co..

Kromm, D. E. & White, S. E. (1992). Groundwater Problems. In D. E. Kromm & S. E. White (Ed.), *Groundwater Exploitation in the High Plains* (pp. 44-63). Lawrence: University of Kansas Press.

LaForest, G. V. (1973). *Water Law in Canada: The Atlantic Provinces*. Ottawa: Regional Economic Expansion.

Latham, CJK. (2002, June 17-21). Nyika vanhu: The land is the People: An examination of natural resource management in Zimbabwe's Communal Lands. Paper presented at the 9th Conference of the International Association for the Study of Common Property Resources, Victoria Falls, Zimbabwe.

Latornell, A.D. (n.d.-a). Contacts. Retrieved 23 August 2007, from http://www.latornell.ca/contact.html

Latornell, A.D. (n.d.-b). *2006 Glimpse*. Retrieved 23 August 2007, from http://www.latornell.ca/2006/2006_program_w1.html

Lawton, D. R. & Teahon, D. R. (1984). *Inventory of irrigation water use, Box Butte County, Nebraska, 1981.* Lincoln: Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Legislative Commission on Water Resource Needs of NYS and Long Island. (2004, Fall/Winter). The Great Lakes Basin. *Newsletter*, 3-5.

Legislation Update. (2003, Summer). *Holetalk*, 7.

Legislative Update. (2004, Winter). *Holetalk*, 7.

Lehr, J. (1990, May). The Dose Makes The Poison. *Water Writes*, 13, 22-23.

Little Blue Natural Resources District. (1986, July 01). *Groundwater Management Plan.* Davenport: Little Blue NRD.

Loáiciga, H. A. (2004). Analytic game-theoretic approach to ground-water extraction. *Journal of Hydrology*, 297, 22-33.

Long Island Farm Bureau. (2007). Long Island's AG Industries. Retrieved 16 July 2007, from http://www.lifb.com/li_ag_industries.0.html

Lower Republican NRD. (n.d.). *Staff*. Retrieved 26 November 2007, from http://www.lrnrd.org/staff_field.htm

Lubell, M., Schneider, M., Scholz, J. T., & Mete, M. (2002, January). Watershed Partnerships and the Emergence of Collective Action Institutions. *American Journal of Political Science*, 46(1), 148-163.

Lupia, A. & Sin, G. (2003). Which public goods are endangered?: How evolving communication technologies affect *The Logic of Collective Action*. *Public Choice*, 117, 315-331.

Manley, R. (1993). Land and Water in 19th Century Nebraska. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (pp. 9-31). Lincoln: Conservation and Survey Division, University of Nebraska.

Marquardt, T. (2002, Summer). Greetings From Your President. *The Source*, 7.

Marshall, G. R. (2005). *Economics for Collaborative Environmental Management: Renegotiating the Commons*. London: Earthscan.

Marshall, G. R. (2007). Nesting, Subsidiarity, and Community-based Environmental Governance Beyond the Local Level. Occasional Paper. Institute for Rural Futures.

McCarten, J. (2003, September 22). 2,000 wells may not be safe; Contractors say Ontario environment ministry admits it doesn't understand own rules. *Hamilton Spectator*.

McCarthy, J. D. & Zald, M. (1977). Resource Mobilization and Social Movements: A Partial Theory. *American Journal of Sociology*, 82(6), 1212-1241.

McClenaghan, W.A. (1974, June 7-8). History of the Water Well Drilling Industry. *Official Program*. OGWA Annual Convention, Belleville, On., 30-31.

McGraw Hill Higher Education. (2000). *High Plains Aquifer Map*. Retrieved 22 May 2006, from http://www.mhhe.com/earthsci/geology/mcconnell/demo/hpaq.htm

McKenzie, J. (2002). *Environmental Politics in Canada. Managing the Commons in the Twenty-First Century*. Don Mills: Oxford University Press.

McLaughlin, R. (1968, June 19-20). The CWWCA and What It Means. *Souvenir Programme*. OGWA Annual Convention, Toronto, On., 9-11.

McLean, C.D. (1965, June 16-17). A Report on the Progress of the Canadian Water Well Contractor's Association. In *Souvenir Program*. OGWA Annual Convention, Honey Harbour, On., 3.

Meeting Agenda. (2000, Summer). *Holetalk*, 1.

Merritt, J. (1991, Fall). Three NRD managers comment on Rural Water Systems. *Water Writes*, 4.

Middleton, T.A. (2005). The Hydrogeology of Lambton County. In *Drinking Water Sources in Lambton County*. Sarnia Lambton Environmental Association. Retrieved 22 February 2006, from http://lis.sarnia.com/01.html

Michigan Tech University. Ecological Monitoring and Mapping Lab, Forest Resources & Environmental Science. (2004, March). Great Lakes Basin Map. Retrieved 22 May 2006, from http://forest.mtu.edu/staff/hyslop/maps/basin /greatlakes_basin.pdf Milner, J.B. (1957). The Ontario Water Resources Commission Act, 1956. *University of Toronto Law Journal*, 12(1), 100-102.

Mission. (2007, Summer). *Holetalk*, 1.

Moravec, R. S. (2002, Summer). Accurate and More Consistent Well Log Descriptions. *Holetalk*, 7.

Moravec, R. S. (2005, Summer). How Does NYSDOH Justify Proposed Flow Testing Requirements? *Holetalk*, 24-25.

Morwood, E. (2003, Fall). Executive Director's Message. *The Source*, 2.

MOU between NYS Department of Health and NYS Department of Environmental Conservation. 1998.

Muldoon, P. & T. McClenaghan. (2007). A Tangled Web: Reworking Canada's Water Laws. In K. Bakker (Ed.), *Eau Canada: The Future of Canada's Water* (pp.245-261), Vancouver: UBC Press.

Nantel, M.. (1995, December). Sewage Treatment and Disposal in Quebec: Environmental Effects. Retrieved 25 February 2005, from http://www.environmentprobe.org/enviroprobe/pubs/ev532.htm

National Archives and Records Administration. (2006, Dec. 29). Susquehanna River Basin Commission - Review and Approval of Projects; Special Regulations and Standards; Hearings and Enforcement Actions; Final Rule. *Federal Register*. Retrieved 31 July 2007, from http://www.srbc.net/projreview.htm

National Cancer Institute. (2006, 10 May). *Cancer Clusters*. Retrieved 11 March 2008, from http://www.cancer.gov/cancertopics/factsheet/Risk/clusters

National Ground Water Association. (n.d.-a). About NGWA. Retrieved 15 July 2007, from http://www.ngwa.org/about/index.aspx

National Ground Water Association. (n.d.). Certification and professional recognition. Retrieved 15 July 2007, from http://www.ngwa.org/cert/index.aspx

Nebraska. Department of Environmental Control. (1991). *Nebraska Wellhead Protection Program*. Lincoln: NDEC.

Nebraska. Department of Environmental Quality. (n.d.). *Water Programs*. Retrieved 05 November 2007, from http://www.deq.state.ne.us/

Nebraska. Department of Environmental Quality. (n.d.-a). *Agency Overview*. Retrieved 25 November 2007, from http://www.deq.state.ne.us/

Nebraska. Department of Environmental Quality. (1997, Octobre 27). DEQ, Two Livestock Operations Reach Settlements Over Illegal Discharges of Livestock Waste. *Press Release*. Retrieved 09 September 2007, from http://www.deq.state.ne.us/

Nebraska. Department of Environmental Quality. (1998, August 10). Portions of Lower Republican Recommended for Ground Water Management Area Designation. *Press Release*. Retrieved 07 September 2007, from http://www.deq.state.ne.us/

Nebraska. Department of Environmental Quality. (1999). *Nebraska Source Water Assessment Program*. Lincoln: NDEQ.

Nebraska. Department of Environmental Quality. (2001). *North Platte River Settlement Information*. Retrieved 03 October 2007, from http://www.dnr.ne.gov/legal/nebraska.html

Nebraska. Department of Environmental Quality. (2005, December). *2005 Nebraska Groundwater Quality Monitoring Report*. Lincoln: NDEQ.

Nebraska. Department of Natural Resources. (n.d.-a). *Compacts and Decrees*. Retrieved 17 October 2007, from http://www.dnr.ne.gov/

Nebraska. Department of Natural Resources. (n.d.-b). *Bleed Bio*. Retrieved 10 November 2007, from http://www.dnr.ne.gov/docs/BleedBio.html.

Nebraska. Department of Natural Resources. (n.d.-c). *Nebraska Estimated Total Water Withdrawals (for 2000)*. Factsheet. Lincoln: NDNR.

Nebraska. Department of Natural Resources. (n.d.-d). Platte River Cooperative Hydrology Study (COHYST). Retrieved 01 November 2007, from http://www.cohyst.dnr.ne.gov/?&

Nebraska. Department of Natural Resources. (2003, June). Summary of Republican

River Compact Litigation Settlement. *Factsheet*. Lincoln: NDNR..

Nebraska. Department of Natural Resources. (2005, June). LB 962 Implementation. *Factsheet*. Lincoln: NDNR.

Nebraska. Department of Natural Resources. (2007, February). Integrated Water Management Planning Process. *Factsheet*. Lincoln: NDNR.

Nebraska. Department of Natural Resources. (2007, September). Snapshot of Present Water Management Areas and Restrictions. *Factsheet*. Lincoln: NDNR.

Nebraska. Department of Water Resources. (1981). *43rd Biennial Report of Department of Water Resources - 1979-1980*. Lincoln: NDWR.

Nebraska. Game and Parks Commission. (n.d.). *Mission Statement*. Retrieved 02 November 2007, from http://www.ngpc.state.ne.us/admin/divisions.asp

Nebraska. Groundwater Foundation. (n.d.). About Us. Retrieved 06 November 2007, from http://www.groundwater.org/au/missionstatement.html

Nebraska. Groundwater Foundation. (n.d.-a). *About Us - Technical Advisory Committee*. Retrieved 15 October 2007, from http://www.groundwater.org/au/boardtac.html

Nebraska Association of Resources Districts. (n.d.). *About Nebraska's NRDs*. Retrieved 25 November 2007, from http://www.nrdnet.org/nrd_guide/about_nrds.html

Nebraska Association of Resources Districts. (n.d.-a). *Find Your NRD*. Retrieved 12 December 2007, from http://www.nrdnet.org/nrd_guide/find_nrd.html

Nebraska Association of Resources Districts. (n.d.-b). *NARD Directors*. Retrieved 01 December 2007, from http://www.nrdnet.org/about_nard/directors.html

Nebraska Cattlemen Association. (n.d.). *About Us*. Retrieved 20 November 2007, from http://www.nebraskacattlemen.org/home/AboutUs/MissionStatement/tabid/83/Default.aspx

Nebraska Resources. (1997, Summer). *Lower Platte River Alliance*. pp. 1-3.

Nebraska Resources. (1999, Spring). *Cooperative SSURGO Effort*. pp. 1, 5.

Nebraska Resources. (2001, Summer). *LB 667*. p. 4.

Nebraska Resources. (2002, Winter). *Legislative Session*. p. 1.

Nebraska Resources. (2004, Spring). *Nebraska Rainfall and Information Network*. p. 1.

Nebraska Resources. (2004, Summer). *LB 962 Enacted Into Law*. pp. 1-5.

Nebraska State Irrigation Association. (n.d.). *Officers*. Retrieved 18 October 2007 from http://www.nebraskastateirrigationassociation.org/officers.htm

Nebraska State Irrigation Association. (2003, July 21). *NSIA Comment Letter*.

Nebraska Water Policy Task Force. (n.d.). *Water Policy Task Force Membership*. Retrieved 10 November 2007, from http://www.dnr.ne.gov/watertaskforce/docs/WPTFMembership.pdf

Nebraska Water Policy Task Force. (2002-2007). *Meeting Minutes*. Retrieved 01 November 2007, from http://www.dnr.ne.gov/watertaskforce/docs/TFminutes.html

Nebraska Water Resources Association. (n.d.-a). *Board of Directors*. Retrieved 12 December 2007, from http://www.newra.net/board.html

Nebraska Well Drillers Association. (1966-2005). *Annual Short Course Program*. Retrieved 08 November 2007, from http://nwda.unl.edu/banquet.asp

Nebraska Well Drillers Association. (1970-2006). *Annual Meeting Minutes*. Retrieved 08 November 2007, from http://nwda.unl.edu/minutes.asp

Nebraska Well Drillers Association. (1976-2006). *Annual Convention Program*. Retrieved 07 November 2007, from http://nwda.unl.edu/banquet.asp

New York (State). (1980). *McKinney's session laws of New York, 1979*. Brooklyn: E. Thompson.

New York (State). (1989). *McKinney's session laws of New York, 1988*. Brooklyn: E. Thompson.

New York (State). (1990). c. 566 a.15 Title 16 - Great Lakes Water Conservation and Management. *McKinney's session laws of New York, 1989*. Brooklyn: E. Thompson.

New York (State). (2002). *NYS Great Lakes Basin Advisory Council - Annual Report for 2001*. Retrieved 15 July 2007, from http://www.dec.ny.gov/docs/regions_pdf/report.pdf

New York (State). Department of Agriculture and Markets. Soil and Water Conservation Committee. (n.d.). *Who We Are*. Retrieved 01 August 2007, from http://www.agmkt.state.ny.us/SoilWater/about_us/who_we_are.html

New York (State). Department of Environmental Conservation. (n.d.). *Great Lakes Water Withdrawal Registration Program*. Retrieved 22 February 2007, from http://www.dec.state.ny.us/website/dow/bwp/withdrawal1.html

New York (State). Department of Environmental Conservation. (n.d.). *Lands and Waters*. Retrieved 06 July 2007, from http://www.dec.state.ny.us/61.html

New York (State). Department of Environmental Conservation. (n.d.). Long Island Aquifers. Retrieved 12 July 2007, from http://www.dec.ny.gov/lands/36183.html

New York (State). Department of Environmental Conservation. (n.d.-a). *Great Lakes Water Withdrawal*. Retrieved 18 June 2007, from http://www.dec.ny.gov/lands/25581.html

New York (State). Department of Environmental Conservation. (n.d.-b). *Public Water Supply Permit Program: Do I Need A Permit?* Retrieved 09 July 2007, from http://www.dec.ny.gov/permits/6379.html

New York (State). Department of Environmental Conservation. (n.d.-c). *Division of Water*. Retrieved 18 July 2007, from http://www.dec.ny.gov/about/661.html

New York (State). Department of Environmental Conservation. (n.d.-d). *Water Supply and Conservation*. Retrieved 07 July 2007, from http://www.dec.ny.gov/lands/313.html

New York (State). Department of Environmental Conservation. (n.d.-e). *Division of Law Enforcement*. Retrieved 19 July 2007, from http://www.dec.ny.gov/regulations/621.html

New York (State). Department of Environmental Conservation. (n.d.-f). *Guide to Mediation*. Retrieved 19 July 2007, from http://www.dec.ny.gov/regulations/2578.html

New York (State). Department of Environmental Conservation. (n.d.-g). *State Pollutant Discharge Elimination System*. Retrieved 09 Jult 2007, from http://www.dec.ny.gov/permits/6054.html

New York (State). Department of Environmental Conservation. (n.d.-h). *Great Lakes Basin Advisory Council*. Retrieved 20 July 2007, from http://www.dec.ny.gov/lands/25585.html

New York (State). Department of Environmental Conservation. (n.d.-i). *Determining Agricultural Water Loss in the Great Lakes Basin*. Retrieved 01 August 2007, from http://www.dec.ny.gov/lands/25667.html

New York (State). Department of Environmental Conservation. (1990). *New York State Wellhead Protection Program*. Albany: NYSDEC.

New York (State). Department of Environmental Conservation. (1990). *New York State Wellhead Protection Program - Submittal to USEPA*.

New York (State). Department of Environmental Conservation. (1995). *Regulations, Water Supply Applications (Exclusive of Long Island Wells)*. Retrieved 09 July 2007, from http://www.dec.ny.gov/regulations/regulations.html

New York (State). Department of Environmental Conservation. (1998). *Unified Watershed Assessment Report*. Retrieved 20 July 2007, from http://www.dec.ny.gov/lands/25602.html

New York (State). Department of Environmental Conservation. (2000). *Water Well Program*. Retrieved 17 July 2007, from http://www.dec.ny.gov/lands/4997.html

New York (State). Department of Health. (n.d.). *Drinking Water Program*. Retrieved 22 June 2007, from http://www.health.state.ny.us/environmental/water/drinking/drinkingwaterprogram.htm

New York (State). Department of Health. (1966). *Rural Water Supply*. New York: NYS Department of Health.

New York (State). Department of Health. (1999). *Source Water Assessment Program Plan - Final.*

New York (State). Department of Health.. (2000, March 31). Health Commissioner Releases E. coli Outbreak Report. *Press Release*. Retrieved 01 August 2007, from http://www.health.state.ny.us/press/releases/2000/ecoli.htm

New York (State). Department of Health. (2002). *New York State Department of Health, 1901-2001, a century of building healthier communities: commemorative journal*. Retrieved 17 July 2007, from http://nysl.nysed.gov/Archimages/14187.PDF

New York (State). Department of Health. (2003). Part 76 Public Health Administrative Tribunal. *10 NYCRR Part 76*. Retrieved 30 July 2007, from http://www.health.state.ny.us/nysdoh/phforum/nycrr10.htm

New York (State). Department of Health. (2003-a). Recommended Standards for Water Works. *10 NYCRR Apdx. 5-A*. Retrieved 30 July 2007, from http://www.health.state.ny.us/regulations/

New York (State). Department of Health.. (2006-a). Standards for Water Wells. *10 NYCRR Apdx. 5-B*. Retrieved 30 June 2007, from http://www.health.state.ny.us/environmental/water/drinking/

New York (State). Department of Health.. (2006-b). *Individual Supply Wells - Fact Sheet #4*. Retrieved 03 July 2007, from http://www.health.state.ny.us/environmental/water/drinking/part5/append5b/fs4_abandoning_wells.htm

New York (State). Department of Health. (2007). Houghton Water District - Watershed Rules and Regulations. *NYCRR 10, Part 101, s. 101.4* Retrieved 10 July 2007, from http://w3.health.state.ny.us/dbspace/NYCRR10.nsf/11fb5c7998a73bcc852565a1004e9f87/8525652c00680c3e8525652c006da850?OpenDocument

New York (State). Department of Health. (2007). *Source Water Assessment Program (SWAP) Staff Contacts for City/County Health Departments and State District Offices.* Retreived 03 July 2007, from http://www.health.state.ny.us/ environmental/water/drinking/swapcnty.htm

New York (State). Department of Health. (2007). Village of Akron, Erie County - Watershed Rules and Regulations. *NYCRR 10, Part 113, s. 113.1* Retrieved 10 July 2007, from http://www.health.state.ny.us/nysdoh/phforum/nycrr10.htm

New York (State). Department of State. (n.d.). *Division of Code Enforcement.* Retrieved 23 July 2007, from http://www.dos.state.ny.us/code/ls-codes.html

New York (State). Executive Chamber. (1998). *Letter of Transference WHPP to DOH - Governor Pataki to J.M. Fox, EPA Reg. 2 Regional Administrator.*

New York Rural Water Association. (n.d.). *Wellhead Protection Technical Assistance Program - Fact Sheet.*

New York Rural Water Association. (n.d.-a). About NYRWA. Retrieved 05 July 2007, from http://www.nyruralwater.org/about/about.cfm

NGWA Auxiliary Scholarship. (2003, Winter). *Holetalk,* 15.

Nilsson, T. (2001). *Management of Communal Grazing Land: A case study of institutions for collective action in Endabeg village, Tanzania.* MSc. Thesis, Kungl. Tekniska Hogskolan, Royal Institute of Technology, Stockholm, Sweden..

Nooteboom, B. (n.d.). Trust, opportunism and governance. *Organization Studies* 17: 985-110. Quoted in Gjalt de Jong and Bart Nooteboom, *The Causal Structure of Long-Term Supply Relationships: An Empirical Test of a Generalized Transaction Cost Theory* (Boston: Kluwer Academic Publishers, 2000), 21.

Now Available! General Exam for Pump Installers. (2002, Spring). *Holetalk,* 1.

Patterson, T. E. (2008). *The American Democracy* (8th ed.). New York: McGraw Hill Higher Education.

Percy, D. R. (1988). *The Framework of Water Rights Legislation in Canada.* Calgary: Canadian Institute of Resources Law.

O'Connor, D. R. (2002). *Part I - Report of the Walkerton Inquiry: The Events of May 2000 and Related Issues.* Toronto: Queen's Printer for Ontario.

O'Connor, D. R. (2002). *Report of the Walkerton Inquiry.* Toronto: Queen's Printer for Ontario.

OGWA Regional Meetings. (2003, Summer). *The Source,* 8,12, 19, 24, 26.

Olson, M. (1965). *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge: Harvard University Press.

Olson, J. C. & Naugle, R. C. (1997). *History of Nebraska* (3rd ed.). Lincoln: University of Nebraska Press.

Ontario. (1937). The Well Drillers Act, RSO 1937, c. 50. *Statutes*.

Ontario. (1950). Regulations Made by the Minister Under the Well Drillers Act, RRO 1950, r. 368. *Regulations*.

Ontario. (1950). The Well Drillers Act, RSO 1950, c. 423. *Statutes*.

Ontario. (1971). Regulation 648 (under The OWRC Act), RRO 1970, r. 648. *Regulations*.

Ontario. (1980). Environmental Protection Act, RSO 1980, c. 141 s. 122-125. *Statutes*.

Ontario. Ministry of the Environment. (n.d.). *Operations*. Retrieved 19 May 2007, from http://www.ene.gov.on.ca/envision/org/op.htm

Ontario. Ministry of the Environment. (n.d.-a). *Groundwater Studies*. Retrieved 15 February 2006, from http://www.ene.gov.on.ca/water.htm#groundwater

Ontario. Ministry of the Environment. (1972-1987). *Annual Reports*. 1971-1986. Toronto: Queen's Printer.

Ontario. Ministry of the Environment. (1998-2002). *Business Plans*. 1999-2003. Toronto: Queen's Printer.

Ontario. Ministry of the Environment. (2002, November 08). Minister of the Environment to address Delegates at the A.D. Latornell Conservation Symposium. *Media Release*. Retrieved 23 August 2007, from http://www.grca.on.ca/archival/releases2002/releasenov0802.html

Ontario. Ministry of the Environment. (2005, April). *Permit To Take Water (PTTW) Manual*. Toronto: Queen's Printer for Ontario.

Ontario. Ministry of the Environment. (2005, December). The Proposed Clean Water Act. *Factsheet*.

Ontario. Ministry of the Environment. (2005). Permit To Take Water (PTTW) Administration Fees. *Greenfacts*.

Ontario. Ministry of the Environment. (2007, July). Clean Water Act Support Info. *Factsheet*.

Ontario. Ministry of the Environment. Advisory Committee on Watershed-based Source Protection Planning (ACWSPP). (2003, April). *Protecting Ontario's*

Drinking Water: Toward a Watershed-based Source Protection Planning Framework. Toronto: Queen's Printer for Ontario.

Ontario. Ministry of the Environment. Land Use Policy Branch. (2001). *Municipal Groundwater Studies - Summary of Study Requirements, 2001/2002*. Toronto: Queen's Printer for Ontario.

Ontario. Ministry of the Environment. Sector Compliance Branch. (2006, September 25). Ensuring a High Level of Environmental Protection. *Wells Inspection Report*. Public Information Bulletin 5966e, September 2006. Retrieved 25 October 2006, from http://www.ene.gov.on.ca/envision/scb /wellsinspection.htm

Ontario. Ministry of the Environment. Strategic Policy Unit. (2004, February). White Paper on Watershed-based Source Water Protection Planning. Retrieved 31 August 2007, from http://www.ene.gov.on.ca/programs/3585e01.htm

Ontario. Ministry of the Environment. Watershed-Based Source Protection Planning Implementation Committee. (2004, November). *Watershed Based Source Protection: Implementation Committee Report to the Minister of the Environment*. Toronto: Queen's Printer for Ontario.

Ontario. Ministry of the Environment. Watershed-Based Source Protection Planning Technical Experts Committee. (2004, November). *Watershed-Based Source Protection Planning, Science-based Decision-making for Protecting Ontario's Drinking Water Resources: A Threats Assessment Framework Technical Experts Committee*. Report to the Minister of the Environment. Toronto: Queen's Printer for Ontario.

Ontario. Ministry of Natural Resources. (1984). *Water Quantity Resources of Ontario*. Toronto: Queen's Printer.

Ontario. Ministry of Natural Resources. (2003). *Ontario Low Water Response*. Toronto: Queen's Printer. Retrieved 19 September 2006, from http://www.mnr.gov.on.ca/mnr/water/publications/OLWR_2003.pdf

Ontario. Ministry of Natural Resources. (2005). *Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement*. Retrieved 15 November 2006, from http://www.mnr.gov.on.ca/mnr/water/greatlakes/index.html

Ontario. Ministry of Natural Resources. (2005, December 13). *Great Lakes-St. Lawrence River Basin Compact*. Retrieved 30 May 2007, from http://www.mnr.gov.on.ca/mnr/water/greatlakes/Compact.pdf

Ontario. Office of the Auditor General. (2004, November). *2004 Auditor General's*

Report. Retrieved 15 November 2006, from http://www.auditor.on.ca/en/reports_2004_en.htm

Ontario Ground Water Association. (n.d.). *The Groundwater Industry in Ontario*. Retrieved 12 January 2007, from http://www.ogwa.ca/

Ontario Ground Water Association. (1965-1998). *Souvenir Programme*. OGWA Annual Convention.

Ontario Ground Water Association. (2001). *The Groundwater Industry in Ontario*. Submission to the Walkerton Inquiry Part II.

Ontario Ground Water Association. (2004, Spring). OGWA Brief to Minister of Environment. Reproduced in *The Source*, 4-5, 11, 12-16.

Ontario Ground Water Association & Green Communities Association. (2003). *Well Aware: A guide to caring for your well and protecting your family's health.* Peterborough: Green Communities Association.

Ontario Water Resources Commission. (1956-1972). *Annual Reports*. Toronto: OWRC Public Relations and Information.

Ontario Water Resources Commission. (1965). *Groundwater in Ontario, 1957*. Toronto: OWRC - Division of Research.

Ontario Water Resources Commission. (1969). *Ground Water Probability - County of Elgin*. Toronto: OWRC - Division of Research.

Ontario Water Resources Commission. (1969). *Water Management in Ontario. Pamphlet.* Toronto: OWRC.

Ontario Water Resources Commission. (1969). *Water Resources in Ontario*. Toronto: OWRC Public Relations and Information.

Ontario Water Resources Commission. (1970). *Ontario Water Resources Commission - What it is and what it does*. Booklet. Toronto: OWRC Public Relations and Information.

Opie, J. (1993, 2000). *Ogallala, Water for a Dry Land: A Historical Study in the Possibilities for American Sustainable Agriculture*. Lincoln: University of Nebraska Press.

Ostrom, E. (1986). An agenda for the study of institutions. *Public Choice*, 48(3), 3-25.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

Ostrom, E. (1999). Coping with tragedies of the commons. *Annual Review of Political Science*, 2, 493-535. Quoted in T. Dietz, N. Dolšak, E. Ostrom & P.

C. Stern, The Drama of the Commons. In E. Ostrom, T. Dietz, N. Dolšak, P. C. Stern, S. Stonich, & E. U. Weber, *The Drama of the Commons* (pp. 19-20). Washington, D.C.: National Academy Press, 2002.

Ostrom, E. (1999). Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (pp. 35-72). Boulder, CO: Westview Press.

Ostrom, E. (2000, Summer). Collective Action and the Evolution of Social Norms. *The Journal of Economic Perspectives*, 14(3), 137-158.

Ostrom, E. (2005, September 21-24). Developing a Method for Analyzing Institutional Change. Paper presented at the Symposium on "Who Should Do What in Environmental Governance: Institutions and Constraints," Porto Conte Ricerche (PCR) Centre, Tramariglio, Sardinia, Italy.

Ostrom, E. (2005). *Understanding Institutional Diversity*. Princeton: Princeton University Press.

Ostrom, E., Gardner, R., & Walker, J. (1994). *Rules, Games, and Common-Pool Resources*. Ann Arbor: University of Michigan Press.

Paehlke, R. (2001). Spatial Proportionality: Right-Sizing Environmental Decision-making. In E. A. Parson (Ed.), *Governing the Environment: Persistent Challenges, Uncertain Innovations* (pp. 73-124). Toronto: University of Toronto Press.

Pal, L. A. & Weaver, R. K. (Eds.). (2003). *The Government Taketh Away: The Politics of Pain in the United States and Canada*. Washington, D.C.: Georgetown University Press.

Palmer, C. (1996). *Principles of Contaminant Hydrology* (2nd ed.). New York: Lewis Publishers.

Percy, D. R. (1988). *The Framework of Water Rights Legislation in Canada*. Calgary: Canadian Institute of Resources Law.

Peters, B. G. (1999). *Institutional Theory in Political Science: The 'New Institutionalism'*. New York: Pinter.

Pond, D. (2004, June 05). Rewriting the Rules of the Game: The Common Sense Revolution and Administrative Justice. Paper Presented at the "Common Sense in Ontario?" Session, Canadian Political Science Association Annual Meeting, University of Manitoba, Winnipeg, Manitoba.

Powell, J. W. (2004). *The Arid Lands*. Reprint. Edited by Wallace Stegner. Lincoln: University of Nebraska Press.

Pross, P. A. (1992). *Group Politics and Public Policy* (2nd ed.). Toronto: Macmillan of Canada.

Put Those Complaints In Writing. (1999, Fall). *The Source*, 1-2.

Rabbitt, M. C. (1989). *The United States Geological Survey: 1879-1989*. USGS Circular 1050.

Rao, P. K. (2003). *The Economics of Transaction Costs: Theory, Methods and Applications*. New York: Palgrave Macmillan.

Reeve, I.. (2003). Principles for the Nested Governance of Water Resources. Occasional Paper 2003/1. Institute for Rural Futures.

Regulation 903 Questions to the Ministry of Environment. (2003, Fall). *The Source*, 10-11.

Renzetti, S. (2005). Canadian Agricultural Water Use and Management. Working Paper, Dept. Economics, Brock University. Retrieved 21 June 2006, from http://64.233.161.104/search?q=cache:7yZlBeB2FT0J:139.57.161.145/papers/Ag_Water_Chapter.pdf+growth+irrigated+agriculture+ontario&hl=en&ct=clnk& cd=10

Ress, S. (2000). NU researchers track endangered and threatened sturgeon in Platte River. *Research Note*. Retrieved 22 November 2007, from http://www.watercenter.unl.edu/archives/sturgeon.asp

Richardson, J. & Jordan, A. G. (1979). *Governing Under Pressure: the policy process in a post-parliamentary democracy*. Oxford: Oxford University Press.

Richardson Jr., J. J. (2002). Legal impediments to utilizing groundwater as a municipal water supply source in karst terrain in the United States. *Environmental Geology*, 42, 532-537.

Rindfleisch, A. & Heide, J. B. (1997, Oct.). Transaction Cost Analysis: Past, Present, and Future Applications. *Journal of Marketing*, 61(4), 30-54.

Rivera, A. (2004). How Well Do We Understand Groundwater in Canada? A Science Case Study." Ottawa: Natural Resources Canada. Retrieved 02 April 2005, from http://www.nrcan.gc.ca/

Roberts, R. S. (1992). Groundwater Management Institutions. In D. E. Kromm & S. E. White (Ed.), *Groundwater Exploitation in the High Plains* (pp. 88-109). Lawrence: University of Kansas Press.

Rose, C. M. (2002). Common Property, Regulatory Property, and Environmental Protection: Comparing Community-Based Management to Tradable Environmental Allowances. In E. Ostrom, T. Dietz, N. Dolšak, P. C. Stern, S.

Stonich, & E. U. Weber (Ed.), *The Drama of the Commons* (pp. 233-258). Washington, D.C.: National Academy Press.

Rothenberger, D. & Truffer, B. (2005). Private-sector participation in water and sanitation reviewed. In J. Chenoweth & J. Bird (Ed.), *The Business of Water and Sustainable Development* (pp. 82-98). Sheffield, U.K.: Greenleaf Publishing.

Rothstein, B. & Steinmo, S. (2002). Restructuring Politics: Institutional Analysis and the Challenges of Modern Welfare States. In B. Rothstein & S. Steinmo (Ed.), *Restructuring the Welfare State: Political Institutions and Policy Change* (pp. 1-19). New York: Palgrave MacMillan.

Rutherford, S. (2004, Nov.). *Groundwater Use in Canada.* Vancouver: West Coast Environmental Law. Retrieved 02 April 2005, from http://www.gordonfn.org/buried_treasure/index2.cfm

Sancton, A. (2000). *Merger Mania: The Assault on Local Government.* Montreal: McGill-Queen's University Press.

Sarker, A. & Itoh, T. (2001). Design principles in long-enduring institutions of Japanese irrigation common-pool resources. *Agricultural Water Management*, 48, 89-102.

Scharpf, F. W. (1997). *Games Real Actors Play: Actor-Centred Institutionalism in Policy Research.* Boulder: Westview Press.

Schlager, E. (2005). Getting the Relationships Right in Water Property Rights. In B. R. Bruns, C. Ringler, & R. Meinzen-Dick (Ed.), *Water Rights Reform: Lessons for Institutional Design* (pp. 27-54). Washington, D.C.: International Food Policy Research Institute.

Schlager, E. (1994). Fishers' Institutional Responses to Common-Pool Resource Dilemmas. In E. Ostrom, R. Gardner, & J. Walker (Ed.), *Rules, Games, and Common-Pool Resources* (pp. 247-266). Ann Arbor: University of Michigan Press.

Schlager, E. & Blomquist, W. (2005, November 22-23). Beneath the Surface: Shared Attributes of Fisheries and Aquifers, and Implications for Institutional Design. Paper presented at the Festschrift for Elinor Ostrom, Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, U.S.A..

Schlager, E., Blomquist, W., & Tang, S. Y. (1994, Aug.). Mobile Flows, Storage, and Self-Organized Institutions for Governing Common-Pool Resources. *Land Economics*, 70(3), 294-317.

Schlager, E. & Ostrom, E. (1992, Aug.). Property Rights and Natural Resources: A Conceptual Approach. *Land Economics*, 68(3), 249-262.

Schmitter, P. C. (1979). Still the Century of Corporatism. In P. C. Schmitter & G. Lehmbruch (Ed.), *Trends Towards Corporatist Intermediation* (pp. 7-52). Beverly Hills, CA: Sage Publications.

Schneider, R.L., Negley, T. L., & Wafer, C. (2005). Factors influencing groundwater seepage in a large, mesotrophic lake in New York. *Journal of Hydrology*, 310, 1-16.

Schwartz, F. W. & Zhang, H. (2003). *Fundamentals of Groundwater*. New York: John Wiley & Sons, Inc..

Schwindt, R. & Globerman, S. (1996). Takings of Private Rights to Public Natural Resources: A Policy Analysis. *Canadian Public Policy*, 22(3), 205-224.

Seacrest, S. (1989, May). Thanks from NGWF. *Water Writes*, 18.

Seacrest, S. (1993, Summer). Letter of Appreciation. *Water Writes*, 16.

Sedlack, R. G. & Stanley, J. (1992). *Social Research: Theory and Methods*. Toronto: Allyn and Bacon.

Seidel, M. (1993). Nebraska Well Drillers Association: Leadership for the Water Well Industry. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (p. 236). Lincoln: Conservation and Survey Division, University of Nebraska.

Selin, H. & VanDeveer, S. D. (2003). Mapping Institutional Linkages in European Air Pollution Politics. *Global Environmental Politics*, 3(3), 14-46.

Sheffield, L. F. (1993). Technology. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (pp. 87-106). Lincoln: Conservation and Survey Division, University of Nebraska.

Sheffield, L. F. (1993). The '70s Boom Meant Well Installations Skyrocketed; the '80s Bust Saw a Well-Drilling Downturn. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (127-128). Lincoln: Conservation and Survey Division, University of Nebraska.

Sheffield, L. F. & Rundquist, B. (1993). Circles of Green on the Plains: Frank Zybach, Valmont and the Center-pivot Revolution. In C. A. Flowerday (Ed.), *Flat Water: A History of Nebraska and Its Water* (132-133). Lincoln: Conservation and Survey Division, University of Nebraska.

Sizer, D. (2003, Fall). Well Logs. *Well Bits*, 3.

Sloggett, G., & Dickason, C. (1986). Groundwater Mining in the United States. USDAERS, Washington, DC, Agricultural Economic Report 555.

Smith, J. (1999, April). Spring Legislative Report. *Holetalk*, 3-4.

Smith, J. (2002, January). From the President. *Holetalk*, 3.

Smith, M. J. (1990). Pluralism, Reformed Pluralism and Neopluralism: The role of pressure groups in policy-making. *Political Studies*, 38(2), 302-322.

Snook, V. A. (2001). Movements and habitat use by hatchery-reared pallid sturgeon in the Lower Platte River, Nebraska. MA Thesis, University of Nebraska-Lincoln.

Somma, M. (1997). Institutions, Ideology, and the Tragedy of the Commons: West Texas Groundwater Policy. *Publius: The journal of Federalism*, 27(1), 1-14.

Sophocleous, M. (2005). Groundwater recharge and sustainability in the High Plains aquifer in Kansas, USA. *Hydrogeology Journal*, 13(2), 351–365.

Souders, V. L., Smith. F.A., &. Swinehart, J. B. (1980). *Geology and groundwater supplies of Box Butte County, Nebraska*. Lincoln: Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Southern Lake Michigan Regional Water Supply Consortium. (n.d.). *Groundwater*. Retrieved 25 February 2006, from http://www.nipc.org/environment/slmrwsc/Water%20quantity%20management%202.htm

Spalding, R. F. (1977). *Reconnaissance Sampling for Nitrate-Nitrogen in the Groundwater of the Upper Big Blue Natural Resources District*. (OFR-17). Lincoln: Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Spalding, R. F., Gormly, J. R., Curtiss, B. H., & Exner, M. E. (1978). (RS-20). Nonpoint Nitrate Contamination of Ground Water in Merrick County, Nebraska. *Ground Water*, 16(2), 86-95.

Spalding, R. F. & Loope, C. N. (1984). *Uranium concentrations in groundwater: Central Platte Region, Nebraska, 1982-1983*. Lincoln: Conservation and Survey Division, University Of Nebraska-Lincoln.

Sproule-Jones, M. (1979). Coordination and the management of estuarine water quality. *Public Choice*, 33(1), 41-53.

Sproule-Jones, M. (1982, Dec). Public Choice Theory and Natural Resources: Methodological Explication and Critique. *The American Political Science Review*, 76(4), 790-804.

Sproule-Jones, M. (1989). Multiple Rules and the 'Nesting' of Public Policies. *Journal of Theoretical Politics*, 1(4), 459-477.

Sproule-Jones, M. (1993). *Governments at Work: Canadian Parliamentary*

Federalism and Its Public Policy Effects. Toronto: University of Toronto Press.

Sproule-Jones, M. (1995). Institutional Design for the Economy and the Environment: The Identification and Representation of Stakeholders. In T. Manning, B. Sadler, & J. Dendy (Ed.), *Balancing the Scale: Integrating Environmental and Economic Assessment* (pp. 85-100). Toronto: Foundation for International Training, Canadian Environmental Assessment Agency, and Consulting and Audit Canada.

Sproule-Jones, M. (1996). Institutions and Constitutions: Public Choice in Canada. In L. Dobuzinskis, M. Howlett, & D. Laycock (Ed.), *Policy Studies in Canada: The State of the Art* (pp. 149-169). Toronto: University of Toronto Press.

Sproule-Jones, M. (2000, Spring). Horizontal management: implementing programs across interdependent organizations. *Canadian Public Administration*, 43(1), 93-109.

Sproule-Jones, M. (2002). *Restoration of the Great Lakes: Promises, Practices, Performances*. Vancouver: UBC Press.

Sproule-Jones, M. (2006, May 31-June 03). Public Administration: An Intellectual Crisis or a New Direction? Paper presented at the Conference on "Vincent Ostrom and the Quest for Understanding Human Affairs", Workshop on Political Theory and Policy Analysis, Bloomington, Indiana, U.S.A..

Sproule-Jones, M. (2008). Property Rights for Water Resources Management. In M. Sproule-Jones, C. Johns, & T. Heinmiller (Ed.), *Water Politics and Policy* (Chapter 5). Vancouver: UBC Press.

Starr, G. (2005, Summer). Republican River Basin Environmental Quality Incentives Program. *Nebraska Resources*, 1.

State of Nebraska. Governor's Office. (1990, January 25). *Letter of Designation NDEC Lead Agency for WHP Program - Governor Orr to NDEC Director Grams*.

Susquehanna River Basin Commission. (1972). *Susquehanna River Basin Compact* Retrieved 19 June 2007, from http://www.srbc.net/about.htm

Susquehanna River Basin Commission. (2001). Susquehanna River Basin County Map. Retrieved 31 July 2007, from http://www.srbc.net/gis/image/maps/140d_CountiesPopCntrs.pdf

Swenson, E. (1999). Public Trust Doctrine and Groundwater Rights. *University of Miami Law Review*, 53(2), 363-391.

Swigle, B. D. (2003). *Movements and habitat use be shovelnose and pallid sturgeon* *in the Lower Platte River, Nebraska*. MA Thesis, University of Nebraska-Lincoln.

Templer, O. W. (1992). The Legal Context for Groundwater Use. In D. E. Kromm & S. E. White. *Groundwater Exploitation in the High Plains* (pp. 64-87). Lawrence: University of Kansas Press.

Thelen, K. & Steinmo, S. (1992). "Historical Institutionalism in Comparative Politics. In S. Steinmo, K. Thelen, & F. Longstreth. (Eds.), *Structuring Politics* (pp. 1-32). New York: Cambridge University Press.

The Source. (2003-2004).

Tietenberg, T. (2002). The Tradable Permits Approach to Protecting the commons: What Have We Learned? In E. Ostrom, T. Dietz, N. Dolšak, P. C. Stern, S. Stonich, & E. U. Weber (Ed.), *The Drama of the Commons* (pp. 197-232). Washington, D.C.: National Academy Press.

Tilly, C. (1978). *From Mobilization to Revolution*. Reading, Mass.: Addison-Wesley Publishing Company.

Ting, M. M. (2002, April). A Theory of Jurisdictional Assignments in Bureaucracies. *American Journal of Political Science*, 46(2), 364-378.

Tremblay, R. (1989, Nov.). Education Requirement for Licensing. *Water Writes*, 16.

Tremblay, R. (1990, May). Examination for Licensure and Certification. *Water Writes*, 7.

Tucker, C. (1998, June 10-14). Evaluating a Common Property Institution: Design Principles and Forest Management in a Honduran Community. Paper presented at the 7th Conference of the International Association for the Study of Common Property, Vancouver, Canada.

Udéhn, L. (1993). Twenty-five Years with *The Logic of Collective Action. Acta Sociologica,* 36, 239-261.

United States. Department of Agriculture. National Resources Conservation Service. (2006). Who We Are. *Factsheet*.

United States. Environmental Protection Agency. (n.d.). *Sole Source Aquifer Protection Program*. Retrieved 12 July 2007, from http://cfpub.epa.gov/safewater/sourcewater/sourcewater.cfm?action=SSA

United States. Environmental Protection Agency. (n.d.-a). Wellhead Protection Program. Retrieved 30 June 2007, from http://www.epa.gov/region02/water/whp.htm

United States. Environmental Protection Agency. (n.d.-b). *National Drinking*

Water Advisory Council. Retrieved 21 July 2007, from http://www.epa.gov/safewater/ndwac/index.html

United States. Environmental Protection Agency. (1984). *Ground-Water Protection Strategy*. Washington, D.C.: USEPA.

United States. Environmental Protection Agency. (1986, June 20). President Signs Safe Drinking Water Act Amendments. *Press Release*.

United States. Environmental Protection Agency. (1997). *State Source Water Assessment and Protection Programs - Final Guidance*. (EPA 816-R-97-009).

United States. Environmental Protection Agency. (2002). *American Government Roles: The Clean Water Act, The Safe Drinking Water Act, EPA*. Retrieved 20 July 2007, from http://www.epa.gov/safewater/dwa/electronic/ematerials.html#SWP

United States. Environmental Protection Agency. National Drinking Water Advisory Council. (1996). Source Water Protection Working Group. Retrieved 20 August 2007, from http://www.epa.gov/safewater/ndwac/swp.html

United States Geological Survey. (2004). *Groundwater Atlas*. Retrieved 15 February 2006, from http://capp.water.usgs.gov/gwa/

United States Geological Survey. (2004, March). *Report on 2000 Water Use*.

University of Nebraska-Lincoln. Conservation and Survey Division. (n.d.-a). *School of Natural Resources - Meet Our Faculty: J. Michael Jess*. Retrieved 18 November 2007, from http://snr.unl.edu/people/faculty/jess-jmichael.asp.

University of Nebraska-Lincoln. Conservation and Survey Division. (1980). *General soil map of Sioux City area - Nebraska*. Lincoln: University Of Nebraska-Lincoln.

University of Nebraska-Lincoln. Conservation and Survey Division. (1981). *Groundwater Reservoir Management Policy Issue Study*. Contract Report for NNRC. Lincoln: UN-L Conservation and Survey Division.

University of Nebraska-Lincoln. Conservation and Survey Division. (1998). *The Groundwater Atlas of Nebraska* (2nd ed.). Resource Atlas No. 4a/1998. Lincoln: Conservation and Survey Division, University of Nebraska.

Upper Thames, Lower Thames and St. Clair Region Conservation Authority. (2007, March 19). Discussion Paper on Participation in the Source Protection Planning Process. (v. 1.4).

VanAlstyne, F. (2003, Spring). Never too late to say Thanks. *Holetalk*, 8.

Vanek, W. (2003, Spring). Digitalized Soil Surveys. *Nebraska Resources*, 4.

Volger, D. (2002, Spring). Legislative Session. *Nebraska Resources*, 1-4.

Waterloo Hydrogeologic, Inc. (2004, May). *Sinkhole Investigation for Areas Mainly within the Municipalities of Huron East And West Perth - Final Report.* Waterloo: Waterloo Hydrogeologic.

Water Systems Council. (n.d.). *About Us*. Retrieved 15 July 2007, from http://www.watersystemscouncil.org/about/index.cfm

Water Systems Council. (2003). Who Owns The Water. *Factsheet.*

Water Writes. (1982, March). NE driller to be President of NWWA, 4.

Water Writes. (1985, February). Executive Changes for Drillers Association, 2.

Water Writes. (1985, February). Grams Tells Plans in Water Quality, 10-11.

Water Writes. (1985, August). New forms for well registrations, 18.

Water Writes. (1988, November). NWWA Summary, 14.

Water Writes. (1991, February). Tutoring Exams Scheduled, 6, 21.

Water Writes. (1993, Fall). NGWA Washington Results, 14.

Weaver, R. K. & Rockman, B. A. (Eds.). (1993). *Do Institutions Matter? Government Capabilities in the United States and Abroad.* Washington, D.C.: Brookings Institution.

Weeks, J. B., Gutentag, E. D., Heimes, F. J., & Luckey, R.R. (1988). *Summary of the High Plains Regional Aquifer--System Analysis in Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming.* U.S. Geological Survey Professional Paper No. 1400-A.

Well Aware: A Well Owner's Video. (2002). Videocassette. Narrated by Bob McDonald. Toronto: Ontario Groundwater Video Working Group.

Well Bits. (2005). Addition to Water Well Standards and Contractor Licensure Program, 1.

Wentink, M. (1991, February). Test Wells. *Water Writes*, 6.

Wick, S. (1998). Farming the Land of Their Dreams. *Long Island History*. Retrieved 25 July 2007, from http://www.newsday.com/community/guide/lihistroy/ny-history-business_bizfarm,0,6400231.story?coll=ny-lihistory-navigation

Williamson, D. (1999, Fall). The Lower Platte Rive Corridor Alliance. *Nebraska Resources*, 3-4.

Williamson, P. J. (1989). *Corporatism in Perspective: An Introductory Guide to Corporatist Theory*. London: Sage.

Williamson, O. E. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: Free Press.

Williamson, O. E. (1985). *The Economic Institutions of Capitalism: firms, markets, relational contracting*. New York: Free Press.

Williamson, O. E. (2000, September). The New Institutional Economics: Taking Stock, Looking Ahead. *Journal of Economic Literature*, 38(3), 595-613.

Williamson, S., Brunckhorst, D. & Kelly, G. (2003). *Reinventing the common: Cross-boundary Farming for a Sustainable Future*. Sydney: The Federation Press, 2003.

Wilson, J. (2002). Scientific Uncertainty, Complex Systems, and the Design of Common-Pool Institutions. In E. Ostrom, T. Dietz, N. Dolšak, P. C. Stern, S. Stonich, & E. U. Weber (Ed.), *The Drama of the Commons* (pp. 327-360). Washington, D.C.: National Academy Press.

Wilson, P. (1998, March). President's Report. *OGWA Annual Report 1997-98. AGM Minutes* 27. Waterloo, On..

Wilson, P. (1999, April). President's Report. *OGWA Annual Report 1998-1999 AGM Minutes*. London, On.

Wondolleck, J. M. & Yaffee, S. L. (2000). *Making Collaboration Work: Lessons from Innovation in Natural resource Management*. Washington, D.C.: Island Press, 2000.

Woolstencroft, P. (1997). Reclaiming the 'Pink Palace': The Progressive Conservative Party Comes in from the Cold. In G. White (Ed.), *The Government and Politics of Ontario* (pp. 365-401). Toronto: University of Toronto Press.

Worthington, S. R. H., Smart, C. C. & Ruland. W. W. (2002, October). Assessment of Groundwater Velocities to the Municipal Wells at Walkerton. Proceedings of the 55th Canadian Geological and 3rd Joint IAH-CNC and CGS Groundwater Specialty Conference. Niagara Fall, On., 1081-1086.

Young, O. R. (2002). Institutional Interplay: The Environmental Consequences of Cross-Scale Interactions. In E. Ostrom, T. Dietz, N. Dolsak, P. C. Stern, S. Stonich, & E. U. Weber (Ed.), *The Drama of the Commons* (pp. 263-292). Washington, D.C.: National Academy Press.

Zimmerman, K. (2007, August). Lone Star Dedication. *Nebraska Resources*, 3.

Zwarteveen, M. & Meinzen-Dick, R. Gender and property rights in the common: Examples of water rights in South Asia. *Agriculture and Human Values*, 18, 11-25.

Appendix I – Complementarity Gradations

A. Governance Vision Gradations:

(Examples given are in relation to New York WHPP unless otherwise noted):

• **High**, if, governance unit visions (goals) demonstrate a significant degree of overlap.

Example: The NYS Department of Environmental Conservation Ground Water Management Branch (NYSDEC GWMB) and the NYS Department of Health Bureau of Water Supply Management (NYSDOH BWSM) have a high similarity in governance visions with the NYSDEC GWMB working to protect and conserve the waters of New York through various programs such as the Wellhead Protection Program (WHPP), and the NYSDOH BWSM working to protect and promote the health of New Yorkers through various programs including the delivery of safe drinking water via the development, implementation and enforcement of well construction standards.

• **Moderate**, if, a degree of overlap exists but is not significant. For example, overlap may be diluted by a diffuse or slightly different mandate.

Example: The NYSDEC GWMB and the United States Geological Survey (USGS) Water Resources Division (WRD) have a moderate similarity in governance visions with the NYSDEC GWMB working to protect and conserve the waters of New York through various programs such as WHPP and, the USGS WRD providing scientific information related to the country's water resources including river and lake water levels, water consumption, water quality, water's economic value and aquifer dynamics among other things. Note that the USGS's goals are varied and only some of them directly apply to WHP planning (e.g. aquifer dynamics, water consumption if groundwater data available). In short, the USGS WRD vision is to produce scientific information of value for Americans while the NYSDEC GWMB is much more narrowly focused (e.g. WHPP).

• **Low**, if, overlap is so diffused that any similarity is overshadowed by other core goals.

Example: The NYSDEC GWMB and NYS Regional/County Planning Councils have a low similarity in governance visions with the NYSDEC GWMB working to protect and conserve the waters of New York through various programs such as WHPP, and the Planning Councils' focus on fostering coordination among/within neighbouring counties and providing a regional approach to concerns that cross local boundaries including watershed protection, economic development and data management (e.g. socio-economic data). Goal similarities are low due to the highly diffused goals of the Planning Councils.

• **Nil, or non-existent**, if, there is no similarity in goals, that is, the governance units have different goals.

Example: In relation to well driller regulatory changes in Ontario (1966-1970), the courts and the Research Division (RD) of the Ontario Water Resources Commission (OWRC) had no similarities in governance goals with the courts adjudicating disputes while the OWRC Research Division worked to provide scientific information in regards to water quantity and quality.

B. Communication Level Gradations:

• **High**, if, the governance units had frequent meetings (i.e. >3/yr), were involved in various educational activities, seminars, conferences (i.e. 1-3/yr) and elaborated a position or proposal (i.e. min. 1/yr; new, refinement, or responding to the other's position/proposal).

Example: In relation to well driller regulatory changes in Ontario (1966-1970), the Ontario Ground Water Association (OGWA) and the OWRC Ground Waters Branch (GWB) had high communication levels as exemplified by the frequency of meetings (>3 per year), yearly advertisements by the OWRC GWB in the OGWA's annual convention "Programme", as well as, manning a display booth at such conventions, numerous OWRC GWB officials speaking at the OGWA annual conventions, participation of the OGWA members in the OWRC GWB conferences and responding to each other's concerns in various legislative and regulatory proposals.

• **Moderate**, if, the governance units met infrequently (i.e. 1-3/yr), less involvement in various educational activities, seminars, conferences (i.e. 0-1/yr) and elaborated few positions or proposals (i.e. min. 1/yr; new, refinement, or responding to the other's position/proposal).

Example: In relation to well driller regulatory changes in Ontario (1966-1970), the OGWA and the OWRC had moderate communication levels based on few meetings held (only held if need exists to consult OGWA as part of a research project), a number of seminars ("Research Days") held to disseminate research information to the OGWA and its members with no formal positions elaborated (though as one former OWRC GWB Official noted, many were offered informally during the "Research Days").

• **Low**, if, the governance units rarely met (i.e. 0-1 per *time frame; i.e. not per year*), little, if any, involvement in various educational activities, seminars, conferences (i.e. 0-1 per *time frame*) and elaborated little, if any, positions or proposals (i.e. 0-1 per *time frame*; new, refinement, or responding to the other's position/proposal).

Example: In relation to well driller regulatory changes in Ontario (1966-1970), the OGWA and the courts had low communication levels noted by few meetings (<3 cases) and no interaction in regards to educational and or proposals/positions.

• **Nil, or non-existent**, if, communication levels between the governance units were either not discernable or so infrequent to border on non-existent, that is, they only met once overall (i.e. 0-1 per *time frame*), OR had no to little involvement in various educational activities, seminars, conferences (i.e. 0-1 per *time frame max.*) OR elaborated *a* position/proposal (i.e. 0-1 per *time frame*; new, refinement, or responding to the other's position/proposal).

Example: In relation to water takings in Ontario 1999-2006, Conservation Authorities and the courts had no communication. Simply put, no cases were before the courts that necessitated the involvement of Conservation Authorities, no positions or proposals were put forth and no educational activities between the two occurred.

C. Collaboration Level Gradations:

• **High**, if, governance units were involved in many (>5/yr) collaborative efforts (e.g. program delivery, educational activities, joint work to address new issue/problem).

Example: In relation to water takings regulatory changes in Nebraska (2000-20005), the Nebraska Department of Natural Resources (NDNR), the University of Nebraska

(Lincoln) Conservation and Survey Division (UN-L C/S Division) and the Natural Resource Districts (NRDs) had high collaboration levels. This is evidenced by their respective roles in the evaluation of water permits and in other activities such as the joint review of both NRD Groundwater and Integrated Management Plans, participation in the Lower Platte River Corridor Alliance, the digitalization of soil surveys and the Platte River Cooperative Hydrology Study (COHYST).

• **Moderate**, if, governance units were involved in fewer collaborative efforts (1-5/yr).

Example: In relation to water takings regulatory changes in Nebraska (1980-1987), the NRDs, the Nebraska Natural Resources Commission (NNRC) and the Nebraska Department of Environmental Conservation Ground Water Unit (NDEC GWU) had moderate collaboration levels. This is evidenced by their joint reviews of NRD Groundwater Management Plans and in joint efforts to address the decommissioning of water wells.

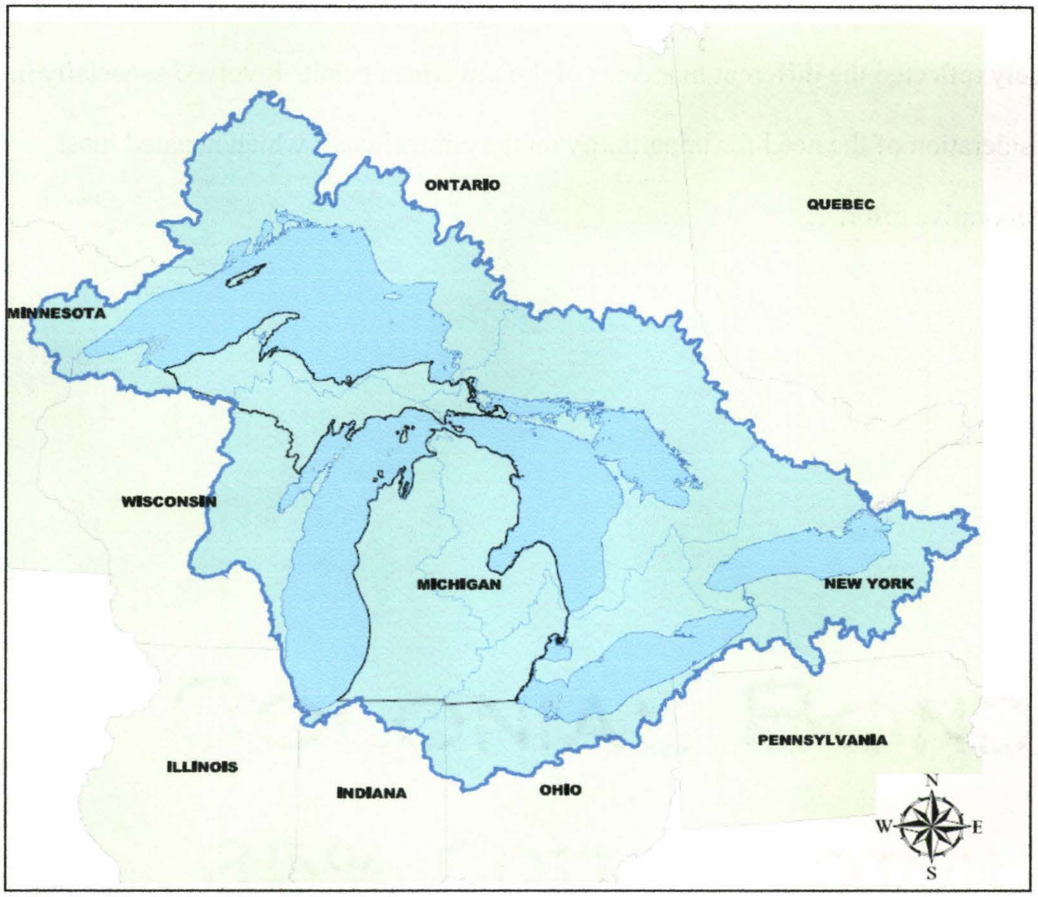
• **Low**, if, governance units were involved in few (0-1) collaborative efforts *per time frame* (not per year).

Example: In regards to water takings regulatory changes in Nebraska (2000-2005), the UN-L C/S Division and Local Governments had low collaboration levels. Note that collaboration only occurred when a Local Government required assistance in the evaluation of a new groundwater source.

• **Nil, or non-existent**, if, collaboration levels between governance units were either not discernable (nil) after review of the governance framework or did not exist during the time frame in question.

Example: In relation to water takings regulatory changes in Nebraska (2000-2005), collaboration between the courts and most governance units was non-existent. This largely reflected the different mandates of the governance units involved especially in consideration of the need for impartiality on the courts behalf which negated most collaborative efforts.

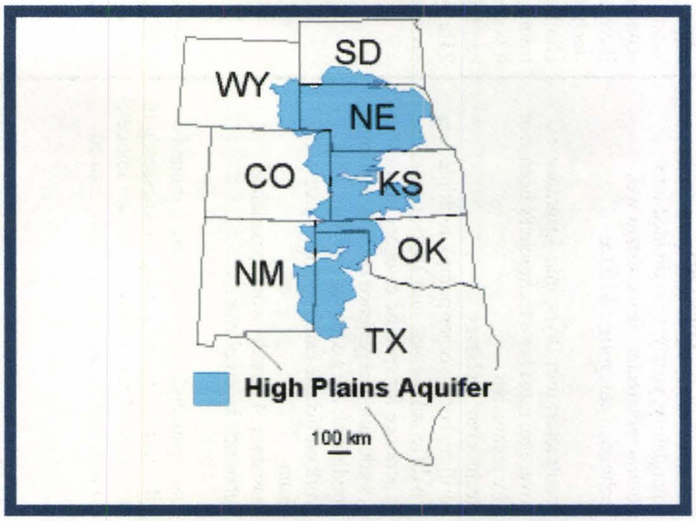
Appendix II
Map of the Great Lakes Basin



Source: Ecological Monitoring and Mapping Lab, Forest Resources & Environmental Science, Michigan Tech University, March 2004, Available: http://forest.mtu.edu/staff/hyslop /maps/basin/greatlakes_basin.pdf

Appendix III

Ogallala Aquifer Map



Legend: CO = Colorado, KS = Kansas, NE = Nebraska, NM = New Mexico, OK = Oklahoma, SD = South Dakota, TX = Texas, WY = Wyoming

Source: McGraw Hill Higher Education, 2000, <http://www.mhhe.com/earthsci/geology/mcconnell/demo/hpaq.htm>

Note: The Ogallala Aquifer is also known as the High Plains Aquifer.

Appendix IV: Summary of Well Driller Regulatory Changes, Ontario, Select Years

	pre-1966	1966-1970	1980-1984	2000-2004
Licensing	-mandatory yearly licensing contractors; license fee $2 -2 yrs experience or employs one with 2 yrs experience -mandatory reporting to OWRC/well owner	-mandatory, yearly; separate licenses for drilling /boring wells; license fee $10 -same qualifications but includes corporations re employ one with 2+ yrs experience	-mandatory, yearly; now divided into contractors /technician/assistant well technician categories; $10 fee -contractor: min 18yrs; min. insurance coverage; must have technician's license or hire technician -technician: 4 classes (drilling/boring/other/pump); multiple fees fro different classes; min 18yrs; 6 months experience for specific category plus either 2 yrs education/experience or 2 yrs academic; conditions: 2pcs equip at one time, only work on license category; must pass MOE exam -assistant: 4 months work experience submitted by employer	-same classifications; -contractors: same except insurance rqts increased tenfold -technician: 3 classes (other category eliminated); min 18yrs; min 30hr training course for each category plus 4,000hrs work experience; same conditions; must pass MOE exam; 21hrs/yr continuing education -assistant: same
Construction casing/sealing/ location	-new casing materials only; mandatory sealing; water free well pits	-same plus specifies nominal casing thicknesses	-casing extends min 30cm above ground or pit floor; changes in casing thicknesses; min separation distances from pollution sources; no well pits unless automatically drained	-more detailed depending on drilled/bored; casing 40cm above highest pt within 3m radially from well; casing thicknesses to conform to ASTM/AWWA standards; illegal to ground lightning rod to well casing; exemptions for test holes/dewatering wells; new well tagging rqts; location via GPS; deliver well info package to owners; new well cluster rqts; more specific min separation distances; new shallow works section
annular space	-if necessary seal with cement/other material	-mandatory; more choices for material to be used; specific procedures	-very specific; varies on whether drilled/bored, depth	-same rqts but more general in terms of "sealant"
chlorination	-no rqts.	-250ppm; all contact; min 12 hrs with Chlorine	-same (250mg/L)	-50mg/L Chlorine; all contact

Appendix IV: Summary of Well Driller Regulatory Changes, Ontario, Select Years (cont'd)

	pre-1966	1966-1970	1980-1984	2000-2004
pumps	mandatory commercial seal if pump installed; water tight connections	-very detailed, differs based on drilled/bored; mandatory well seal/pitless adaptor; watertight connections	-same rqts, though much less specific (simplified)	-same except cannot make hole for pitless adaptor with cutting torch; more flexibility in use of sealants
venting	-if used, min. 12" above ground and screened	-mandatory venting; specific venting sizes and heights depending on casing size and whether pit used	-same; natural gas provision	-same but min 40cm
abandonment /plugging	-mandatory (driller) if salty, sulphurous, mineralized and might affect quality of any groundwater -mandatory (owner) if may result in aquifer contamination	-same provisions however onus is on owner to plug well; (new) mandatory plugging of dry/abandoned wells (owner)	-generally same; mandatory if well not used; producing non-potable water; dry well; natural gas encountered; plug with concrete/suitable material	-new; very detailed and in addition; different processes based on well diameter; rqd chlorination; removal of equipment/casing to 2m; sealing with bentonite; min 30cm soil cover
Enforcement	-licensing: $10-100 on summary conviction -construction: $5-500 on summary conviction	-licensing: same -construction: $25-1,000 on summary conviction	-grounds for license issue/renew refusal explained; Director must give notice of refusal; applicant can request hearing before Env. Appeal Board; can appeal EAB decision on question of law to Divisional Courts; can appeal decision in writing to Minister within 30dys; Minister final say; if appealed, can issue interim orders	-same

Appendix V:

Summary of Water Takings Regulatory Changes, Ontario

	pre-1960	1960-1964	1999-2006
Water Permit	-nil-	-permit required for takings >10,000 gal(UK); no fees -exceptions: domestic, farm (livestock watering only, not irrigation), firefighting	-permit required for takings > 50,000 L/day and installed after March 1961 -fees: $750-3,000 depending on classification; no fee for agricultural permits (irrigation) -exemptions: same
Considerations	-nil-	-can refuse, cancel alter permit at any time	-add ecosystem functions, groundwater availability, use, low water response, high use watersheds, GL Charter, GL Annex, AGL Amending Agreement, cumulative effects
Enforcement	-nil-	-max. $200/day on summary conviction	-max. $50,000 fine/day first conviction -max. $100,000 fine/day subsequent convictions and/or max. 1 year prison term

Appendix VI

Well Driller Regulatory Changes, pre/post 1999, New York

	pre-1999	post-1999
Registration	-Long Island Counties only	-required, yearly; all drillers operating in NY
Certification	-nil	-mandatory drillers 2003, pump install. 2006
Construction		
casing/sealing/ location	-200' from leaching bed, 50' from septic tank -11 different rqts depending on hydrogeologic conditions -mandatory cement grouting -well sealing and caps required	-100' from leaching bed, 50' from septic tank -same/smaller/flexibility depending on method used for drillhole oversize for grout -new ASTM approved material only -flexibility in/if to grout & material used -more specific in well seals
chlorination/yield testing/venting	-mandatory chlorination -well seals, pitless adaptor, (venting if required)	-mandatory disinfection, no specs provided -yield testing min. 4 hour drawdown <u>or</u> an adequate alternative -well seals/pitless adaptor/vent screens rqd
abandonment	-shallow wells earth fill; drilled fill with puddled clay/concrete -see nat. std. AWWA A-100-58	-shallow wells earth fill, remove top 4' min. -drilled wells remove entire casing where possible, fill with grout
Note 1: Above specs for individual supply wells (private); regulatory standards more stringent for public supply wells (e.g. 4hr yield test mandatory, min. separation distances increase). **Note 2: The above pre-1999 construction standards were for *<u>guidance</u>* purposes only, that is, they were not mandatory except for Long Island counties.**		
Enforcement	-Long Island counties only	-registration/certification: $1,000 per offence; equipment seizure -construction: -self-enforcement by drillers -if by Code Enforcement Official, no Certificate of Occupancy and/or $1,000/day -if County Health Dept, no Cert. of Occ. -if civil matter, courts decide

Appendix VII: Summary of Well Driller Regulatory Changes, Nebraska, Select Years

	pre-1981	1981-1986	1993-1994	2001-2004
Licensing		-mandatory, yearly; separate license for well & pump contractors/supervisors & associated def'ns including water well -age of majority, good moral character, pay fee, comply with rules/regs -pump installers: need cert. of competence in their trade + pass exam, pay fee, comply rules/regs	-add to w.w. def'n wells for hydrogeologic information -define w.w. monitoring technician	-add water well monitoring technicians, natural resources GW technicians (& def'ns for) -def'n clarification re w.w. contractor, supervisor re add decommissioning wells as possible type of work except own property sandpoint wells -clarification licensing, what includes/not includes re categories
		-W.W. Stds. & Contractor's Licensing Bd. created (9 members: 5 industry, 4 agency people) -determines exam particulars re categories, knowledge, processes, fees...); all grandfathered in initially but must pass exam w/i one year; can retake exam(3+ time) after 6 month wait -12 hrs CEUs per 3yrs -make rules/regs well construction stds with agencies	-delete 6 month wait to retake exam for 3+time -18 hrs CEUs now needed	-exam particulars refinement -develop cert. program for nat. resource technicians
Construction registration	-register wells within 20days -abandoned registered wells must be decommissioned as per Dept. Water Resources rules/regs & give notice w/i 60dys -replacement wells must be registered w/i 30dys (and need permit if > capacity) -provide evidence of	-replacement well permit now based on pump column size (if >) -no fee to register for wells with permits -defines replacement well (w/i 5yrs last operation and w/i 600' of old one) -require well driller license info	-no registration required for wells prior to operative date of this section -registration completed by owner or well contractor -30dys to register except test/dewatering wells have 90days -more specific info to be furnished -re abandoned well, now 30dys to notify; changed to 60 days within a year; owner	-registration information to be from well log -electronic filing 2002 -can pay registration fees by credit card -cannot register replacement well until notice of abandonment old one given -must notify of changes to well/pump after registration done (re new pump, upgrades/maintenance) -re illegal wells: allowance to correct deficiencies added -all wells illegal except pre-1993 domestic wells, test holes/dewatering wells until

Appendix VII: Summary of Well Driller Regulatory Changes, Nebraska, Select Years (cont'd)

	pre-1981	1981-1986	1993-1994	2001-2004
registration (cont'd)	well ownership and notify when change in ownership		responsibility to notify -permit needed for replacement wells in gw mgt/control areas -replacement well operative date now 3yrs -well field/series of wells considered one registration -replacement well must supply water to same tract of land	registered with NDNR -separate provisions developed for sandpoint wells re registration
spacing rqts.	-600' between irrigation wells; replacement irrigation wells to be w/i 50' old one if old one as per 600' spacing -exempt domestic, culinary, stock, watering lawns/gardens if < 2 acres -can apply for exemption from spacing rqts.; may be granted; considerations outlined	-applies only to irrigation wells; space protection applies to unregistered well for 30days after completion	-exemptions only apply to irrigation wells; application changes	-exemption only for if irrigate <2acres regardless of purpose -space protection now applies for 60 days -cannot use non-irrigation well for irrigation if w/i 600'
	-other spacing: 1,000' between municipal, irrigation, industrial wells -can override re special permit as above	**-other spacing:** not apply to wells owned by same owner; 30 days limitation unregistered wells		**-other spacing:** change in use of well subject to spacing as if new well -limitation increased to 60 days from 30 days
Other (e.g. illegal wells, decommissioning)		-6 fold classification for illegal water well	-creates program for decommissioning water wells; pays to 75% to costs to set level	-simplify def'n illegal water well

Appendix VII: Summary of Well Driller Regulatory Changes, Nebraska, Select Years (cont'd)

	pre-1981	1981-1986	1993-1994	2001-2004
Enforcement	-violations justiciable in county court where occurred	-re license -can refuse/revoke/suspend due to fraud, rule/reg violation, incompetence, unsafe practices -wait one year to reapply; reinstatement if show good cause -unauthorized employment, construction, decommissioning/installation w/o license is a Class 2 misdemeanor max $1,000/day; can sue to collect in district court of county, foreclose/lien -failure to comply with standards is a Class 3 misdemeanor max 500/day civil penalty; may be prohibited from continuing via injunction **-re** no permit to construct well: Class 4 misdemeanor	-same but add fraudulent trade, impairment (e.g. alcohol), facilitating practice by unqualified people as reasons to deny -must provide documentation if license refused/cancelled/suspended in another state -suspended til Director of Health reinstates; revocation is for 1 year; reinstatement for good cause deleted -hearing procedure established and specifies actions Health Director may take -for violations Director can issue administrative order re violation/corrective actions required; violator can request hearing -re no permit pump installation: Class 4 misdemeanor	-no changes

Appendix VIII: Water Takings (Permits) Regulatory Change Summary, Nebraska, Select Years

	pre-1980	1980-1987	1991-1999	2001-2007
transfer permits	-permit required for GW withdrawals and transfers to adjoining state -Director must find applic. reasonable, not contrary to conservation efforts, nor detrimental to public welfare -Director to consider if use beneficial; availability of other SW and GW; negative impacts on existing supplies; other like considerations	-changed to another state from adjoining state -statement recognizing need to regulate transport of such transfers -must comply with rules/regs, provide access to property for inspections -Director may impose conditions on permits	-transportation restrictions w/i powers of NE police	-permit considerations changed (e.g. meets present and future demands; meets interstate compacts) -consider adverse environmental effects and cumulative effects
irrigation permits	-need permit if w/i 50' streambank; Director to consider effects on stream and needs or applicant	-no changes		
municipal permits	-permit required (1963) to locate GW supplies and transport to area served by city/village/ municipality -fees are $50/first 5 million gal/day + $20 per each 5 million /gal/day increment -public notification -permits 5yr duration and for as long as water for which permit is granted for is used -can issue recharge permits to store GW - same process as above	-changed to public water suppliers and use to be for domestic/municipal purposes only -public notification to be for 3 consecutive wks in counties where wells located; to include specifics e.g. quantity used; must file objection w/i 2 wks last notice.	-public notification at applicant's expense	
industrial permits		-need permit if withdraw/transfer >3,000acreft/year (manufacturing, commercial, power generation) -must be in public interest, consider adverse effects on existing GW and SW users and reasonable future demands, other water sources, economic benefits	-any industrial withdrawal needs permit -no permit required in transfer <150acreft w/i state to property you own; however, must notify Director of such transfers, meter transfers provide yearly reports re quantity	-consideration must include interstate compacts

Appendix VIII: Water Takings (Permits) Regulatory Change Summary, Nebraska, Select Years (cont'd)

	pre-1980	1980-1987	1991-1999	2001-2007
industrial permits (cont'd)		of proposal... -Director may deny application or grant it for less then asked for; may impose conditions; 90 days to issue decision - permit revoked after hearing if not use GW w/i 3yrs of for 3 consecutivemonths thereafter; revoked/suspended if withdraw more than allowed or violate permit conditions	used...; noticed published 3x in papers where withdrawal located -permit revocation re only have to show that "it appears" permit holder withdrew more than or....	
management/ control area permits	-permit required if in control area (1975); $25 fee; provide information re location, nature of use -permit denied only if not beneficial use, incomplete application -Director has 30dyas to make decision, can deny, impose conditions... -one year to construct well; if not, permit cancelled	-application must be filed with the Natural Resource District; reviewed and forwarded to Director Water Resources with comments w/i 30 days -if for a let permit; same process but fee is $275 - applicant must show acted in good faith though late -only applies for wells on land one owns -expand to include if in management area	-exempt test holes/dewatering wells <90day use (1993) -wells <50gpm exempt (1994) -need a permit before modifying a well (1996) -co-mingled/clustered wells considered as one well (1998) -may request a permit if <50gpm except for human needs re health, fire, sanitation, livestock in mgt areas	
	-NRDs can adopt more restrictive controls re well spacing rqts., moratoriums... after consultation with UN-L C/S and NNRC -can adopt different restrictions for different parts of control area	-NRD (1983) reviews/issues/denies permit	-NRDs can impose added restrictions for wells where GW SW connections exist for integrated mgt.	-NRDs can allocate GW to be used, limit consumptive uses, require approval of transfers, deeper wells...
Enforcement	-re transfers: Class 4 misdemeanor; prohibit from transfer until permit obtained	-re prior to well construction: Class 4 misdemeanor -re transfers: same	-re transfers: add false info. as Class 4 misdemeanor; enforcement by NDWR	-re transfers: each day in violation is a separate offence; enforcement by NDNR and Atty. General and County

Appendix VIII: Water Takings (Permits) Regulatory Change Summary, Nebraska, Select Years (cont'd)

	pre-1980	1980-1987	1991-1999	2001-2007
Enforcement (cont'd)	-re municipal permits: aggrieved party can pursue through NE Supreme Court	-re industrial: Class 1 misdemeanor; each day in violation is separate offence -changed in 1986 to Class 4 misdemeanor -re mgt. control areas: $1,000 - $5,000 /day; consider degree of violation, size of operation; can sue/foreclose via district courts in county but must consult get approval Atty General before issuing cease/desist order; civil penalties goes into coffers of who brings action forward	-re municipal permits: proceedings can be initiated in NE Court of Appeals -re mgt. control areas: -if no penalty stated then Class 3 misdemeanor $500/day -appeal mechanism re Admin. Procedure Act	Atty's -re mgt. control areas: -district can reduce water allocated, acres irrigated

Appendix IX

List of Interviews

The following is a list of interviews conducted for this dissertation. The names of individuals are provided to protect their identity and ensure confidentiality.

Organization Name	Date	Type
Ontario		
CO	14 June 2007	In Person
OGWA	25 September 2006	In Person
	11 October 2007	In Person
OMOE EMRB	21 February 2007	Telephone
OMOE LWPB	26 March 2007	In Person
OMOE PTTW Program	09 March 2007	In Person
OMOE WWBU	21 February 2007	Telephone
OWRC GWD (ret.)	13 October 2007	In Person
OMOE Regional Operations (ret.; 2)		
	11 October 2007	Telephone
UTRCA	11 June 2007	In Person
New York		
DRBC	29 June 2007	Telephone
ESWWDA	09 July 2007	Telephone
NGWA	06 July 2007	Telephone
NYRWA	23 July 2007	Telephone
NYSDEC (3)	06, 13, 30 July 2007	Telephone
NYSDOH (3)	20, 25 July 2007	Telephone
SRBC	25 June 2007	Telephone
USEPA (Head Office; Drinking Water Division)		
	27 July 2007	Telephone
USEPA Region 2 Office	19 July 2007	Telephone
Nebraska		
LBNRD (2)	09 November 2007	Telephone
LNM	13 December 2007	Telephone
NARD (2)	12, 14 November 2007	Telephone/In Person
NDHHS (2)	16 November 2007	In Person
NDEQ (3)	14, 15 November 2007	In Person
NDNR (3)	15 November 2007	In Person
NGWF	05 November 2007	Telephone
NRWA	25 October 2007	Telephone
NWDA	14 November 2007	In Person
NWRA	12 December 2007	Telephone
UN-L C/S Division	16 November 2007	In Person
USEPA Region 7 Office	02 November 2007	Telephone