Designing Innovative Corporate Water Risk Management Strategies from an Ecosystem Services Perspective

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Cover depicts the Double Mountain Fork of the Brazos River, Fisher County, Texas. Photo courtesy of Wikipedia commons

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EXECUTIVE SUMMARY

In January of 2012, we teamed up with representatives from the sustainability department at The Dow Chemical Company with the goal of creating a viable, creative solution that would advance The Company's efforts to address the risk associated with freshwater scarcity. With uncertainty surrounding the impacts of climate change and other environmental threats, it is becoming increasingly important for corporations to fully understand and incorporate the value of the benefits nature provides into strategic decisions. The focal ecosystem service of our project was freshwater provisioning. Freshwater is critical to life and a key ingredient to many economic activities, such as power generation, agriculture and industrial processes. Water scarcity is of particular interest to Dow, given that 20 percent of The Company's global production comes from the Freeport, Texas facility on the water-stressed Brazos River.[1] Water is used as both an input to production and a coolant for electricity generation. The growing uncertainty around the future supply of water could threaten continuity of operations at Freeport and other increasingly water-stressed sites.[2]

After surveying the common responses to water scarcity, the team broke down these various solutions into three categories: technology-based, policy-based, or management-based. Management-based solutions, defined here as responses developed within the organization that involve changes to internal policies and processes, were determined to hold the most promise for creating a robust, organization-wide solution for potential freshwater scarcity.

We conducted a broad search to identify creative management responses by a variety of institutions to natural resource challenges and selected ten types of responses, referred to as "analogues," exemplified through one or more specific case studies. We then considered how each analogue could be adapted to the unique characteristics of water and the context of the corporate setting. Our five-step methodology including the following: 1) develop criteria for evaluating the analogue cases; 2) identify and evaluate the cases against those criteria; 3) deconstruct each case to determine the mechanisms driving effective resource management decisions; 4) adapt those mechanisms to the freshwater challenge; and 5) as necessary, adapt those mechanisms to the corporate context.

We then evaluated the purpose, strengths and weaknesses of each analogue and identified common enabling conditions, benefits and limitations. After considering commonalities, we compared and mapped out unique benefits and limitations for application to freshwater scarcity in the corporate context.

The analysis was used to provide a strategic recommendation for addressing water scarcity at The Dow Chemical Company. Building from the analogue benefits and limitations outlined above, we were able to identify a way in which multiple analogues could be used in a complementary manner to achieve Dow's goals within its particular organizational context. The initial proposal incorporated mechanisms from carbon taxing, infrastructure portfolio standard, and revolving fund analogues. These analogues provided mechanisms to generate and allocate capital by placing a tax on water use, with fee revenue dedicated to a revolving fund. This revolving fund financed water projects prioritized through the portfolio standard.

Through further iterations and discussions with environmental and finance staff at Dow, we further refined our proposal to combine elements from two analogues – infrastructure portfolio standards and revolving funds – with a balanced scorecard approach to performance evaluation. In this case, capital is allocated internally to a fund that is used to finance projects prioritized by the portfolio standard. Projects are evaluated and reviewed for continued funding based on a scorecard that considers both financial return and other beneficial outcomes. This recommended strategy is sensitive to the financial realities and processes within Dow and is flexible to allow for the varied operational and policy contexts in which Dow faces freshwater scarcity challenges around the globe. Further, it addresses the desire of The Company to frame and address sustainability holistically, while still using freshwater scarcity as a focal challenge within the new effort.

We believe that the analogues analyzed in this report can be combined in multiple ways to overcome a broad range of sustainability challenges. The analysis is designed to illuminate the potential applications of the mechanisms underlying each analogue. We hope that it inspires readers to think more broadly and creatively about effective options for responding to natural resource challenges.

SECTION I | INTRODUCTION

Humans experience myriad benefits provided by the natural world. These resources and processes, or "Ecosystem Services", include pollination, freshwater provisioning, coastal storm surge protection, and many more. The concept of ecosystem services first entered the broader conversation on global environmental issues with the publication of the Millennium Ecosystem Assessment in 2005 and has been gaining increasing popularity as a framework for conceptualizing mankind's relationship with nature ever since.[3] Yet the environment's ability to provide for human society is not unlimited. As global populations rise and resource demands continue to increase, we are seeing significant erosion in many of the services upon which we depend.[4] This poses threats to society in general, and their economies in particular, which have only just begun to understand the importance of these services.

In January of 2012, we teamed up with representatives from the sustainability department at The Dow Chemical Company with the goal of identifying viable, creative solutions that will advance The Company's efforts to address the risk associated with freshwater scarcity.

With uncertainty surrounding the impacts of climate change and other environmental threats, it is becoming increasingly important for corporations to fully understand and incorporate into strategic decisions the value of the benefits nature provides. The private sector is gradually beginning to realize the importance of ecosystem services in global business operations. However, these considerations are rarely incorporated into decision-making. Experts predict that firms will need to develop a new set of competencies to manage the relationship between company and nature.[5] Incorporating a value of nature's services into more traditional corporate decision-making processes will be critical to recognizing and optimally managing in times of increasingly scarce natural capital.

The focal ecosystem service of our project was freshwater provisioning. Freshwater is critical to life and a key ingredient to many economic activities, such as power generation, agriculture and industrial processes. According to the Organization for Economic Co-operation and Development, freshwater demand grew twice as fast as population in the past century. Increased consumption was driven by population and income growth and economic activity. Demand is projected to grow 55 percent by 2050, with manufacturing demand increasing by over 400 percent and demand from thermal electricity generation growing by roughly 140 percent.[6] At the same time, approximately 3.9 billion people, or 40 percent of the world's population is predicted to live in river basins experiencing severe water stress by that time.[7] Growing demand, lessening supply, and lower natural ecosystem capacity to mediate water events like floods and droughts will exacerbate already severe water-related problems and will likely impact economic growth. The rate of groundwater depletion, which doubled between 1960 and 2000, is also likely to increase. Without appropriate mitigating action, water quality is expected to deteriorate due to nutrient flows from agriculture, poor wastewater treatment and the rise of new micro-pollutants. Economic value of assets at risk from floods and other water related disasters is predicted to be US$ 45 trillion by 2050, a growth of 340 percent from 2010.[8] A 2012 report issued by the U.S. intelligence community (ICA) asserts that "during the next 10 years, water problems will contribute to instability in states important to U.S. national security interests."[9]

One organization that has emerged on the front lines of ecosystem-inspired decision-making is The Dow Chemical Company. Dow is a global chemical, advanced materials, agrosciences and plastics manufacturing company that relies on an array of ecosystem services to provide raw materials and facilitate the production of various products. The Company has facilities in 36 countries around the world and has revenues upwards of $59 billion annually.[10,11] The Company is structured as a "matrix", with organizational divisions based on business unit, function, and location. As a global industrial enterprise, Dow is seeking innovative, pragmatic and efficient means to incorporate growing environmental concerns into business decisions and operations.

Water scarcity is of particular interest to Dow, given that 20 percent of The Company's global production comes from the Freeport, Texas facility on the water-stressed Brazos River.[12] Currently, The Company holds water withdrawal rights from the Brazos River, on which it depends.[13] Abundant freshwater is a necessity for Dow's Freeport operations. It is used as both an input to production and a coolant for electricity generation. Specifically, freshwater is integral to the production of propylene glycol, a feedstock in a range of Dow's other chemical manufacturing operations globally. As water levels in the Brazos increasingly fluctuate, the growing uncertainty around the future supply of water could threaten continuity of operations at Freeport and other increasingly water-stressed sites.[14]

SECTION II | BACKGROUND AND PROCESS

Choosing an Ecosystem Service

Arriving at Freshwater Provisioning

The Millennium Ecosystem Assessment lists 24 key ecosystem services that society relies upon heavily. Rather than looking broadly at challenges across multiple services, we chose to investigate the service most critical to Dow's continued global production—water. This allowed us to dig much deeper into the intricacies and challenges of the specific service and to offer more robust and focused recommendations. To determine which ecosystem service should be our focus, we conducted conversations with members of Dow's sustainability team, including the Vice President of Sustainability and the Director of Sustainability Programs. (See Appendix A for a list of individuals consulted). The initial list of potential focal services included freshwater provisioning, coastal surge protection, and air quality. Based on our discussions with Dow, freshwater emerged as our focal ecosystem service because water is a critical input for The Company's operations in many locations globally, and the availability of the resource is likely to change significantly in supply, regulation and price in the near future. Freshwater provision is also a service that Dow shares with thousands of local stakeholders around the globe, making responsible water management a priority not only for profitable operations, but also for maintaining Dow's license to operate in water-stressed localities.

Access to and use of freshwater presents a number of unique challenges, and to create recommendations that address the true challenges of freshwater management, we needed to know the specific differences between water and other resource issues. The team consulted Dow staff and environmental leaders in the freshwater arena (see Appendix A) to determine what makes water such a unique management challenge. Secondary research was performed by inventorying academic and online sources of environmental study, including electronic databases, in-print collections at the University of Michigan Library, and online sources (see Appendix B) to better understand what the current state of knowledge around resource management and freshwater security. We determined that water has a number of qualities that make it uniquely challenging in terms of natural resource management, thus separating it from many other ecosystem services, including:

Water is essential to biological life

On a fundamental level, water is essential to life and has no substitutes. This fact leads to a contentious set of human rights issues during times of extreme scarcity, placing corporate water management in a potentially controversial place.

Availability is local
The geographic nature of freshwater means that any improvements made to address water availability are largely confined to the particular watershed. Common strategies for addressing other environmental challenges, such as carbon offsets, must be adapted to address a resource that his highly localized rather than globally dispersed.

Freshwater availability fluctuates temporally and non-linearly
Fluctuation in freshwater availability on the local or watershed level means that water scarcity is often not a constant threat. It may vary with season or year-to-year, and shortages can be temporary. This high degree of variability makes any associated risk assessment and planning increasingly challenging. Ambiguous threats, such as acute freshwater shortage, lend themselves to a different kind of corporate response, since issues seen as temporary are often viewed differently in the management context than those with a steady signal.

Water has both consumptive and non-consumptive uses
Water is used in many industries in both consumptive and non-consumptive ways. Organizations that generate electricity on-site, for example, often require large volumes of water for cooling purposes. This non-consumptive use removes water from the watershed only temporarily. Consumptive use, on the other hand, uses water as an ingredient in the creation of a product. This means any water used is effectively removed from the local environment permanently.

Water quality and temperature vary
Unlike a unit of energy or a molecule of carbon, water comes in different types that have varying potential for usability in industrial, social, and natural systems. Many uses of water, whether consumptive or non-consumptive, require a high level of purity, necessitating some form of purification between intake from the natural system and use. Further, many states also regulate the reintroduction of wastewater into the environment, requiring organizations to clean non-consumptively used water before discharge back into the watershed.

Similarly, water temperature is not constant in its natural state or across the cycle of its extraction, use in industry and return. Cooling water used in thermal electricity generation is a prime example of a non-consumptive use that alters the temperature of the water, with discharge back to the source typically being warmer than is the intake water. As with water purity, the temperature at discharge is often regulated in the industrial context.

Water is often relatively inexpensive for large-scale industrial consumers
While most inputs to industry today carry a significant cost for the company, water itself often does not. Because the cost of water is sometimes negligible, the monetary savings from reduced use are also negligible. This creates issues when considering efficiency projects, which will have an inherently low return on investment.

Determining the Approach

Technology, Policy, or Management-based Solutions

Based on these unique characteristics of water, and with the goal of creating a robust strategy for addressing freshwater supply risk, we conducted an extensive inventory of available research on corporate ecosystem service decision-making (see Appendix B for a full list of publications reviewed). Responses to water scarcity as they relate to the private sector were organized into three categories: technology-based, policy-based, or management-based, which are explained in greater detail below. We determined an optimal corporate response to natural resource challenges would meet the following three criteria:

1	Expertise	The corporate department or team charged with implementing the solution would have some level of expertise in the subject, based on academic or professional experiences.
2	Control	To the extent possible, the success of the response would depend on the actions of the corporation and not be dependent on outside forces.
3	Universality	The solution would have to work both in a variety of physical and political environments and into the foreseeable future.

Technology
Each response category was evaluated based on these criteria, beginning with technology-based solutions. These responses involve use of a specific technology, such as desalination, to achieve freshwater security. Ultimately, any technology-specific recommendation would have limited longevity since technologies advance, mature and are superseded relatively quickly. Technological advancement and changing dynamics of water availability will also surely significantly change the economics of any technology recommendation. The field is also advancing in uncertain directions, and new solutions are likely to come online in the future that

will upend current thinking and considerations. In addition, continuous monitoring of technological advances would be an impractical recommendation for corporations without also recommending they hire additional internal expertise.

Policy

Policy-based solutions require a specific regulatory environment to be successful. For example, purchasing water rights to ensure a continued volume of freshwater would depend on a system that allows this kind of transaction to occur. Based on a concurrent collaboration between The Nature Conservancy (TNC) and Dow, we were able to work closely with water policy experts at TNC to examine different policy landscapes in both water-stressed and water-secure areas where Dow operates. We conducted a basin-level analysis of water governance for 22 water stressed and water secure regions where Dow currently has operations (see Appendix C). This research revealed that the policies governing freshwater in each Dow location can be significantly different. As an organization with a widespread global presence, Dow is operating in numerous policy environments, and any recommendations made would be of limited use to the organization as a whole. Further, as water demand continues to rise and the critical resource becomes increasingly scarce, water policy is also certain to change in unpredictable and non-uniform ways.

Management

Management-based solutions are responses that are developed within the organization and involve changes to management policies or processes. Environmental examples include levying an internal carbon fee or administering a revolving loan fund to finance energy efficiency. Unlike technology- or policy-based solutions, management responses have the potential to be both widely applicable across the geographies occupied by any particular organization and long-lived. Internal solutions can work anywhere the company operates since they are based within the organization, unlike policy-based responses that depend on specific regulatory environments or technologies that are optimized for a specific resource context. Further, appropriately developed management-based responses can remain relevant until the organization fundamentally restructures or changes its strategic goals. For these reasons, the team decided to pursue a management-based response to freshwater scarcity.

Methodology of Approach

Introduction to the Analogue Concept

To create a management-based solution grounded in proven success, we pursued an approach that sought to adapt other common or creative management responses to natural resource challenges to the specific context of increasing corporate freshwater security. These became known as our study's analogues. For each analogue, we evaluated one or more examples, or "cases" of the analogue's application. Our methodology involved five steps: 1) develop criteria for evaluating the analogue cases; 2) identify and evaluate the cases against those criteria; 3) deconstruct each case to determine the mechanisms driving effective resource management decisions; 4) adapt those mechanisms to the freshwater challenge; and 5) as necessary, adapt those mechanisms to the corporate context.

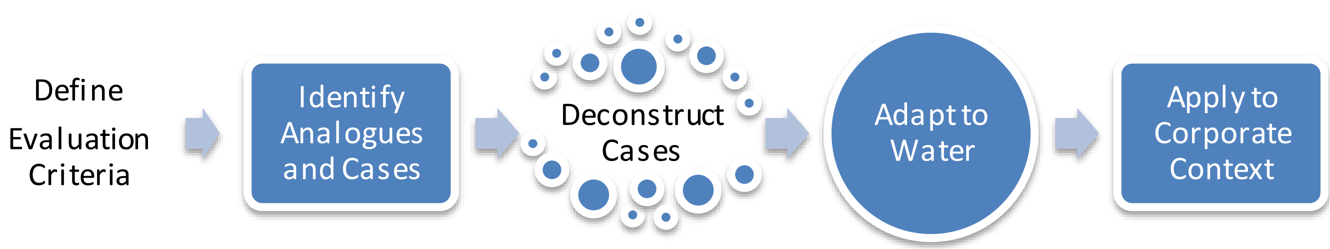

Figure 1: Visualization of research methodology

To create a set of criteria that would evaluate each case effectively, the team consulted both online and in-print sources, including publications on corporate water risk by CERES, literature on water accounting by The Pacific Institute,[15] and emerging research on water stress mitigation by the AquaStress Integrated Project[16] on domains private resources management, corporate accounting and culture, and freshwater as a resource. To ground our analysis in the specific Dow Chemical Company operational and management context, the team consulted management, operations, strategy, finance, and environmental specialists within Dow. Table 1 includes an outline of data collection methods and Appendices A and B for additional details on individuals and sources consulted.

Table 1: Literature Review and Interviews	
Science and Water Policy	*Scientific Perspective:* Reviewed both scientific literature and the work of organizations to address freshwater scarcity. This included publications by CERES,[17] The Pacific Institute, [18] The Nature Conservancy,[19] The Economics of Ecosystems and Biodiversity (TEEB), [20] and more.
	Policy Response Mechanisms: Reviewed regulations and institutions in Brazil, Texas, and other areas where Dow operates to gain an understanding of the various policy mechanisms that govern freshwater access, including water markets, withdrawal permits, etc.
	Corporate Response Mechanisms: Reviewed industry guides and case studies to understand the methods, challenges, and best practices for managing environmental regulation, resource scarcity, and ecosystem services risk, including publications by the World Business Council on Sustainable Development[21] and the World Resources Institute.[22]
Corporate and Municipal Response	*Risk Assessment*: Consulted finance and strategy experts at The Dow Chemical Company to understand corporate methods to predict resource availability and other risk assessments, as well as their applications to strategic planning.
	Review of Past Work: Reviewed current and developing sustainability projects at Dow through press releases and information provided by members of Dow's Sustainability Department.
	Review of Water Use: Consulted staff at Dow's Freeport facility and former director of sustainable development at Dow to assess current and future water use, along with challenges that exist to standard resource management approaches.

This information was then used to establish the criteria by which potential analogue cases would be evaluated. These criteria, laid out in Figure 2 below, represent the most appropriate characteristics to enable effective adaptation in both the natural resource- and Dow-specific contexts.

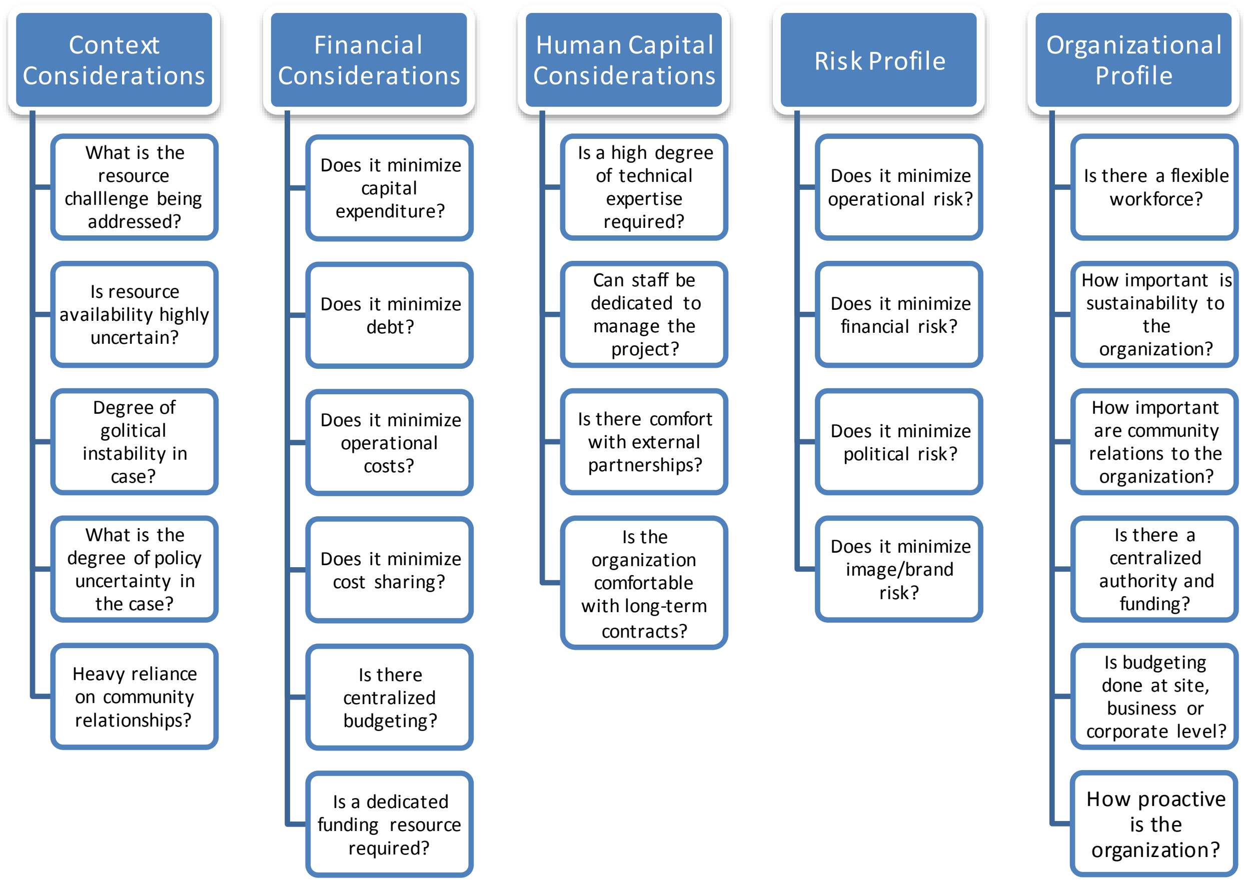

Figure 2: Criteria for evaluating case studies

Once we created a framework for evaluation, we identified analogues that could be analyzed using these criteria. Identification of potential analogues began through a process of team-based discussion on which resource issues were to be included. A broad search was then conducted of print, scholarly, and academic literature to identify potential analogues for further investigation. Selection was based on subjective measures of perceived impact and potential for application to water and the corporate context as well as for a broad array of approaches to be used for comparative purposes. Ten analogues were chosen for study. Some analogues had several "cases" of implementation by different institutions, showcasing different methods of application of the same underlying analogue principle, while others are represented by a single case example.

Each analogue was reviewed and grouped into four broad themes to highlight commonalities and differences (See Figure 3). This grouping is not intended to be definitive. Rather, the groupings and order of explanation that follows are intended to call out the most important illustrative characteristics of each analogue for the purposes of this study.

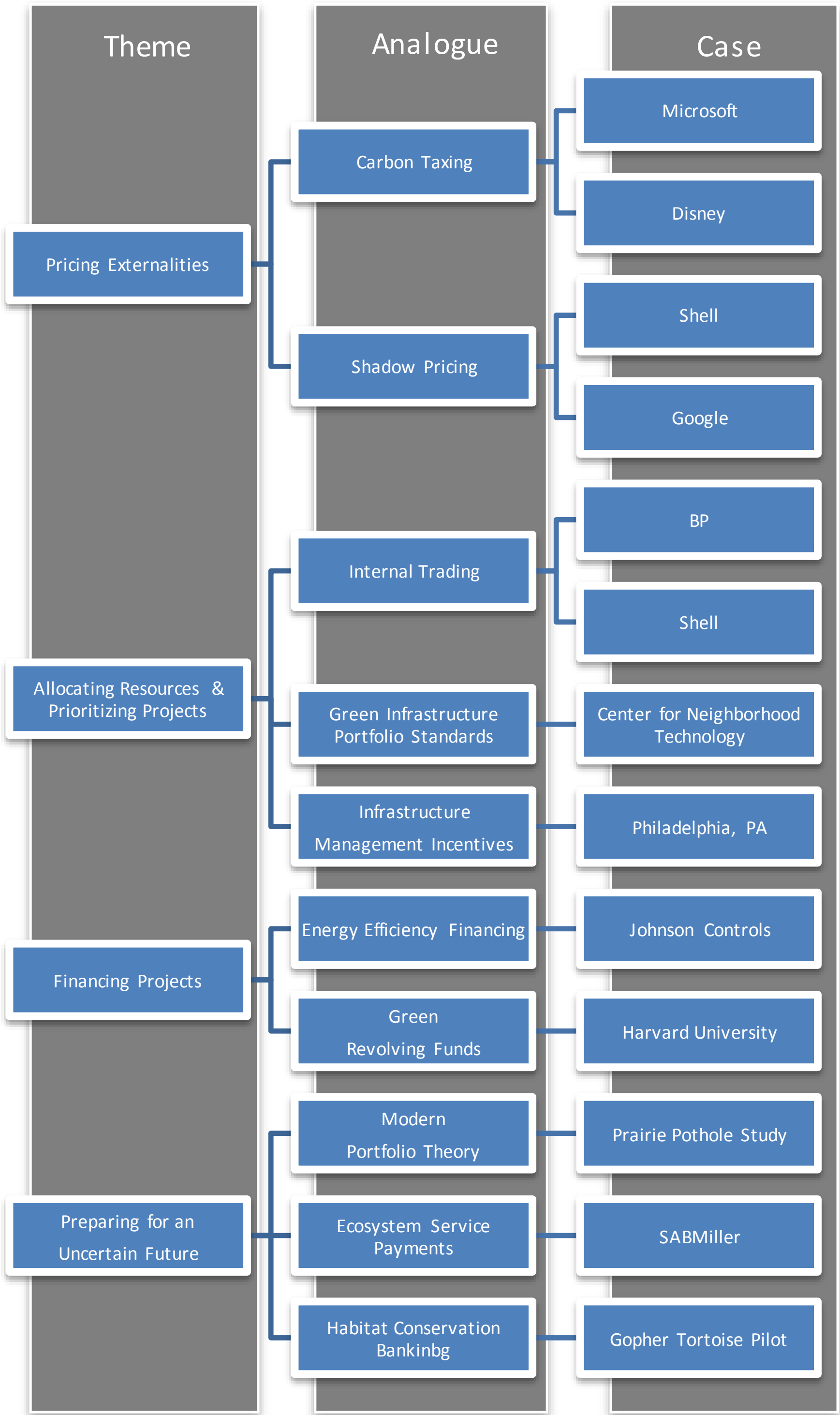

Figure 3: Grouping of cases by analogue and theme

SECTION III | THEMES AND ANALOGUES

IIIA | Theme 1: Pricing Externalities

One of the most vexing problems that corporations deal with in response to ecosystem and natural resource challenges is whether and how to incorporate ecosystem value and risk into the company's financials. Firms recognize that ecosystem resources hold strategic value, that damaging them creates externality costs, and that a lack of them may present regulatory or production risks in the future. However, given the absence of external markets for most ecosystem services and the high degree of uncertainty regarding their future states, firms rarely have good methods of pricing the value of or risk posed by ecosystem services. This section draws lessons from carbon taxing and shadow pricing, two mechanisms designed to help corporations place an internal "price" on carbon that better reflects the negative externalities or negative effects of a product or activity not captured monetarily.[23] Carbon pricing is used to address greenhouse gas emissions,[a] the principal driver of anthropogenic climate change.

In the first decade of the 2000s in particular, addressing the external costs of carbon dioxide emissions was an important topic. Governments and companies widely discussed putting a price on carbon emissions, and some enacted such prices. The operational carbon prices implemented more recently by Microsoft Corporation (Microsoft) and The Walt Disney Company (Disney), illustrate different but related carbon fee application strategies. The examples of Royal Dutch Shell (Shell) and Google, Inc. (Google), on the other hand, illustrate the application of a price on carbon emissions in the analysis of future investments as opposed to current business operations. This second approach is forward looking and therefore does not involve actual flows of money or emissions of greenhouse gases at the time that the shadow pricing tool is employed. The benefits and challenges of carbon pricing via these two methods are discussed, followed by the potential for application to corporate freshwater strategy.

Natural Resource Challenge: The negative externality and true cost of carbon dioxide emissions is not incorporated into the financial cost of business operations. The application of a fee on actual or projected emissions of carbon dioxide can be used as a tool to internalize and monetize the externality cost of greenhouse gas emissions.

[a] Throughout this paper, the terms greenhouse gas emissions, carbon, carbon emissions and carbon dioxide emissions are used interchangeably.

IIIAi | Analogue: Carbon Taxing[b]

Emissions taxes are typically applied per ton of actual carbon emitted. The number of tons emitted is calculated via "carbon footprinting," which applies carbon emission factors to records of carbon-emitting activities, such as gallons of gasoline burned, passenger-miles flown or kilowatt-hours of electricity used. The level of the tax can vary widely among tax systems. Similarly, there is a wide range of estimations as to what the true cost of carbon is that should be used as the externality cost (the tax) in such systems.

<u>Organization: Microsoft</u>
Brief summary: The Microsoft carbon neutrality pledge is rooted in the company's acknowledgement that the "alarming" trajectory of climate change indicated by the scientific data demands a "comprehensive and global response."[24] Announced in May 2012, Microsoft pledged to become carbon neutral by the end of their 2013 fiscal year in July 2013. In addition to continuing to improve its own greenhouse gas emissions footprint through efficiency and renewable energy investments, Microsoft designed a carbon fee that will apply to all offices, business air travel, data centers and software development labs across more than 100 countries.[25] Microsoft uses the carbon tax to fund the purchase of renewable energy credits and carbon offsets to achieve neutrality. Microsoft's tax is applied at a relatively granular level in order to engage at the level of decision-making.

Microsoft is measuring carbon in various operational buckets, including plug load (electricity used) and business travel on a per-mile basis. The company then offsets each category by purchasing renewable energy certificates (RECs) for electricity and carbon offsets for travel.[26] The price charged for each unit of carbon emitted by a business team will be based on the cost of carbon offsets and RECs, thereby moving towards full cost accounting for emitting activities.[27]

Results: According to one observer's estimate, the Microsoft carbon fee could raise about $50 million to invest in carbon offsets and RECs by 2020.[28] Additionally, Microsoft expects to realize a number of co-benefits as a result of taking this sustainability step, including operational cost savings through efficiencies, employee engagement, consumer goodwill, and attention to Microsoft's own carbon management tool offerings. Microsoft's leadership also views this initiative as an opportunity to be proactive in light of a potential global carbon policy.[29]

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[b] Using a tax to incentivize reduced carbon emissions is one of the more simplistic systems to achieve emissions reductions, although carbon trading has tended to be more politically popular and therefore more widely implemented by governments around the world.

Organization: Disney

Brief summary: In 2009, Disney started taxing its business units according to their proportional contribution to the company's total direct carbon dioxide emissions footprint. The tax charged per business unit is calculated from the unit's projected increase or decrease in carbon emissions over a five-year period. The tax remains in effect in 2013[30] and the company is currently working towards a goal of zero net direct greenhouse gas emissions.[31]

Results: Money generated by the tax, which has ranged from $10-20 per ton, is placed in a "Climate Solutions Fund" that invests in offset projects around the globe. The Fund has been in existence since 2008. Offset investments are focused on forest restoration and protection projects and are made in partnership with major environmental organizations including Conservation International and the Nature Conservancy.[32] The tax program has raised about $35 million to date and offsets purchased using the funds contributed to Disney reducing its net greenhouse gas footprint by half in 2012 relative to 2006.[33]

IIIAii | Analogue: Shadow Pricing

According to the European Commission,[34] a "shadow price," also known as the "accounting price" is "the opportunity cost of goods, generally different from actual market prices and from regulated tariffs, [which can be] used in project appraisal to reflect better the real costs of inputs to society, and the real benefits of the outputs." Shadow pricing can be applied to both economic inputs and outputs. Shadow prices are a means to include the externality costs of carbon emissions as a consideration when evaluating capital investments and long-term expenditures, thereby making carbon-intensive project alternatives less attractive investments.

Organization: Shell

Brief summary: Shell launched its carbon strategy in the late 1990s after determining that a carbon price would be a reality in some parts of the world in the near future, and that both climate change and the policy responses to it would materially affect Shell's business. One pillar of the Shell strategy is to apply a shadow price of carbon during all new project evaluations.[35] The company adds a per-ton price of carbon dioxide to project costs based on emissions projections. The shadow price is set internally according to the company's appetite for risk due to carbon and is re-evaluated as needed. The price is not set according to Shell's assessment of the true cost of carbon, nor does it represent the company's estimate of a future regulatory price on carbon.

Results: More than a decade after initial implementation of the carbon shadow price, Shell is still using this approach. The company has simplified the application of the price to use just one price of $40 per tonne, regardless of project location. Previously, the shadow price had different regional values based on regulatory context. Instead, the $40 price is now applied universally and sensitivity analyses are done to test the effect of the price on the decision to invest in a project or any associated emissions mitigation strategies.

In our conversation with one of the leaders of Shell's carbon strategy,[36] we learned that the company has sought to simplify the price to make it more effective and clear as a management tool. Further, he believes that the shadow price has been effective as a driver of investment in mitigation, as it has successfully incentivized mitigation activities up to the cost of $40 per tonne. The shadow price has also made some investments sufficiently unattractive that Shell did not undertake the project at all.[37]

<u>Organization: Google</u>
Brief summary: In 2007, Google announced a new carbon shadow price to be used when evaluating power purchase costs for new data centers.[38] The intent is to calculate a more accurate cost of power, particularly when conducting site selection. In anticipation of carbon regulation, by applying a shadow price Google is reducing the financial risk inherent in carbon-intensive energy investments, which may become more expensive in the future. Carbon shadow pricing puts renewable energy on a more level playing field. [39]

Results: Google applies a shadow price to its power purchase agreement (PPA) cost analyses. The usual 20-year life of a PPA creates significant uncertainty as to what the energy market will look like over the life of a contract. Google has chosen to purchase wind-generated renewable energy as one way to lock-in a known power price and avoid a future cost of carbon emissions. Google evaluates the PPA over its lifetime using a price of carbon that ranges from $50 to $200 per ton.[40] Adding this shadow price makes the renewable PPA a more attractive investment than it would otherwise appear without assuming a future price of carbon. By signing long-term PPAs, Google helps to bring new renewable energy sources online by providing a guaranteed customer and helping to assume much of the risk of constructing a wind farm.[41]

IIIAiii | Lessons Learned

Experiments with internal carbon pricing schemes have had mixed environmental and financial results. What is consistent across all the pricing schemes is an attempt to incorporate externality costs to give a more complete picture of the true cost of operations. The use of this price varies from understanding the cost that future external markets may impose to estimating the value of the risk of emissions-intensive operations. While Disney and Microsoft, can place a specific number on the amount of money generated by their policies, it is harder to tell if and how Google and Shell are able to quantify success. In theory, they could quantify the total value of investment dollars influenced by their respective shadow prices or how many tons of emissions have been prevented by changing one project type to another or undertaking mitigation activities as a result of the shadow price. However, with or without a number the most notable impact of a pricing scheme appears to be the change in mindset that comes with assigning value to a previously unvalued environmental cost.

Microsoft states, "Even as we developed our strategy, the initial discussions within our company have already served as a catalyst for driving deeper dialogue and analyses that should result in improved efficiencies and more sustainable practices."[42] The company also cites desired indirect impact on employee engagement, consumer goodwill and attention to products like its carbon management tool. Similarly, Disney's use of a carbon tax as a focusing, rather than just a marketing, tool is evidenced by the fact that though internal carbon efforts began in 2006, the internal tax was not publicly revealed till 2009.[43] The ripple effects within the organization go beyond the Conservation Fund to the introduction of alternative fuel vehicles, retrofits to Resort trains to run on Disney restaurant-sourced biodiesel, lighting upgrades and data center efficiency.[44] One major difference between the funds is that the Microsoft charge is applied per ton of carbon and the Disney fee is a proportional amount of the total that the company decides to puts into the Conservation Fund. Microsoft business units therefore have clearer incentives to make incremental carbon emissions reductions, meaning that employee behavior change is more likely to be seen at lower levels. The difference highlights that the value of an externality monetization mechanism is best viewed through a comprehensive lens of the proposed policy's impact not only on carbon but also on organizational culture and co-benefits in other areas, not the least of which can be monetary savings.

IIIAiv | Application to the Corporate and Water Context

Though no previous cases of internal taxing or fees or shadow pricing applied to water were found, the team feels that pricing schemes have high potential for successful application across a variety of corporate contexts to address water challenges. Though the price on natural resources can be subjective and difficult to define, once chosen, a price can be fairly easily inserted into existing corporate accounting systems and processes. There are also precedents beyond carbon in transfer pricing and other areas not explored by this paper that can serve as guides as to how to implement a price on eco-externalities or corporate risk. In general, a shadow price is operationally simpler to put into practice than is a fee system. Whereas a water tax would involve deployment of management systems to track water consumption and apply the fee at a decision-relevant level, shadow pricing at the investment phase would be applied based on proposed alternative investments estimated to use or impact water resources in different manners. Because no retroactive measurement or fee collection takes place, the planning and implementation burden across the organization of a shadow pricing policy is much lower.

That said, applying either pricing either scheme to water would be somewhat more complex than it is with carbon. Of the major differences between water and carbon discussed in this paper's introduction, the differences most relevant to pricing are localized value and uncertain future availability. Unlike carbon emissions, water does not have the same value across locations in terms of either value per volume or value per level of quality. In other words, while a single carbon price can exist across a multi-national firm, water values are most appropriate at a watershed or basin level. Further, carbon dioxide has similar impact and therefore externality cost anywhere, whereas water comes in different qualities and relative quantities, affecting its local ecosystem or use value. In addition, although it is not easy to predict future carbon market prices, it is even more uncertain what future value should be placed on water in different settings. Unlike carbon emissions, which are largely tied to fossil fuel consumption and its economic drivers, seasonal and climatic variability make future water availability, and therefore value, extremely difficult to forecast.

The first implication for firms is that an internal water price would have to be set to multiple values in different geographies depending on the characteristics of the local water supply and how the firm uses water as a resource. For example, a manufacturing company like Dow with water-intense operations in a few key sites could potentially set a shadow price for future investments at major manufacturing sites according to the level of water scarcity at any particular site. A more disperse retail organization with a lighter water footprint might find it more useful to implement a common water use fee to incentivize individual stores to install rainwater catchment systems or widely applicable water efficiency technologies.

The second implication is that the actions generated by a tax or shadow price would have to be much more closely tied to the local area to achieve an ecologically relevant impact. For example, were a water tax system extended to the Microsoft model, whereby tax revenues are used to offset the environmental impact, water "offsets" funded by the tax would need to take place within the same basin. Funding "payments for ecosystem services" (PES) projects, which are discussed in Theme 4 of this paper, would be one potential way to use such funds to achieve something like the water equivalent of carbon neutrality.

Finally, because water availability and scarcity are difficult to predict on an annual and multi-year basis, prioritizing water-based investments based on highly uncertain estimated future availability would add another layer of complexity. In Theme 4: Preparing for an Uncertain Future, various analogues that could supplement a water fee to help organizations deal with this future uncertainty are analyzed in greater depth.

IIIB | Theme 2: Allocating Resources & Prioritizing Projects

How to allocate resources for and prioritize potential courses of action is a related but distinct challenge to valuing and pricing ecosystem impacts. A price allows quantitative comparison of various courses of action and provides a basis for incorporating action into established budgeting and operational procedures. However, it is not always easy to gather sufficient information or make all the calculations necessary to determine a price, let alone the most efficient or feasible course of action. In addition, in large decentralized organizations, there is often a lack of authority or capacity to take actions at the local level. This section describes three different allocation and prioritization mechanisms—internal trading schemes, green infrastructure portfolio standards and infrastructure management incentives – that are designed to help organizations overcome these challenges of effectively using a price to guide action.

Internal trading schemes are one way to allow more decentralized distribution of responsibility for addressing natural resource issues by letting different business units or departments use a market-like system to make decisions about their individual action plans. In addition, trading in a credit system could have the advantage of skipping the pricing challenge all together by letting the internal "market" effectively set the price for the company. Experiments with internal trading mechanisms by Royal Dutch Shell (Shell) and British Petroleum (BP) are used to explore the opportunities and challenges of using trading at a corporate level.

Green infrastructure portfolio standards (GIPS) are another way to allocate responsibility across a decentralized constituency that similar to trading schemes, allow for an overall goal to be reached in a flexible manner. The work of the Center for Neighborhood Technology in Chicago is used as an example case of how GIPS, which are an infrastructure-based version of the more common Renewable Energy Standard, can be used to scale up investments in sustainability in a cost-effective manner.

Finally, the case of a stormwater reduction incentive program instituted by the City of Philadelphia is used to illustrate the use of incentives to encourage behavior change in home and business owners without prescriptive or mandatory action. The least restrictive allocation mechanism described in this section, the Philadelphia program seeks to set the right conditions for actors to voluntarily act to reduce their impact.

IIIBi | Analogue: Internal Trading

Natural Resource Challenge: How to allocate and prioritize financial investments by evaluating competing courses of action with the inclusion of the cost of carbon.

Organization: Shell

Brief summary: Shell Oil started its cap and trade system in 2000 with a three-year pilot internal trading program run by the Environmental Health and Safety group within the Corporate Affairs department. The goal of the Shell Tradable Emissions Permit System (STEPS) was to reduce emissions of participating units by two percent below 1998 levels using declining caps on permit allocations. Participation in STEPS was voluntary, and participating units accounted for 70 percent of Shell's emissions in Annex 1 countries, as defined by the Kyoto Protocol. Allocation of permits was based on each unit's emissions history. A concurrent initiative setting a shadow price on carbon when evaluating future investments, which is discussed in the Carbon Pricing section of this report, supported the trading system and is still in use in spite of the termination of the cap and trade program.[45]

Results: The STEPS pilot was only partially successful. Shell failed to meet its emissions reduction and financial goals under the program, but it did gain valuable experience that allowed it to participate in shaping external carbon markets. According to Shell, STEPS failed to meet the targets for three reasons: First, participation in STEPS was voluntary. Units that could easily reduce emissions chose to participate and units that would bear a high cost for reducing emissions did not. The result was an artificially low permit value that was not substantial enough to incentivize business units to take action. Second, units in different countries could not monetize trades for tax liability reasons, making it hard to effectively put credits into use. Third, halfway through the pilot, some participating units asked for and received extra permits, further weakening the utility of the internal market by lowering prices even more and reducing overall liquidity.[46]

But as a learning tool, the program gave Shell experience in carbon trading prior to entry into external carbon markets and generated awareness throughout the company as to the importance of carbon reductions.[47] After the STEPS experiment, Shell shifted its trading focus from internal to external at the end of 2001 with the creation of the carbon desk within Shell Trading.[48] Shell was an early participant in the Danish and UK carbon trading programs prior to the opening of the EU market, with the first EU trade occurring in 2003.[49]

Organization: BP

Brief summary: BP was the first oil company to publicly recognize the threat of climate change in a speech by CEO John Brown at Stanford in 1997.[50] When BP set up its own internal carbon trading system, the first in the industry, its goals were threefold. First, it wanted to gain experience that might be useful were an external market to develop. Second, it wanted to show that the trading method would be less costly than a potential carbon tax in reducing emissions, and third, it wanted to find the most efficient way of reducing emissions across business units.[51] In contrast to the Shell method of implementation, BP chose one representative from each business unit to oversee trading rather than centralizing the responsibility within the Environmental Health and Safety function. Managers also had access to a $25 million capital fund that was dedicated for investment in emissions reduction projects.[52] The three-year program ran from 1999 through 2001. All business units globally were included in the mandatory program. There were real rewards for those that achieved targets.[53]

Results: The target of reducing emissions by 10 percent relative to the 1990 baseline was achieved seven years early in 2001, with a net savings to the company of $600 million.[54] Despite this success, BP still ended the internal trading program in 2001 with the start of trading on external European carbon markets.

IIIBii | Analogue: Green Infrastructure Portfolio Standards

Natural Resource Challenge: How to guide allocation of financial investments to support environmentally beneficial projects when those environmental projects do not compete as strongly for capital as traditional projects.

Organization: Center for Neighborhood Technology

Brief summary: The Center for Neighborhood Technology, a 34-year old Chicago-based organization focused on urban sustainability, developed and is currently testing a green infrastructure portfolio standard (GIPS), which seeks to leverage the recent success of state-based renewable energy portfolio standards and apply them to stormwater management. The overall intent is to push cities to scale up investments in green infrastructure in a cost effective manner that ultimately reduces the volume of stormwater runoff into the sewer system. The basic idea is that a certain portion of infrastructure investments must be in infrastructure that meets designated "green" criteria. The portion of overall investment is calculated based on the amount it would take to create the aggregate desired impact. Thus each person responsible for making investment decisions has leeway for deciding where and how to spend the portion of the portfolio that must meet the criteria, but the centralized goal is still achieved. This program is currently being tested in two cities – Grand Rapids, Michigan and Milwaukee, Wisconsin.

Results: Although neither Grand Rapids nor Milwaukee GIPS's have produced a financial return as yet, the financial benefits of green infrastructure versus grey infrastructure have been realized in other instances across the country.[55]

Grand Rapids is in the process of piloting GIPS on a 200-acre plot of mixed-use land that lies within a single drainage area, where progress can be easily tracked. Grand Rapids is not unlike other urban areas where the likelihood of new development or redevelopment is rather low. As a result, the success of this GIPS pilot and others relies on the city's ability to make small improvements over long periods of time. In Grand Rapids, the Department of Environmental Services has committed to a one percent reduction in runoff volume each year over a ten-year period. During the first year of operation, the city plans to achieve this reduction through a combination of porous pavement projects, a rain barrel program for individual households, and parkway rain gardens.[56]

Milwaukee is currently at an earlier stage in the process, having just identified two target watersheds with historical issues of flooding. The city is now in the process of identifying the baseline runoff volume and potential green infrastructure investment projects to meet the (yet to be established) stormwater volume reduction targets.[57]

IIIBiii | Analogue: Infrastructure Management Incentives

Natural Resource Challenge: How to incentivize property and land management practices that reduce undesirable stormwater runoff.

<u>Organization: City of Philadelphia</u>
Brief summary: Prior to the summer of 2010, Philadelphia assessed a stormwater fee to all commercial properties based on property size. In July 2010, the Philadelphia Water Department switched from assessing stormwater fees based on lot size to charging based on a ratio of pervious to impervious surface. The change created an incentive for homeowners to maximize pervious surface and minimize runoff-causing infrastructure. The new policy applies to all public and private landowners except residential buildings with four or fewer units.[58] It is being phased in over the course of four years, as the fee transitions from 100 percent meter-based to 100 percent parcel-based by July 2013.[59] Impervious surface area on large parcels of land are calculated using Geographic Information Systems (GIS) tools, while smaller parcels are

calculated using a standard 85 percent impervious area for developed properties and 25 percent for undeveloped sites. This means that an average property with 10,000 square feet of impervious surface would experience a stormwater fee of around $100 per month. Fees were determined by calculating the total stormwater fee requirements, mapping the total gross and impervious surface area, and attributing a revenue multiplier to each (20 percent for gross area, 80 percent for impervious area). Ultimately, this created a program that was revenue neutral.[60]

To encourage property owners to adopt better water management practices and to reward those that already implemented such practices, the City of Philadelphia approved a variety of credits and incentives to facilitate change in response to the new stormwater policy. For example, an Impervious Area Credit to defray costs of higher stormwater fees can be earned by developing a stormwater management plan that manages the first inch of runoff from an impervious area on a site.[61] A Green Roof Tax Credit incentivizes green roof construction through a Department of Revenue program that subsidizes 25 percent of the cost to install a green roof up to $100,000, applied against Philadelphia's Business Privilege Tax liability.[62] Significantly, not all incentives are monetary in nature. New property development on sites over 15,000 square feet that reduces connected impervious surface area by 20% percent or more can effectively decrease permitting time by getting waived from Flood Control and Channel Protection requirements.[63]

Results: Parcel management incentives created by stormwater fees are now more clearly aligned with the root cause of the stormwater problem. However, it is too early to tell how this new policy will affect stormwater trends in Philadelphia for several reasons. First, at the time of writing, parcel-based billing was still in the process of implementation.[64] Second, businesses likely to experience the greatest impact from the policy shift are the same businesses with the greatest inertia. These businesses own vast parcels of land representing large capital investments, and the decision to implement stormwater reduction measures will require a significant amount of consideration. Finally, climatic patterns create significant variation in rainfall from year to year. Decades of data will need to be collected before any reduction trend is visible.

In the short term, proponents and advocates of the policy have brought up several possible secondary impacts of the stormwater policy. Since the property owner is ultimately responsible for paying the stormwater fee, the change is expected to increase some property values while decreasing others due to changes in expected long-term operating costs. Private, non-residential parcels are expected to experience a $190 million decrease in value leading to an estimated decrease of $3.9 million in property tax revenue.[65] Overall, the change in property tax revenue will be minimal, since a number of sites will increase in value due to decreased stormwater fees.[66]

IIIBiv | Lessons Learned

A number of lessons can be learned from the Allocating Resources & Prioritizing Projects analogues. First, as will be discussed again in many analogues, all the initiatives had high-level support from organizational leaders that allowed for adoption and implementation.

Second, the cases demonstrate the importance of ensuring effective implementation once the decision to go forward with the initiative has been made. Beyond the basic challenge of deciding which outcomes to prioritize, the arguably greater challenge is getting the designated business units or parties to execute the desired action. Different methods of ensuring action differ in the degree of flexibility in who makes decisions and what methods are used.

The two trading examples are both very decentralized in terms of who makes decisions and in specifying what actions are to be taken to achieve desired outcomes. However, as a comparison of the two trading program shows, a lack of accountability is counterproductive. One of the primary reasons identified for failure of the STEPS program at Shell was the voluntary nature of the program. In contrast, reasons that BP cited as contributing to program success included mandatory participation, as well as business unit input in creating a flexible, appropriate system design, transparent reporting of results and enforcement of stated penalties for non-compliance.[67]

The GIPS programs in Milwaukee and Grand Rapids ensured implementation by giving centralized decision-making authority to a smaller set of people. However, this group of people had great leeway in deciding how to go about meeting overall standards. At the other end of the spectrum, Philadelphia's stormwater incentives dictate the exact action desired, but leaves the decision-maker role completely unspecified and voluntary. At its core, the system is a method of incentivizing, without mandating, a desired management action by changing the cost-benefit analysis for property managers. The "business unit" in this case is the residential lot and the "manager" is each landowner. The system is at once more specific than the previous two analogues in that it designates both the exact place and type of desired action, but at the same time less prescriptive because there is no obligation for action on the part of any single lot owner.

Second, the allocation and prioritization theme reveals the significance of sustainability initiatives to development of future strategy and for preparation for potential future external environmental markets. Shell used the internal pilot trading system as a way to influence the design of its first carbon desk within Shell Trading in 2001 and to prepare itself for a probable future external carbon market, which eventually did begin in 2003.[68] Shell has since maintained its status a first mover in the space by making the first trade in California's new cap and trade carbon market on August 29, 2011.[69] Using the credibility gained through demonstrable internal action, both Shell and BP were able to be active participants in the debate on design of external markets.

The GIPS and Philadelphia stormwater initiatives are both precedents for greater use of green infrastructure and more broadly, for innovative realignment of policy incentives to promote actions which contribute to both financial and environmental goals. All three are good examples of how addressing current natural resource challenges can bring together multiple stakeholders in new arrangements and partnerships, an experience which can then be leveraged in other areas.

IIIBv | Application to the Corporate and Water Context

Because allocation of responsibility for and prioritization of projects is in many ways at the heart of program design and execution, the lessons learned from the analogues in this theme have an array of applications in corporations and to water management. Existing corporate accounting, resource sharing or investment guidelines and incentives could be adapted to implement trading, portfolio standard or resource use incentives related to water use. Like any case of water management, special consideration would have to be given to the local, non-fungible nature of water as a resource. For example, an internal trading scheme would likely have to be scaled to a basin-level cross-business unit credit system in order to be meaningful. Portfolio standard and use incentives, however, could be more flexibly applied (e.g., a requirement that a percent of annual capital expenditures be "green;" or reduced internal transfer rates for certain resources if water efficiency improvements are made) to centrally promote sustainable action while allowing for local prioritization of best use.

In spite of the difficulties of measurement and tracking, substitutability and uncertainty, the real challenge of applying the analogues in this, or any, of the themes is one of commitment. Corporations must recognize the importance of water and prioritize sustainable water use in operations and corporate strategy. Though many corporations recognize water issues, few are dedicating substantial human and monetary resources to address them. In some cases, this is not due to a lack of desire, but to financing systems and rules designed for very different purposes that can be barriers to project financing. Unlike the Center for Neighborhood Technology, which received Environmental Protection Agency funding for its GIPS program, or the City of Philadelphia, which as a public sector entity has a more flexible set of policy setting justifications, corporations have to find ways of reallocating or raising money that has traditionally gone to uses aimed to maximize shareholder value in the near term. Analogues that exemplify different ways that corporations have overcome this financial challenge are explored in Theme 3.

IIIC | Theme 3: Financing Projects

Even if corporations are able to overcome the challenges of valuing and prioritizing responses to natural resource challenges, the unusual nature of some environmental mitigation projects often presents the added difficulty of trying to secure dedicated or supplemental internal or external financing to implement the chosen response. This section examines different ways that institutions have tried to overcome various project financing barriers, from access to external capital to inclusion in ongoing budgeting and workarounds for inflexible project approval hurdles.

Some of the most common examples for overcoming environmental project financing challenges are found in energy efficiency projects. Energy efficiency projects are often ideal candidates for innovative external and internal project financing because although they face many of the common barriers to financing, they often have high rates of return and quick payback periods that make crossing these barriers easier to justify. A high initial capital outlay requirement can be a barrier to project development when competing for a slice of budgets that are typically focused on continued operations and can allocate only limited funds to new capital investments.[70] Johnson Controls, Inc. (Johnson Controls), a leading provider of equipment and services for building energy and security systems, has developed financing solutions that make investing in energy efficiency more accessible as part of the set of services they offer to their customers. The Harvard Revolving Fund is an example of a financing solution with the potential to provide a long-term source of capital for energy efficiency and other sustainability initiatives.

IIICi | Analogue: Energy Efficiency Financing

Natural Resource Challenge: Electricity and utility costs can be a significant portion of operating costs for many corporations. The projects required to address energy consumption via efficiency upgrades may face difficulty securing internal or external financing.

<u>Organization: Johnson Controls</u>
Brief summary: Energy efficiency renovations and upgrades are crucial as energy prices rise, but major such upgrades are capital intensive. High capital costs make them attractive to put off as institutions, property owners, and others leave the financing for a later budget cycle or another person to tackle. Upgrades designed to reduce future costs, such as energy retrofits, must compete with immediate maintenance demands for limited budget allocations. The discrepancy in perceived urgency of maintenance, growth or environmental mitigation projects

is a matter of perspective that is closely related to valuation discussed in Theme 1 and which often compounds the financing challenge.

As Johnson Controls has developed its portfolio of energy efficiency service offerings, it has developed several ways to help its customers finance these projects. Table 2 provides a summary of six of these options.

Table 2: Summary of Johnson Controls Solutions to Energy Efficiency Financing

Anchor Tenant Financing[71]	Effective when long-term tenant occupies all or most of a large building. The owner of the building passes the cost of energy retrofits on to the large tenant through an adjustment to leasing terms. Energy bill savings derived by the tenant offset this additional leasing expense. This arrangement allows the building owner to overcome the financing hurdle that the owner must pay retrofits while the tenant is the entity reaping the savings from a lower energy bill.
Shared Savings Agreements (SSA)[72]	This type of off-balance sheet financing enables a building owner to benefit from energy retrofit savings without any initial capital expenditure. Rather than enter a performance type of agreement with the building owner, the energy services company (ESCO) sells a portfolio of energy retrofits with guaranteed savings to a third party ownership company (OwCo). The building owner then remits a pre-determined percentage of the energy savings directly to the OwCo (typically 80 – 90 percent) as payment for taking on the risk and capital expenditure of the investment. At the conclusion of the SSA contract (typically 10 – 12 years), the building owner takes over control of all assets and retains all future energy cost savings.
Power Purchase Agreements (PPA)[73]	Through a PPA, a business enters a long term contract to purchase renewable energy or heated or chilled water (generated by either a high efficiency heating or cooling plant) from a contracting firm.. The contracting firm pays the up-front costs for installation as well as the ongoing costs for operation and maintenance, but benefits from the long-term contract structure

Property-assessed Clean Energy (PACE) Bonds[74]	PACE Bonds were created as a mechanism to encourage energy retrofits by circumventing potential barriers caused by building ownership structure. PACE bonds fund energy efficiency retrofits and renewable energy projects through long term (20 years) financing assessed through the property tax bill. This ensures that the tax lien remains in place even in the case of a change in ownership, making it significantly more attractive to potential lenders.
Green Leases[75]	Seeking to address the conflict in incentives between the building owner, who is responsible for making capital improvements and tenants, who are responsible for paying the electricity bill, green leases use three techniques to incentivize tenants to conserve energy and water amongst other green building practices: - Triple-net lease: requires the tenant to pay for all taxes, maintenance, and utility expenses for the property in addition to monthly rent. This effectively shifts the burden of capital improvements and incentivizes the tenant to prioritize energy efficiency when making improvements, because the tenant can realize the benefits of these investments over the lease term. - Sub-metering: ensures individual tenants are directly responsible for the water and energy they use, thus discouraging excess consumption - Capital cost pass-through: owners have the right to pass on to tenants the capital costs that result in operational savings. Since the tenants pay the utility bills directly, they realize a return on investment through the energy savings achieved.
Performance-based Infrastructure*[76]	Under this all-encompassing agreement, an energy service company (ESCO) assumes responsibility for all building operations and financial and operating risk for an extended period of time. This type of agreement was created to allow companies to focus entirely on their core competency, while "outsourcing" all construction and operations to an ESCO that is qualified and financially incentivized to ensure energy efficiency is considered at each stage in the process.

Results: Since 2000, Johnson Controls' energy efficiency solutions have reduced carbon dioxide emissions by over 13.6 million metric tons. In addition, they have generated over $7.5 billion in savings for their customers.[77] These financing mechanisms allow customers of Johnson Controls to reduce their overall energy usage without additional capital expenditures or debt.

IIICii | Analogue: Green Revolving Funds

Green Revolving Funds (GRFs) are a return-oriented investment vehicle that results in both financial and environmental benefits.[78] GRFs invest in energy efficiency enhancements and decreased resource use, which in turn reduce operating expenses.[79] The cost savings from the decreased operating expenditures pay back the GRF's initial investment allowing for reinvestment in the next wave of energy efficiency upgrades.[80] Payback periods for projects funded by the Harvard fund range from one to 10 years, at an average of four years.[81]

Natural Resource Challenge: How to make the case to invest in environmental projects when payback time horizons are often longer-term and returns on investment can be lower relative to other investment options. A dedicated funding pool creates a financing opportunity and can allow room to consider non-traditional investment objectives, such as reducing environmental impacts.

<u>Organization: Harvard Revolving Fund</u>
Brief summary: Harvard's Green Revolving Fund was founded in 1993 with an initial allocation of $1.5 million.[82] The purpose of this fund was to make investment dollars available to specific projects that saved energy or reduced environmental impact and were projected to save the university money in the long run. This first iteration of Harvard's revolving fund had an annual average savings of $880,000 with an annual ROI of 34 percent.[83] Though disbanded in 1998, the Green Loan Fund (GLF) reemerged in 2001 as a $3 million revolving fund endowed out of the central administrative budget.[84] The success of the fund is reflected in the fact that the University increased the endowment to $6 million in 2004 and then doubled it again in 2006 to $12 million in order to be able to finance more projects.[85] The range of projects the Fund could finance expanded in 2007 with an incremental loan offering that funded the cost difference between "base code and sustainable design" of buildings using a life cycle cost analysis.[86] This means that a building built using sustainable rather than conventional construction practices would receive an incremental loan to finance the green design premium, which is often seen as a barrier for property owners.

Results: Harvard's revolving loan fund has made a significant impact on investments. The average project payback period for GLF-funded projects is three years, with an average return on investment of 29.9 percent. Aggregate savings over the 2001-2010 period total $4.8 million.[87] Environmental outcomes include[88] reducing emissions by 217.7 million pounds CO_2-equivalent, saving 57.47 million gallons of water, and reducing solid waste generation by 1.2 million pounds. Furthermore, as an educational institution, energy efficiency and "green" projects also have an impact by illustrating to the university community that green projects are not only feasible, but also improve the bottom line.

IIICiii | Lessons Learned

Securing financing for environmental projects with longer payback periods and lower returns on investment can be challenging. However, as shown by the Johnson Controls and Harvard studies, there are financing tools available that can mitigate this shortcoming. What is consistent across the Johnson Controls energy efficiency performance contract financing and the Harvard Green Loan Fund is reducing the capital and debt burden of the project for the implementing organization. To set up a revolving fund, a one-time commitment of capital is required to create a funding source that will be self-perpetuating if managed wisely. Once this initial financial commitment is made, the need for sustainability projects to compete with other funding priorities is eliminated. Similarly, with EEPCs, the need for ongoing capital investment is minimized through off-balance sheet financing and external means to raise capital.

EEPCs and other project financing services transfer the investment risks on to those who are experts in energy efficiency technology, and transfer the returns to more patient investors willing to accept a longer time horizon for payback. Revolving funds are a self-sustaining source that guarantees capital for special projects that would otherwise not successfully compete for financing resources. Ultimately, these approaches to financing projects make sustainability investments possible by creating an alternative avenue to source capital. However, organizations may have constraints that limit their ability to take advantage of such financing schemes. For example, accounting policies that allow for off-balance sheet financing and that accommodate tracking the rollover pool of money must be in place. This was not the case at least one of the organizations consulted during the course of this project, in which case there is an organizational policy in place that prohibits deriving benefits from an asset that is not accounted for on the balance sheet.

IIICiv | Application to the Corporate and Water Context

Given the variety of financing projects analogues, there are several applications to corporate water management. For starters, a *revolving fund* could be dedicated strictly to water projects that are self-sustained based on savings generated from reduced water purchasing or processing and usage costs. The fund could be dedicated to one business unit or set up by a central office in order to be accessible across the company. Another application of a revolving fund could be to broaden the criteria to be a comprehensive sustainability fund with a potential portfolio standard that ensures at least a certain level of investment in water projects, despite their low return relative to energy projects. Other types of sustainability projects in the fund portfolio, including energy efficiency projects, could provide the return on investment needed to keep the fund alive. This "bundled" approach can help the portfolio achieve a target internal hurdle rate of return.

Performance contracting is a more challenging analogue to apply because projects that strictly involve water may not provide a return sufficient to attract third-party investors. However, contracting with a partner could be mutually beneficial as companies have varying costs of capital. A larger company may be willing to enter into a 10-15 year purchasing agreement for water provision or purification projects, given its ability to take such a long-term view.

Under *anchor tenant financing*, a corporate-driven water leasing entity could be created to disburse water to various business divisions within a particular location, with the "anchor tenant" being identified as the business process or division who uses the most water at a site. By adjusting the leasing terms upward for the "anchor tenant," funds could be generated to finance water efficiency investments, which would enable additional cost savings to offset the increased leasing costs. However, this could be challenging as there is often times no single user of any allotment of process water, making it difficult to equitably identify the "anchor tenant." Manufacturing corporations vary widely from the traditional retail space that can better implement this type of anchor tenant arrangement.

With a *shared savings agreement*, a water-focused third party ownership company could be created to provide capital to fund water efficiency projects. This ownership company could centrally manage all water-related assets and ensure that efficiency investments are made strategically on a global basis, without burdening individual sites or divisions with the requirement for large capital expenditures and additional debt. As the ownership company receives payment from divisions for the savings achieved, the funds could be re-invested in other areas of the business – similar to a revolving fund approach. However, unlike building management systems, which are generally standardized, water efficiency measures can vary between water applications, business divisions and manufacturing sites, making it difficult to centralize the function, while maintaining required expertise.

Power purchase agreements are already being applied to water in the form of contractor-supplied high efficiency heating and cooling plants. However, this too relies on third party contractors and could be difficult to implement internally in an organization.

Property-assessed clean energy bonds are growing in popularity across the country as a means to improve energy efficiency, primarily of commercial properties. However, the PACE financing model was designed primarily to fund energy efficiency retrofits and small renewable energy projects, and it does not specifically address water efficiency. Consequently, PACE bond legislation would need to be expanded before this concept could be applied to water in the corporate context.

Green leases could be applied to water by treating all business divisions as individual lessees of water. Using triple-net leasing, one could assign a cost to water resources at a site level and then push that cost down to each division to incentivize water efficiency at that level. Sub-metering could be used to ensure divisions are directly responsible for the water and energy they use, thus discouraging excess usage. However, as discussed in the pricing theme, developing a price of water could be a significant undertaking in a large organization. Further, tracing water usage for sub-metering is made complex by the many industrial systems that use water multiple times over or that use water in both consumptive and non-consumptive ways.

Performance-based infrastructure could be used by creating an internal group that manages all construction, operations and maintenance of water resources, and is fully responsible for the budgets that relate to the acquisition and delivery of water. However, separating water-specific construction and operations from currently existing capital budgeting and facilities management within the organization could be quite difficult and likely result in lost efficiencies elsewhere.

IIID | Theme 4: Preparing for an Uncertain Future

The last set of analogues is tied together by an orientation towards mitigating the risk of an uncertain future. Risk management is present in the other analogues discussed, as climatic and regulatory uncertainty are inherent in all sustainability challenges, but the following three analogues are particularly focused on providing flexible response mechanisms for the protection of future resources. Payments for environmental services (PES) are perhaps the best known of the three. In their basic form, they are payments to or incentives for landowners to take certain conservation actions on their property that enhance desired ecosystem services (e.g. freshwater provision). PES systems have gained significant traction among government and non-profit entities, but corporate participation in PES markets is still nascent. Habitat conservation banking is another analogue that has achieved significant results in government-established pilot studies, but as of yet had little use in the private sector. Finally, portfolio theory for conservation is an exciting, but untested idea devised by a set of researchers in Indiana.

Although all the analogues that have been described are somewhat experimental in their focus and application, this last set of analogues would initiate decidedly more adventurous paths for corporate adopters because they all require an even greater comfort with long-term views and uncertain outcomes.

IIIDi | Analogue: Modern Portfolio Theory

Natural Resource Challenge: How to prioritize which habitats and watersheds to preserve and conserve to ultimately manage for maximum diversity and water availability.

<u>Organization: University of Illinois</u>
Overview: Modern Portfolio Theory (MPT) is a standard tool for reducing financial risk. Increasingly, conservationists and scholars are exploring the possibility of using MPT to address climate change-related risk and uncertainty. Researchers at the University of Illinois at Urbana-Champaign applied MPT to optimize spatial targeting (i.e., to better select priority areas) for conservation activities in the Prairie Pothole Region (PPR)[c] of the US. Using MPT, they were able to determine the allocation that would maximize conservation returns for a given level of uncertainty or minimize uncertainty for a given expected level of returns.[89]

[c] The US portion of the Prairie Pothole Region includes portions of Montana, North Dakota South Dakota, Minnesota and Iowa. Although not considered in the study, the PPR also extends into Canada.

MPT is adapted to conservation by using spatial covariance of ecological conditions to target specific conservation and restoration investments. The case study was conducted on the 64-million acre US portion of the PPR, a key breeding ground for many migratory birds. The Fish and Wildlife Service hopes to quadruple the acreage of protected lands in the region, with a starting base of just over three million acres.

The authors divided the PPR into three sub-regions and analyzed habitat quality and average conservation costs per acre under three different potential future climate scenarios. They then assigned a probability to each scenario and used MPT to find the most efficient land portfolio from a pure benefit analysis and from a cost-benefit perspective. In other words, they find the portfolio with the highest expected habitat quality or the highest quality per dollar investment for a given amount of risk.

More common methods of diversification select for diverse biophysical or climatic characteristics (currently or in a future climate scenario), but do not include covariance of ecological outcomes. In contrast, MPT uses joint probability distribution (means, variances, covariances) of outcomes on all possible assets to select the portfolio that most efficiently manages risk. For example, in this study, the Eastern sub-region is expected to do better, or retain more biodiversity, when the Central sub-region is expected to relatively poorly. In other words, the Eastern and Central sub regions are negatively correlated. Depending on the climate scenario, shifting conservation investment from one of these areas to the other reduces risk.

Results: The PPR study found that current conservation investments are surprisingly efficient in the "no climate change" scenario, but much less efficient in a climate-changed future. Using weighted probabilities of each climate scenario, the team found that MPT, relative to simple diversification, would result in 15 percent higher conservation value per dollar spent for the same level of risk, 21 percent less uncertainty over the benefits of conservation investments and six percent greater benefits.[90]

As the study is theoretical, it remains to be seen how the US Fish and Wildlife Service and other organizations will respond to the results. However, the authors do see significant potential for MPT to be used to reduce uncertainty of future ecosystem service benefits from land policy and investment initiatives.

IIIDii | Analogue: Payments for Ecosystem Services

Natural Resource Challenge: How to develop incentives sufficient to persuade landowners to take action to conserve natural habitats for a desired environmental management outcome.

Organization: SABMiller

Overview: In 2008, SABMiller partnered with The Nature Conservancy (TNC) to create a water fund aimed at protecting water quality for both business and the eight million residents in Bogota who are provided water by the Chingaza and Sumapaz national parks.[91] In this system, downstream buyers pay into a fund that goes on to subsidize the implementation and use of watershed best management practices. Buyers include municipalities, water treatment facilities, government agencies and private corporations. Transactions are voluntary and are performed under the expectation that payment into the fund will generate long term returns in the form of better watershed health and corresponding increases in water availability and quality. SABMiller has 6 breweries and 5 bottling facilities spread throughout Columbia, and is thus directly concerned with the volume and quality of freshwater available.[92]

The established water fund focuses on several initiatives that preserve water availability and quality:

- Reforestation: Reforestation and re-vegetation efforts are critical to preventing erosion. Areas that have been deforested can be replanted to prevent further sedimentation while allowing for a return to a natural environmental state.
- Higher Quality Cattle: Higher quality cattle produce more milk from fewer cows, reducing the need to create additional grazing land. Maintaining forested land leads to lower levels of sediment erosion than when land is converted to grazing.[93]
- Park Rangers: Many TNC projects include training park rangers to support the national system in the hopes that a more educated ranger population will increase enforcement and decrease the overall number of acres harvested.[94]
- Park Protection: Projects often include fencing off of headwaters and riparian areas to provide additional protection for ecologically sensitive areas. These are generally considered best management practices for payments for watershed services systems.[95]
- Diversified Livelihoods: One strategy used by a number of payments for watershed services projects is the introduction of diversified livelihoods to compensate for the potentially negative impacts of reduced agricultural acreage. Examples include introduction of guinea pig farms or organic vegetable gardens.[96]
- Community Education: Education is an important strategy for any payment for environmental services system. Creating and expanding knowledge within local

communities can help create support and understanding for how to best protect critical ecosystems.

Results: Initially, the fund received $150,000 in seed funding from SABMiller. Within a year, the fund had raised over $1 million including over $300,000 each from the Inter-American Development Bank and the Bogota Water Company.[97] The fund hopes to raise another $60 million over the next 10 years, and estimates are that municipalities could save over $4 million annually by investing in upstream watershed protection.[98] At the same time, the fund is expected to reduce the need for sediment-driven dredging activity and investment in additional water treatment facilities.[99]

IIIDiii | Analogue: Habitat Conservation Banking

Natural Resource Challenge: How to use proactive partnerships to address the fact that Endangered Species Act (ESA) regulations protect habitat for endangered species, but can be a disruptive and expensive way to protect species once on the brink of extinction.

<u>Organization: Gopher Tortoise Pilot</u>
Summary: Regulation to protect threatened and endangered species can significantly disrupt forest and land management schemes.[100] Forest management, including stewardship and timber harvesting, is particularly at risk of disruption from species regulation. Stemming from wetlands mitigation tactics,[101] Habitat Conservation Banking (HCB) involves protecting specific habitat in one location in exchange for undertaking forest management activities in another.[102] Landowners on qualified land are allotted "credits" that can be transferred to forest managers or land developers and used to comply with the habitat destruction mitigation required in Endangered Species Act's Section 10.[103] The objective of these types of initiatives is to "mitigate the effects human activities have on endangered species while creating an economic driver to incentivize the perpetual preservation of the habitat."[104] The US Fish and Wildlife Service (USFWS) approves landowners to sell credits to project developers seeking mitigation for listed or at-risk species.[105]

Federal regulations protecting species listed on the ESA are cumbersome and can thwart land management activities and development. Far simpler and less burdensome is managing for species that are not yet listed, but are trending toward threatened or endangered status — called "pre-compliance." Through pre-compliance habitat programs, landowners, government agencies, and businesses can take preemptive mitigation actions for species of concern prior to their listing under ESA. These mitigation activities would be accounted for as conservation credits to be sold to project developers who are interested in mitigating future environmental risk of a potential ESA listing. These credits can be used toward meeting regulatory requirements if and when the species is later listed under the ESA. When selling credits, landowners contractually agree to manage their land to meet the specific habitat requirements of the species of concern in perpetuity. The opportunity with such conservation credit programs is the potential to proactively contribute to the necessary conservation efforts that may 1) prevent species listing overall, 2) avoid the high compliance costs to meet regulatory standards under the ESA.

Pre-Compliance Conservation Banking: The World Resources Institute (WRI) and Advanced Conservation Strategies (ACS) are developing a pilot conservation marketplace for the gopher tortoise in its non-federally-listed range of the Southeast United States.[106] The pilot is intended to serve as a model for "advance mitigation" markets for candidate species—a concept that has gained considerable attention nationwide as a potential conservation and conflict resolution strategy for species like the sage grouse and lesser prairie chicken, and that is the subject of proposed rulemaking by the USFWS.[107]

Pre-Compliance Conservation Banking is intended to be a proactive approach to manage for biodiversity and ESA "candidate" species. This approach is taken before a species is listed as an endangered species and is intended to protect the species before regulation and compliance frameworks are established.[108] Pre-compliance conservation is a proactive approach to environmental risk management that can harness the power of financial payments for biodiversity conservation.[109] The ACS and WRI team is currently piloting this marketplace in Georgia with the Gopher Tortoise.

Preliminary Outcomes: The environmental impact of this conservation mechanism is clear—preventing the listing of species on the ESA. By creating a market for habitat conservation, landowners are given a financial incentive to set aside tracts of land for protection.

Federal and private developers, in particular, are poised to benefit from such a localized trading mechanism. By preemptively reducing the risk that development projects will be thwarted by federal regulation from ESA listing, these entities will benefit from successful project completion and reduce losses from unfinished or abandoned development.

IIIDiv | Lessons Learned

In some ways, the principal lesson from the Theme 4 analogues is a reflection itself of the idea of the overall project—that practical solutions can be found by creative adaptation of existing ideas and tools for new purposes. However, while many of the analogues in earlier themes involved adapting from the starting point of existing corporate systems and mechanisms to sustainability or existing sustainability management policies to new applications, the analogues in Theme 4 emphasize that there are potential lessons to be learned from initiatives that are even further afield from customary corporate or sustainability contexts. Whether its taking financial management tools from Wall Street to the prairies of the Midwest or a corporation like SABMiller joining forces at the local level with entities like the Inter-American Development bank, these analogues are evidence that scientists, policy makers and corporate managers are increasingly willing to cross traditional sector boundaries to design programs or form alliances to better meet common goals. More importantly, these cases illustrate a willingness to accept uncertainty and use judgment to balance multiple priorities in order to act proactively to mitigate future threats.

IIIDv | Application to the Corporate and Water Context

The analogues in this section have varying potential for application in the corporate and water context. Taken literally, lack of data and public sector support would likely impede ideas like modern portfolio theory or pre-compliance banking applied to watershed protection at the corporate level. However, at a more general level, the underlying principles could provide corporations with new insight into possible future water availability and management scenarios.

For instance, although data about probabilities for water scarcity in different geographies under different climate outcomes may exist for certain watersheds, corporate access to this data or ability to interpret its variances and covariances is probably limited. In addition, necessary data about the cost of water management in different scenarios is even less likely to be widely available. However, companies could consider the cost of building the infrastructure necessary to respond to water provision at three future ground water levels—current, more scarce or very scarce and then assign a probability of occurrence to each in order to get an idea of what might be a reasonable amount to spend on preemptive water conservation or improvements. With even less data required, corporations could apply the idea of covariance to water risk mitigation by diversifying operations in areas with a likely negative correlation of future water availability. They could also apply the idea of probability-weighted scenarios to help understand what water management might cost under different possible future water markets, given current scarcity. The possibilities are numerous.

Similarly, the basic idea of pre-compliance banking markets, a proactive approach to an unknown future, can be applied by considering flexible investments in future capacity that could be leveraged in distinct ways. For example, an investment in human and organizational water expertise could pay off no matter where water problems are actually encountered. It is essentially a way of setting aside corporate "land" and resources for future application, like a prepaid utilities account.

Cultural and Institutional Challenges: Payment for Ecosystem Services (PES) projects tend to encounter resistance, both culturally and institutionally. Culturally, these initiatives ask communities to change their agricultural practices, many of which are likely to have deep rooted significance to the people. Encouraging these groups to cooperate with the program can be a significant challenge and will require a delicate touch and is not guaranteed to work. Local institutions are likely to present at least a moderate level of resistance to PES programs as well, as these groups tend to prefer familiar solutions. In the case of SABMiller, the water fund established received significant contributions from municipalities and other partners, which were ultimately necessary to achieve the outcomes desired. These contributions are not guaranteed in other areas, and making the case for PES is likely to be a hard sell.

Implementation and Monitoring: Another challenge for effective PES programs is their administration and the monitoring of activity within the system. Administration refers to the work necessary to collect and manage funds, identify potential recipients, determine appropriate use of resources and distribution of capital. Monitoring refers to activities designed to ensure that distributed funds are being used appropriately, or that any agreements between parties remain un-violated. Managing this system will require a sizeable amount of organizational resources (more so in terms of person-hours and organizational expertise than financial) compared to other potential solutions.

Geography and Transferability: PES programs are highly location-specific. SABMiller encountered a situation where terrain, soil composition, riparian layout and social factors created favorable conditions that would allow the use of efficiency measures upstream to create a greater supply of water downstream. In a different ecological context, it is uncertain whether a similar program would experience the same level of effect, or how much work would be required to adapt a similar approach to the local context. Thus, each program must be tailored to specific ecological and social contexts, meaning there is limited transferability between programs. This means that organizations need to continue to devote relatively large amounts of resources to the establishment of each additional program, limiting their overall effectiveness as a universal conservation tool.

Though in its infancy, Pre-compliance Conservation Banking is, theoretically, most promising when looking to foresee future resource constraints and act preemptively. The success of this model is yet to be determined as the gopher tortoise pilot is currently underway. But theoretical applications can be made from the initial model to areas where resources are localized and future federal regulations may be impending.

Freshwater

Habitat conservation banking is a unique application of the “credit trading” mechanism. What is attractive about this mechanism is the specific local nature of these credits. Unlike carbon, which is global and not restricted to a local context, habitat is contextual. This concept could be adapted to address local watershed water use by creating a market that allows for the selling and buying of water credits. Water (and habitat) is local and so local consideration and context must be given.

Corporate Context

In corporations structured with many different business units that operate independently, there is potential for an inter-corporation water-trading scheme between business units. The challenge would be the transaction costs, coordination, and tracking. According to the ACS/WRI team, the credit tracking and accounting system needs to be simple, but include these components: (1) Validate Entity Eligibility [e.g. proposed habitat parcel is important to freshwater provisioning], (2) Calculate, (3) Verify, (4) Register, (5) Track.[110]

The concept of “pre-compliance” can be particularly applicable in areas where there is a potential for new or more stringent regulation – i.e., future restrictions on water use in water stressed regions.

IIIE | Analogue-Based Conclusions

The cases outlined above are not only useful for bringing sustainability practices to an organization, the analogues they represent provide inspiration for innovative responses to many types of challenges posed by engaging with multiple stakeholders in an increasingly interconnected world. Given the constraints of corporate structure, analogues will need to mimic or mirror existing systems and processes so as to reduce administrative burden and increase the likelihood of understanding and cross-organizational buy-in. Microsoft, for example, specifically designed its carbon fee system to operationally align with existing accounting and decision-making structures.[111] Further, the system is strategically aligned with the company's interest in growing the role of technology in improving transparency and increasing awareness of efficiency across the company.

Some cases incorporate partnerships with external entities, including non-profits. For example, Disney's carbon offset payments—totaling $15.5 million since 2009—are directed to forest restoration and protection projects, all channeled through environmental organizations like Conservation International and The Nature Conservancy.[112] These partnerships bring environmental knowledge and expertise to the corporation, reducing the burden on the implementing organization. Large environmental organizations are also reputable and often have positive networks with governments and communities, which can help ensure the corporation's continued social license to operate in the local community.

In the remainder of this section we seek to provide a more integrated perspective of the chosen analogues by highlighting some of their common trends and key differences. First, we consider enabling conditions, benefits and limitations common to all analogues and then move to a comparison of traits found in some but not in others.

IIIEi | Enabling Conditions

A comparison of conditions that enabled implementation of the cases we studied reveals that there are three common types of enabling conditions — organizational fit, strategic fit, and technical fit.

First, organizational fit relies on having an innovative corporate culture that is flexible, open to change and forward-looking. This encompasses organizational willingness to take on unfamiliar projects that may require coordination across units, evaluation of uncertainty and risk, and weighing of tradeoffs between multiple competing priorities. It also implies "openness" to learning and partnership with groups traditionally not valued as corporate stakeholders, including the non-profit and public sectors and local communities.

Second, success is enabled by strategic fit. High-level support by corporate leaders who believe in the importance of the initiatives as an integral part of corporate strategy is essential for giving lower-level managers the freedom to innovate. Strategic fit can arise from multiple motivational drivers, including new regulation, potential for cost savings or reduced risk, to build public goodwill or to take advantage of a new revenue opportunity. Strategic fit is more likely to lead to adequate financial and human resources support and company-wide corporate endorsement, without which it can be difficult for individual business units or departments to approve new strategies. More specifically, the goals of specific environmental initiatives should align with corporate sustainability goals, which in turn align with overall corporate strategy for the future. In the case of water, this is most likely to occur when water is a key input for operations or manufacturing. It is even more likely to occur when the use of water is associated with the company's social "license to operate" in a particular region. As a shared resource essential for daily living, water scarcity is particularly likely to provoke conflict with the community that could threaten the ability to conduct business in an area.

Finally, the implementation of new sustainability-related initiatives is facilitated by technical alignment with existing accounting and data systems. For example, energy efficiency financing cases, especially those that involve power purchase agreements, are not a good fit with accounting systems and rules that do not allow for off-balance sheet financing. Internal trading mechanisms would likely be easier to implement in corporations with existing internal transfer pricing protocols than in those without them. Similarly, mechanisms that are retrospective, or based on measured use of designated resources, require tracking and recording systems that can distinguish the consumption of multiple users. This can be expensive or impractical to implement in some settings. For example, in manufacturing settings, water is usually measured at the point of inflow and outflow, but attributing its use to specific business units across a factory between the point of input and output can be difficult. On the other hand, prospective analogues, or those that depend on projections of future conditions, require the ability to reasonably forecast future scenarios.

Though a fit in all three dimensions is helpful, it is not imperative that all three be in place from the beginning. We found that the most important dimension is cultural. Even with strong strategic reasons for implementation, corporations must first be willing to try something new and make a change. With an innovative, open culture, strategic opportunity can become apparent, and technical capacity can be developed to take advantage of the identified opportunity. Many of the cases profiled here can be influential sources of sustainability education and innovative problem solving, which helps to expand a culture of sustainability thinking and bolster flexibility within the organization.

IIIEii | Common Benefits

We also found that the analogues examined shared four key benefits: changing incentive structures, providing a tool for multi-criteria decision-making on natural resource challenges, increasing awareness and focus on sustainability issues within an organization, and enhancing opportunities for employee and organizational learning.

Changing incentive structures within corporations to align with organizational goals is critical to successful implementation. Individuals will act based on the incentive structure in place. Therefore it is crucial to ensure that organizational incentive structures are made compatible with driving the behaviors that underlie successful mitigation of the natural resource challenge. For example, putting an internal price or tax on a natural resource will send a signal that reduces the resource's consumption or use and drives efficiencies. A strong enough price signal can change not just usage behavior but also drive investment decisions as the return on investment and net present value of proposed projects will incorporate the tax or price.

In prioritizing investments and corporate initiatives, decision-makers face considerable tradeoffs, and more often than not, financial metrics are the primary tradeoff examined. However, incorporating *multi-criteria decision-making* tools and metrics is a process that enables managers to move from using simple, often financial, metrics to weighing the tradeoffs between both financial and non-financial strategic criteria when making decisions. This common attribute highlights the multi-faceted nature of the outcomes derived from implementing an analogue and the benefits and costs that may or may not be quantifiable.

Creating engaged and aware employees and consumers is of considerable value for implementing a response to a natural resource challenge and is often cited as one of the largest unforeseen benefits of sustainability initiatives. *Increased awareness and focus on sustainability issues* within an organization is an often underestimated means to drive employee buy-in, create positive brand image, and improve social license to operate in specific contexts. Natural resource challenges ask corporations to consider a sometimes entirely new set of issues, and changing mindsets can be just as important as changing culture.

Similar to creating awareness both internal and external to an organization, there is considerable *opportunity for learning.* Addressing natural resource sustainability often requires not only learning a new set of issues but also a new set of skills, for example, working with the public sector or using systems thinking. These skills can be transferred to improve performance in other unexpected areas.

IIIEiii | Common Limitations

All the analogues analyzed face a common set of limitations that can impair opportunities to fully realize their potential and impact on corporate decision-making. The following set of limitations, ranging from quantifying impact to multi-scalar mismatch, highlight the most common barriers encountered.

Given the emphasis placed on measurable results, the inability to conclusively attribute impacts to specific corporate actions is problematic. This ambiguity does not align with a corporate culture that requires results to justify new project investments. *Quantifying impacts on resources, financial savings, and organizational and operational processes* can be difficult as creating the correct metric and connecting it to the underlying change (investment or behavior) can be challenging. Reasons for this can be attributed to the non-linear systemic nature of natural resource trends, organizational complexity, and accounting practices. For example, in habitat conservation banking, the impact of land conservation to protect specific species may be insufficient to change or reverse species loss trends unless a critical parcel size is reached. However, positive impacts on the overall ecosystem health could be high. This lack of direct results can make it difficult to build a case for personal or financial support of a project or initiative.

Each analogue hinges on achieving the desired outcome, but as mentioned above, measuring this outcome and attributing it to the mechanism can be difficult. Determining *sufficient impact on natural resources, financial savings, and organizational improvements* requires a balance between accounting for factors outside of a corporation's control (e.g. climatic variability), as well as direct outcomes from mechanism implementation. For example, payments for ecosystem services impacts can be hard to measure because of the confounding influence of all other users of the watershed. However, the challenge of measurement does not mean that these projects do not provide real, substantial value.

Some degree of *temporal, spatial, and jurisdictional cross-level and cross-scalar mismatch*[d] must be overcome by each analogue. Temporal scale mismatch between shorter-term corporate decision-making time horizons (e.g. quarterly returns) and longer-term analogue investment returns can severely reduce likelihood of analogue adoption. Habitat conservation banking, payments for ecosystem services, and modern portfolio theory, for example, all rely on achieving the ecosystem-relevant scale to achieve desired outcomes. Further, because ecosystem spatial boundaries do not align with jurisdictional boundaries, land ownership at the local, state, and federal levels could make analogues irrelevant or inconsequential at the ecologically-relevant scale. Attempted coordination across these scales can become mired in gridlock and inaction, due to parties' pursuit of individual interests.

Common across all the analogues is some degree of *dependence on development of new internal technical and project management expertise.* Even in a case when corporations can partner with outside organizations or hire new talent in order to quickly gain new skills necessary to implement unfamiliar sustainability initiatives, existing managers are often required to become conversant in a new language, and more importantly, a new way of thinking, about natural resource strategy. This kind of organizational change can be difficult to spread across large companies. For example, assigning a carbon tax or fee per unit of carbon requires the expertise to measure such output to quantify the amount to be charged to the business unit or entity and successful implementation may hinge upon ease of understanding of both the technical processes and strategic insights derived from the new system.

IIIEiv | Benefit and Limitation Comparison

The differences in benefits and limitations of individual analogues are perhaps even more important than their commonalities. Considering the unique characteristics of the analogues will better enable companies to pick and choose elements of different analogues that best match their particular context and goals. Table 4 organizes the analogues according to some of the key benefits they may provide. Table 5 provides the same overview for key limitations. Each table is followed by brief explanations of why each benefit or limitation was considered important for inclusion.

[d] Cross-level mismatch refers to misalignment along the same "scale," for example, between the state and county jurisdictional levels. Cross-scalar mismatch refers to misalignment across scales, for example between the temporal and spatial scales.

Figure 4: Comparison of Selected Analogue Benefits

Analogue	Generates funds	Prep for markets	Immediate impact	Short-term responsive	Long-term planning	Decent-ralized. Implem.	Not outcomes -driven	Non-$ rewards	Reduces barriers to capital	Requires less expertise	Holistic view	Addresses root cause
Carbon Taxing	■	■	■	■								
Shadow Pricing		■			■							
Internal Trading		■	■	■		■						
GIPS			■			■	■					
Infrastructure Incentives						■	■	■				
Energy Efficiency Financing			■						■	■		
Revolving Funds	■		■			■			■			
MPT					■						■	
ES Payments										■		■
HCB		■			■						■	■

Potential to generate funds: Identifying funding for environmental projects can be a barrier to successful resource management. These analogues can help mitigate this challenge by either raising capital, providing monetary savings, reducing financial risk, or creating a market for efficiency project investments.

Good preparation for external markets and/or regulation: Similar to the potential for an external carbon market, a future market and increased regulation for freshwater is a possibility. Businesses that adopt innovative management practices can better position themselves to succeed in the face of potential regulation by shifting and changing behaviors to reduce impacts and achieve greater efficiency.

Immediate impact on operations: Sustainability is a long-term issue, and it is often easier for organizations to neglect planning for the future than to implement policies that have an immediate tangible result on the business. These analogues are those that have the potential to create an immediate, operationally visible impact.

Potential to be responsive to short-term conditions: In contrast to long-term agreements on a policy or course of action, these analogues are easily adjustable in the face of short-term climatic variability, for example, during drought conditions.

Long-term planning: While a long-term view is implicit in any sustainability initiative, these analogues go the extra step by attempting to forecast future conditions beyond the 5-10 year time horizons generally used in corporate planning. As a result, they are likely to involve dealing with high levels of uncertainty.

Allow decentralized decision-making and implementation: These analogues are good for implementing changes in large organizations with many business units with varying functions and goals because they allow for flexibility in how the mechanism is implemented. Some, like infrastructure management incentives and internal trading have a unified goal (e.g., carbon reduction), but allow for different means of reaching that goal. Others, like green infrastructure portfolio standards and green revolving funds, may be set up to allow managers to define their own goals (e.g., carbon reduction *or* water management) based on their unit's particular sustainability challenges

Holistic view of total impact across multiple units: These analogues are important in that they provide either trading or offsetting mechanisms that leverage variation across individual units to achieve an overall goal.

Focus on decision-making, not outcomes-driven: Even if designed with a target goal in mind, these analogues do not guarantee or mandate the desired outcome. Instead, they change decision-making procedures or incentives in order to promote desired actions. As a result, results depend largely on the degree of adoption and implementation by managers.

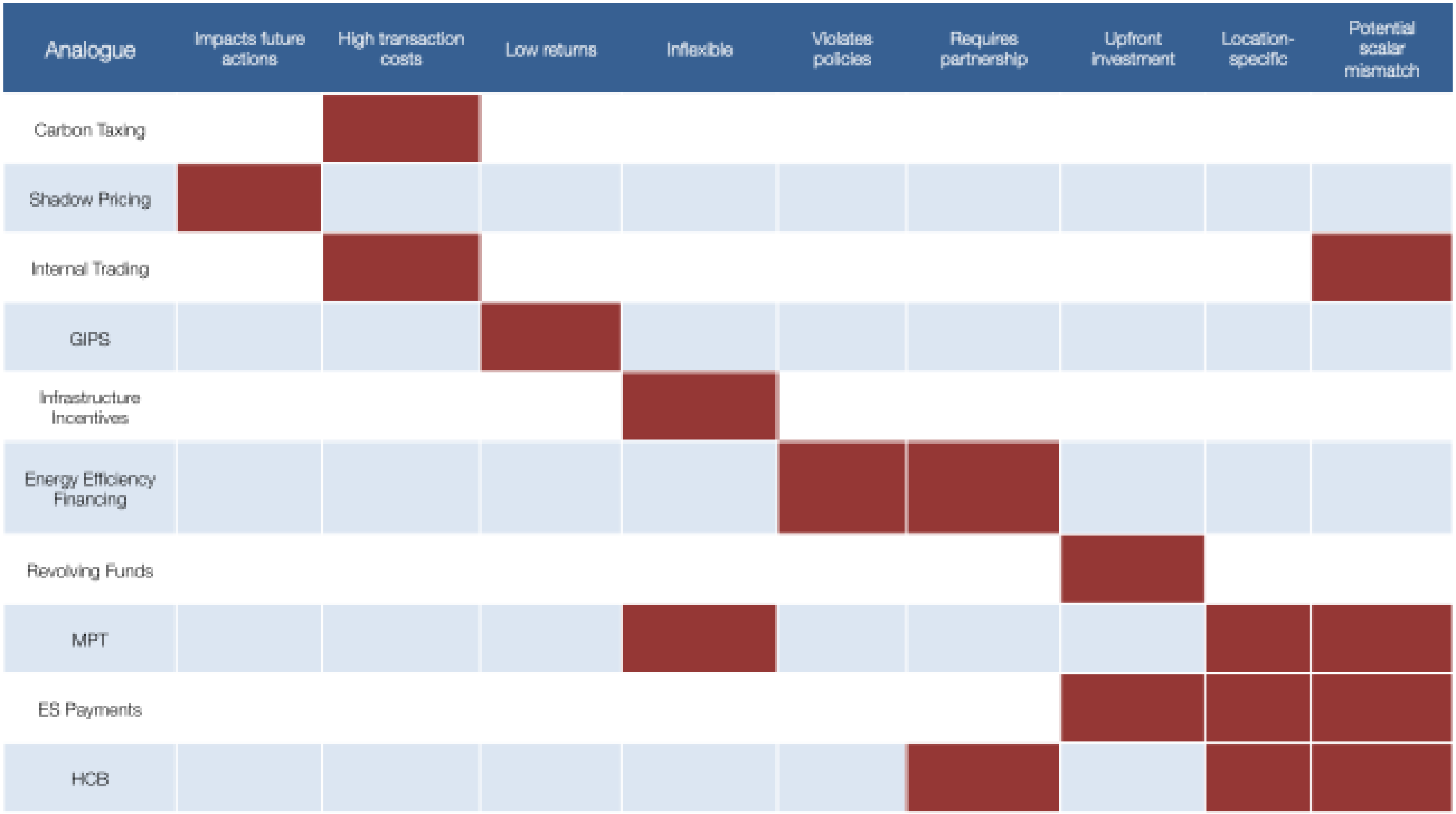
Opportunity to provide non-monetary rewards: The simplified permitting process and other non-monetary incentives in the Infrastructure Management Incentives analogues can get managers thinking about creative non-monetary awards like expedited project approval in a capital constrained context,

Reduces barriers to accessing capital: When access to capital is the barrier to implementing projects that would otherwise be approved, these analogues may provide means of reducing those barriers by transferring longer-than-accepted payback periods to more patient investors or by forming a partnership to take advantage of complementary strengths of a partner (e.g., tax status) that make the overall project cheaper.

Requires less internal technical expertise through transferring risk to expert external partners: Water and sustainability projects often require technical expertise outside the traditional corporate realm. These analogues reduce the need for additional employee training or new hires by engaging a knowledgeable external partner.

Address root cause of problem: Most of the mechanisms profiled in this paper are corporate responses to the symptoms of water scarcity. The mechanisms enable the company to find ways of using less water or to use it more efficiently. These analogues go further to address the root cause of water scarcity by addressing watershed health and water capture.

Figure 5: Comparison of Selected Analogue Limitations



Impacts future actions, not existing operations: Compounding the challenge of convincing business units to take action now because of the possibility of uncertain events in the future is the fact that decision-makers usually find it easier to amend processes governing future actions rather than current ones. For example, incorporating a shadow price of carbon or water into a future investment may alter decisions about the type or location of infrastructure construction, but it does not require immediate behavioral changes to be made. However, such procedural changes do have the potential to avoid significant future negative impacts. The downside is that existing operations continue unchanged and that few individuals outside planning functions may be exposed to the sustainability principles embodied in the policy, making it harder to use the decisions as means to instigate cultural changes that allow for more immediate action at a later date.

High transaction costs: Analogues that require significant coordination within the organization can incur high transaction costs in the form of large, ongoing requirements of employee time. While there are often high learning costs associated with implementing a new sustainability initiative, not all of them continue to require significant investment once they are set up. Internal trading mechanisms are an example of a mechanism that would require continuous renegotiation between participating units. Analogues with high coordination transaction costs are most likely to be useful when there are large gains to be made from more efficient allocation of resources or responsibility for action.

Lower financial returns: It is important to state that not all sustainability projects have low financial returns, even by corporate standards. Energy efficiency projects, for example, may have short payback periods with double-digit returns. However, some projects will require companies to approve investments with returns lower than their standard hurdle rate.

Least flexible as to how the desired change is achieved: These analogues designate specific actions that must be taken in order to achieve the desired effect. These contrast with other more flexible mechanisms that allow different units to choose their own methods for achieving the desired result. If the action is difficult, it could be met with resistance. On the other hand, if the actions are simple, it can save redundant planning. Accordingly, they require well-substantiated and defined actions in order to be successful.

May violate internal corporate governance: There are two particular characteristics of some analogues that make them more likely to violate internal corporate governance standards. The first are long-term contracts. Long-term contracts differ from adopting long-term time horizons for planning in that corporations are legally obligated to fulfill certain duties, often for 10-15 years. The long-term contracts enable initiatives like power purchase agreements by, among other things, lowering the cost of financing. However, some large corporations have corporate governance statutes limiting contracts to far shorter timeframes. Long-term contracts may be especially hard to get approved in highly volatile industries. The second characteristic is the debt to equity ratio, which can be higher than corporate standards in projects heavily financed by debt.

Requires partnerships with external stakeholders: These analogues depend on partnering with external stakeholders for implementation. These partners often come from different sectors or industries than more typical corporate partners. As mentioned above, this can provide a learning opportunity. For example, learning how to engage with non-profits and the public sector. At the same time, any partnership with an external stakeholder imposes risk. There is the reputational risk of being associated with a partner whose goals may not align as well as the operational risk of the experimental relationship, and therefore the initiative, going differently than planned. It is essential to find a trusted, capable partner with the desired complementary expertise.

Upfront capital investment: Sustainability investments, even those that will generate financial returns above corporate hurdle rates, are often difficult to get approved in capital-constrained environments due to a bias towards investing money in what are seen as core business operations.

Success depends on location-specific geological and ecosystem conditions: These are only suitable for implementation in areas with specific geological, ecosystem or climatic conditions. Evaluating potential for success involves making decisions location-by-location instead of company-wide.

Greater potential for jurisdictional and spatial mismatch: Though all the analogue mechanisms are prone to scalar mismatch, these are especially likely to encounter jurisdictional and spatial misalignment that may make implementation more difficult as they rely on one or more geographic areas being organized or regulated by a single entity or multiple entities willing to coordinate.

SECTION IV | APPLICATION OF FINDINGS

As stated above, The Dow Chemical Company has emerged as a leader in the field of corporate ecosystem service management. One example of this commitment was the start of a five-year, $10 million partnership between Dow and The Nature Conservancy (TNC). This groundbreaking collaboration is working to value priority ecosystem services at three Dow pilot sites around the world. Work at the first site in Freeport, Texas is nearly complete and efforts in Brazil have begun. Work is expected to begin on a third site this year.

With this in mind, the team sought to adapt lessons learned through the extensive analogue analyses to the specific context of helping The Dow Chemical Company develop a new tool to address water scarcity. We sought to define a strategy that would seamlessly integrate with established business practices to address water scarcity via sustainable reductions in water withdrawals rather than by increasing supply.[e] Key operational, organizational and financial attributes of The Company guided our considerations and ultimately, our recommendations to develop the best fit solution for Dow today. As indicated earlier, the mechanism developed needed to be flexible across water policy contexts. As a firmly structured organization, the solution needed to be designed to fit existing organizational processes. With Dow being an expert in water and process technologies, the team sought to develop a tool to influence decision-making, not technological choices. Finally, as a company with strong competing demands for investment capital, the solution developed needed to have its own source of funding.

Through conversations with key players within Dow, it became clear that sustainable financing is the greatest challenge within the organization when it comes to developing the sustainability projects that will help Dow to address its exposure to freshwater scarcity. With a low ROI and distant-feeling risk, water sustainability projects are hard to make the case for in all but the most proactive and sustainability-minded of organizations. This challenge is compounded by the competing need to invest scarce capital into regulatory-required or business growth projects. Avoiding the uncertain risk of the avoided cost from lost production is simply too difficult a case to make when it comes to allocating limited funds among projects.

[e] Our intent with this project is to influence long-term sustainability. Therefore, we focused our analysis and recommendations to The Dow Chemical Company on opportunities to reduce freshwater consumption and/or recycle water and not on opportunities to temporarily increase supply, such as through buying options to additional water rights or increasing reservoir capacity.

The team then evaluated each of the 10 analogues for potential application, given what had been discovered about the context presented by The Dow Chemical Company and the central challenge of financing water sustainability projects. Through additional discussions with stakeholders at Dow, it was determined that the more "traditional" and tested analogues from the carbon and financing themes would be the building blocks with the best chance for adoption at Dow.

The Journey to an Environmental Fund

The in-depth analysis of analogues discussed above provided a suite of mechanisms through which freshwater management issues at Dow might be addressed. The aforementioned interviews with Dow personnel generated the following idea by the team of a complete-via-combination system:

- Generate investment capital internally through a fee-based water use mechanism
- Use fees generated as seed capital for a revolving investment fund
- Prioritize investment decisions for water-related capital expenditures while using higher ROI projects (e.g., energy efficiency) for cross-subsidization.

Building from the analogue benefits and limitations outlined above, we were able to identify a way in which multiple analogues could be used in a complimentary manner to achieve Dow's goals. The resulting "preferred" structure is outlined below:

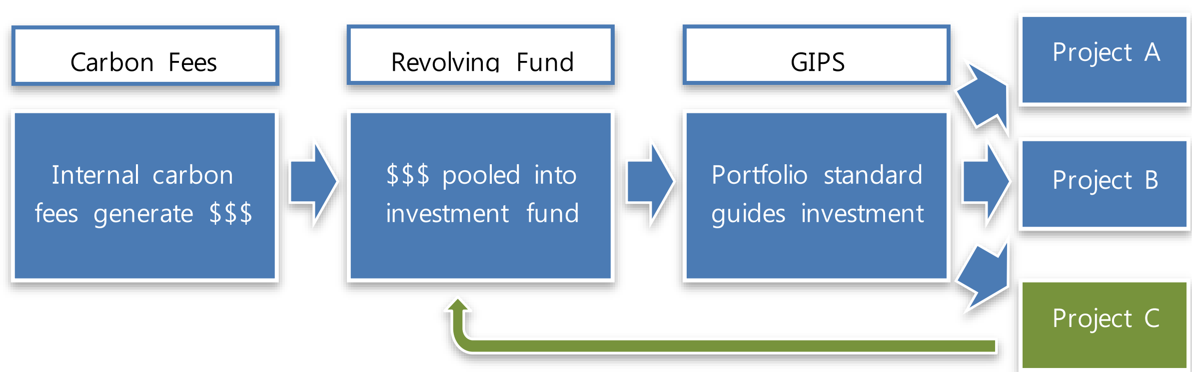


Figure 6: Preferred Fund Structure

This unique combination of mechanisms was designed to address Dow's needs for fundraising, prioritization, and continuity. However, as the team proceeded with additional primary research within a specific Dow manufacturing site, some additional limitations to this approach were identified. First, charging an internal fee for water usage would not be viable due to the integrated operations of The Company and the potential for a fee to raise the cost of doing business between business units, making it difficult to remain competitive in a very price sensitive industry. In addition, it was deemed too operationally difficult to manage a revolving fund since Dow's integrated operations prevented accurate monitoring of cost savings pass-through. One possible workaround we suggested for this would be to identify a reasonable proxy such as a metric measuring resource input efficiency, which would allow savings to be tracked closely, if not directly. Another option, as suggested in a joint report between the Sustainable Endowments Institute and the Association for Advancement of Sustainability in Higher Education, "is to conduct a less rigorous assessment of whether utility costs are decreasing over time. This will not be sufficient to calculate project repayments, but it can help verify that a project or portfolio of projects is decreasing costs broadly."[113]

Amended Proposal for Dow: Mixed application fund with special allocation to environmental challenges

Through further iterations and discussions with environmental and finance team members from across Dow corporate and plant operations, we refined our thinking and developed a proposal that combines elements from two analogues - GIPS and revolving funds – with a balanced scorecard approach to performance evaluation. Rather than generating funds internally through a fee-based mechanism, this proposed solution will need to be funded through a special initial capital infusion to a parallel funding pool managed within the traditional capital budgeting process at Dow. A balanced scorecard approach was recommended to measure and report on the non-financial impact of these capital investments. This would serve to supplement the metrics currently evaluated in the capital budgeting process and facilitate the annual renewal of Sustainability Footprint project funding.

Key Features (Figure 7):

- Uses metrics that go beyond traditional ROI
- Combines projects impacting different resources, with aim to reduce consumption of each
- Managed outside of standard capital budgets to eliminate direct competition with critical funding for today's regulatory requirements and/or business growth imperatives

This recommended strategy is sensitive to the financial realities and processes in place at The Company and is flexible to allow for the varied operational and policy contexts in which Dow faces freshwater scarcity challenges around the globe. Further, it addresses the desire of The Company to frame and address sustainability holistically, while still carving out freshwater scarcity as a focal challenge within the new effort.

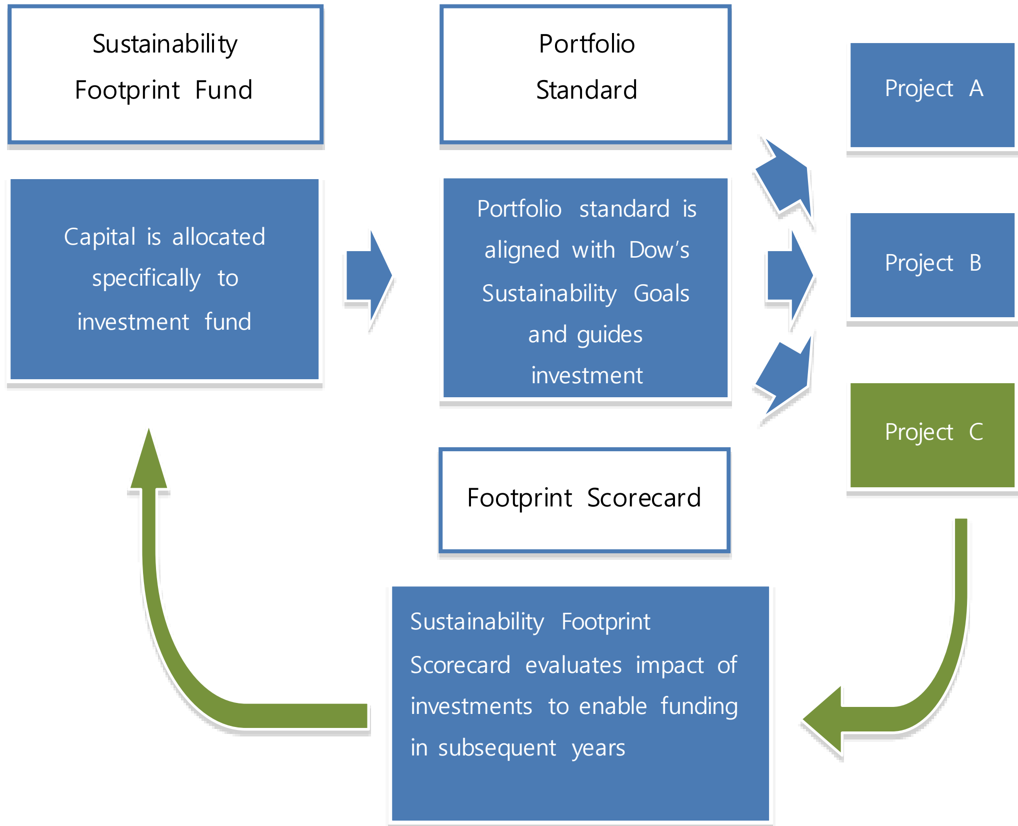


Figure 7: Proposed mixed appropriation fund with special allocation to environmental challenges

Implementation

In discussions with Dow, a few additional organizational management and execution limitations were discovered including scale, budgeting process, and long-term viability. We recommended the following steps to address these issues:

Start with a small scale pilot – Gaining sustainable funding for these types of capital investment projects is, as noted previously, challenging. As such, we recommended starting first with a pilot project led by the thought leaders and more proactive groups within the organization.

Leverage current processes and systems – Given the size and matrix-based structure of the organization we recognize the challenges of large-scale change management. Consequently, we recommended The Company to build the Sustainability Fund in parallel to current processes and thus limit the introduction of new complex structures.

Ensure long-term viability of the fund – Dow has made numerous investments in the identified target areas in the past. However, these have often been one-off investments and therefore have not created the lasting, sustainable value that was originally sought through initiating these projects. With the intent of achieving this long-term viability we made the following additional recommendations:

Buy-in from senior level leadership – To successfully implement the Fund, the Fund's instigators must gain buy-in from high-level leadership.

Tie the purpose and operation of the Fund directly to the broader organization's environmental strategy – Tying the Fund directly to the 2015 Sustainability Goals and potentially, a new post-2015 sustainability investment goal is one potential option to achieve this. We also recommend identifying individual champions and influencers within the organization. These individuals could make up an internal "board of directors" or "review committee" to ensure oversight by different business units as well as project-type champions (e.g., energy efficiency, water, etc.). Committed Fund managers and a link to The Company's sustainability commitments should help to ensure on-going support beyond the initial approval of the Fund, as well as facilitate protection and commitment through future economically challenging times.

Oversight conducted by corporate or EH&S – Oversight of the Fund should come from a corporate entity with broad reach, such as Global Environmental Health and Safety. This will ensure that individual business units are not forced to divert funds from elsewhere in their budget and also allow the capital to be deployed in a manner that provides the greatest net benefit to the organization as a whole.

Capital Investment Scorecard – Another way to improve the long-term viability of the Fund is through creating a capital investment scorecard that measures the non-financial impact of capital investments in environmental projects. This scorecard would supplement the metrics currently evaluated in the capital budgeting process to communicate the environmental benefits of capital investment projects to justify continued funding.

Ultimately, the ability for a chosen implementation strategy to integrate as seamlessly as possible into a business will depend on its organizational fit. Developing a response mechanism that can be integrated without disrupting current organizational structure can reduce the barriers to implementation and ease the burden of ongoing management. If the chosen response to a natural resource challenge requires centralized corporate decision-making or more decentralized, business unit-specific approaches, the design of the mechanism must reflect this need. The implementing business division or unit must have organizational oversight over the respective operations further down the organizational chart. For example, the tax or fee approach should build on current pricing and costing structures and require minimal changes on behalf of those carrying out the operational functions. Beyond structure is the question of fit with organizational culture. Employee buy-in to the reasoning behind program implementation can help overcome barriers of misunderstanding and even build excitement around support for sustainability-enhancing initiatives.

An additional consideration critical to moving initiatives forward is identifying and cultivating a *"champion"* with formal or informal influence and authority to propose innovative responses. A champion can approve, lobby for or allocate financing to carry a project through to execution. Though responses that build on current organizational features will face fewer barriers to implementation, identifying the committed, driving human force customized to a centralized or decentralized structure is essential. This person or persons will promote understanding, build the case for support, and be the promoter of why this change will impact the future success of the corporation.

CONCLUSION

We first approached The Dow Chemical Company with our proposal to do a Master's Project because we were excited about their partnership with The Nature Conservancy and the possibility of taking science-based valuations of ecosystems services and embedding them into the corporate decision-making process of a large multi-national corporation. In the end, our proposed solution represents a less direct method of doing so than initially envisioned because of the unique challenges related to water and ecosystem services in the private sector. However, we believe that the analogues examined do provide hope that creative solutions to tackling these challenges can be successful.

The disparate forms of water policy throughout different locales around the world make it challenging for a multinational company to implement company-wide water initiatives. However, this is not a reason for companies to neglect addressing water-related issues, but instead precisely the reason they should take steps internally at the corporate level. The sooner corporations begin to internally manage water use, the better prepared they will be when scarcity dictates that conservation measures are essential for business functioning or required by regulation.

Through our work with Dow, we gained first-hand exposure to the challenges of operationalizing the outcome of ecosystem service valuation. In all instances, adding an internal price to a commodity that is historically free hinders the company's ability to compete in the market. Consequently, we worked with Dow to help shift the focus to reducing overall dependence on ecosystem services, an approach that reduces risk regardless of the future scenario that unfolds.

Finally, working with Dow helped us learn that problems such as freshwater availability in the corporate context can be addressed through means already proven to address other challenges. We firmly believe that the analogues outlined in this report can be combined in various ways to both overcome their individual shortcomings as well as meet the individual needs of an organization. The solution we developed accomplishes just that. However, we plan to share these findings broadly in the corporate community through webinars and other means to facilitate this type of thinking and have a broader impact through engaging with additional companies.

Appendix A

Individuals with whom we discussed and tested our project approach

Organization	Position
The Dow Chemical Company	Waste Reduction Leader, Environmental Technology Center
	Project Manager, Ecosystem Services
	Senior Director, Advanced Materials Division
	Associate Environmental Director
	Vice President, Global EH&S & Sustainability
	Water Issue Leader, Corporate Water Strategy
	Environmental Operations, Freeport
	Financial Analyst, Environmental Technology Center
	Finance Manager
	Director, Sustainability Programs and Enterprise Risk Management
	Finance Director
University of Michigan	President, WorldView Consulting LLC
	Director, Graham Sustainability Institute
The Nature Conservancy	Senior Environmental Economist
	Director of Science
	Ecosystem Services Scientist
Shell	Vice President, CO_2 Strategy
Walt Disney Imagineering Research and Development	Environmental Scientist
World Resources Institute	Senior Associate, Conservation Incentives & Markets

Appendix B

List of Sources Consulted

Title	Author	Publisher	Year
Frameworks			
Title	Author	Publisher	Year
Charting Our Water Future: Economic Frameworks to Inform Decision-making	N/A	Barilla Group, Coca-Cola Company	2009
The Value of Water: Building the Business Case for Optimizing Water Use in Mining	Garner, Richard	AngloAmerican PLC	2011
Value-At-Risk of Carbon Constraints: An Input Oriented Approach to Resource Scarcity	Busch, Timo and Paul Raschky	Wuppertal Institute	2004
The Right Formula for Growth	N/A	Dow Chemical	2010
Water Resources Across Europe: Confronting Water Scarcity and Drought	Collins, Robert et. Al.	European Environmental Agency	2009
The DPSIR Framework	Kristensen, Peter	National Environmental Research Institute, Denmark	2004
Analysis of Global Change Assessments: Lessons Learned	N/A	National Research Council	2007
Guide to Enterprise Risk Management	N/A	Protiviti	2006
A Practical Guide to Risk Assessment	N/A	PriceWaterhouseCoopers	2008
Risk Assessment Matrix Process	N/A	Michigan State University	2004
Minimizing Risk in Your Raw Material Supply Chain	Hollenbach, John	Doe & Ingalls	2007

Title	Author	Publisher	Year
Corporate Resource Accounting			
Murky Waters: Corporate Report on Water Risk	Barton, Brooke	Ceres	2011
Guidance on Water Stress Mitigation	Wolters, H. et. Al.	AquaStress Integrated Project	2008
Review of Corporate Environmental Indicators	Herva, Marta et. Al.	Journal of Cleaner Production	2012
Corporate Reporting on Water	Morikawa, Mari et. Al.	Pacific Institute	2007
Corporate Water Accounting	Morrison, Jason and Peter Schulte	Pacific Institute	2007
TEEB for Business	Bishop, Joshua et. Al.	TEEB	2010
Guide to Corporate Ecosystem Valuation	N/A	WBCSD	2011

Corporate Resource Accounting			
Title	Author	Publisher	Year
How to Value Ecosystem Impacts and Opportunities	N/A	WBCSD	2011
The Corporate Ecosystem Services Review	N/A	WBCSD, WRI	2011
Nature in Performance: Initial Recommendations for Integrating Ecosystem Services into Business Performance Systems	Hanson, Craig et. Al.	WRI	2011

Ecosystem Services Background			
Title	Author	Publisher	Year
Pricing the Priceless: The Business Case for Action on Biodiversity	Raingold, Andrew	Aldersgate Group	2011
Trends in Ecosystem Service Research: Early Steps and Current Drivers	Vihervaara, Petteri et. Al.	Springer Research	2010
New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty	Waage, Sissel et. Al.	BSR	2011
The Quiet (R)Evolution in Expectations of Corporate Environmental Performance	Waage, Sissel et. Al.	BSR	2012
The Value of Ecosystem Services: Putting the Issues in Perspective	Costanza, Robert et. Al.	Ecological Economics	1998
The Value of the World's Ecosystem Services and Natural Capital	Costanza et. Al.	Nature	1997
Rethinking Ecosystem Services to Better Address and Navigate Cultural Values	Chan, Kai M.A. et. Al.	Ecological Economics	2012
Spatial Scales, Stakeholders and the Valuation of Ecosystem Services	Hein, Lars et. Al.	Ecological Economics	2006
Understanding Changes in Business Strategies Regarding Biodiversity and Ecosystem Services	Houdet, Joel et. Al.	Ecological Economics	2012
State of Watershed Payments: An Emerging Marketplace	Stanton, Tracy et. Al.	Ecosystem Marketplace	2010
Water: A Global Innovation Outlook Report	N/A	IBM	2009
Sustainable Insight: The Nature of Ecosystem Service Risks for Business	Tholen, Jerwin	KPMG	2011
REDD and Forest Carbon: Market-Based Critique and Recommendations	N/A	The Munden Project	2011
Finding Successful Ecosystem Service Projects and Programs in the United States	O'Shea, Tara and Lydia Olander	Duke University	2011
Valuation of Ecosystem Services and Strategic Environmental Assessment	van Beukering, Pieter J.H. et. Al.	Netherlands Commission for Environmental Assessment	2008
Tread Lightly: Biodiversity and Ecosystem Services Risk and Opportunity Management within the Extractive Industry	N/A	The Natural Value Initiative	2011

Ecosystem Services Background			
Title	Author	Publisher	Year
Striving for Positive Water Impact	N/A	PepsiCo, The Nature Conservancy	2011
Designing Payments for Ecosystem Services	Salzman, James	PERC	2010
Ecosystem Services and Cost-Benefit Analysis	Cassola, Rodrigo S.	TEEB	2009
Payment for Ecosystem Services and Alternative Livelihoods in Rural China	Zhi, Lu	TEEB	2010
Water Source Forest Management by Private Sector in Japan	Hayashi, Kichiro	TEEB	2010
Linking People and Nature throughout Watershed Conservation in the East Cauca Valley, Columbia	Goldman, Rebecca L. et. Al.	TEEB	2010
Green Vs. Gray Infrastructure: When Nature Is Better Than Concrete	Talberth, John et. Al.	World Resources Institute	2012

Risk Assessment Tools			
Title	Author	Publisher	Year
The CERES Aqua Gauge: A Framework for 21st Century Water Risk Management	Barton, Brooke and Berkley Adrio	Ceres	2011
Dependence and Impact Assessment Tool Version 2	N/A	World Resources Institute	2012
Global Water Tool	N/A	WBCSD	2011
Global Water Security	N/A	US Dept. of State	2012

Water Policy			
Title	Author	Publisher	Year
Brazos G Region Water Plan	N/A	HDR	2011
Water Policy Brief: Flexible Water Storage Options and Adaptation to Climate Change	Clayton, Terry et. Al.	Intl. Water Management Institute	2009
OECD Environmental Outlook 2050, Chapter 5: Water	Leflaive, Xavier et. Al.	OECD	2012
Public-Private Partnerships in the Urban Water Sector	N/A	OECD	2003
Meeting the Water Reform Challenge	N/A	OECD	2012
Overview of Greywater Reuse: The Potential of Greywater Systems to Aid Sustainable Water Management	Allen, Lucy et. Al.	Pacific Institute	2010
The CEO Water Mandate: Guide to Responsible Business Engagement with Water Policy	N/A	Pacific Institute	2010

Water Policy			
Title	Author	Publisher	Year
New Jersey Stormwater Best Management Practices Manual	N/A	State of New Jersey	2004
Water for Texas: 2012 State Water Plan	Bennett, Jason et. Al.	The Bush School	2012
Property Rights and Environmental Policy: A New Zealand Perspective	Guerin, Kevin	New Zealand Treasury	2002
Legislative Theory and Practice	Hodgson, Stephen	FAO	2006
Briefing Paper on Water Governance Structure in Beijing	Hou, By Eve	PRC	2000
Recent Priority Calls for Texas Water Rights	Ickert, Rachel	Freese & Nichols	2013
Towards adaptive water governance observations from two transboundary river basins	Kranz, Nicole	Institute for International and European Environmental Policy	2009
Conflict, Cooperation, and Collective Action Land Use: Water Rights , and Water Scarcity in Manupali Watershed	Caroline Piñon et. Al.	CAPRi	2012
Water Regime Formation in Europe	Lindemannn, Stefan	Environmental Policy Research Centre	2012
Pipe Dreams: Water Supply Pipeline Projects in the West	Fort, Denise et. Al.	NRDC	2012

Analogue Research			
Title	Author	Publisher	Year
Emissions Trading: Early Lessons from the U.S. Acid Rain Program	N/A	Acid Rain Agency, U.S. EPA	1995
Comparison of marine spatial planning methods in Madagascar demonstrates value of alternative approaches.	Allnutt, Thomas F et. Al.	PLOS One	2012
WATERGY : Energy and Water Efficiency in Municipal Water Supply and Wastewater Treatment The Alliance to Save Energy	Judith A. Barry	The Alliance to Save Energy	2007
Collective Action for Water harvesting Irrigation in the Lerma-Chapala Basin, Mexico	Scott, Christopher A. et. Al.	Water Policy	2001
Going Carbon Neutral and Putting an Internal Price on Carbon	Bernard, Robert	Microsoft	2012
Iger: Disney Units Pay Carbon Tax	Carlton, Jim	Wall Street Journal	2012
Google's Energy Strategy Revealed	Carus, Felicity	AOL Energy	2012
The Nation's First Green Infrastructure Portfolio Standards	N/A	Center for Neighborhood Technology	2012
Welcome to the Green Values® Stormwater Toolbox	N/A	Center for Neighborhood Technology	2012

Analogue Research Title	Author	Publisher	Year
Green Infrastructure Portfolio Standard Retrofit in Action	N/A	Center for Neighborhood Technology	2012
Green Infrastructure Portfolio	N/A	City of Grand Rapids	2011
Habitat Conservation Banking: Profiting from Endangered Species	Hay, Darald J.	Journal of Forestry	2010
Australia's readiness for a low-carbon future: 2012 progress report	N/A	The Economist	2012
Renewable Portfolio Standards Fact Sheet	N/A	U.S. EPA	2012
Innovation in Pre-listing Species Conservation: Conservation Banking for Candidate Species	Gartner, Todd et. Al.	World Resources Institute	2012
Shell Takes Action on Global Warming	Harris, Clare	Shell	2012
Green Revolving Funds : An Introductory Guide to Implementation and Management	Indvik, Joe et. Al.	ICF International	2013
Case Study: Tulane Uniersity	N/A	Johnson Controls	2011
Building Efficiency	N/A	Johnson Controls	2012
Energy Efficiency Financing: Models and Strategies	Kats, Greg et. Al.	Capital-E	2012
Biodiversity banking: a strategic conservation mechanism	Kumaraswamy, S. and M. Udayakumar	Springer	2010
Becoming Carbon Neutral	N/A	Microsoft	2012
A Survey of the U.S. ESCO Industry: Market Growth and Development from 2008 to 2011	Satchwell, Andrew et. Al.	Lawrence Berkeley National Laboratory	2010
Innovative Green Infrastructure Tools	Sprague, Hal	Center for Neighborhood Technology	2011
EPA Brownfields Revolving Loan Fund Grants	N/A	U.S. EPA	2009
Financing Stormwater Retrofits in Philadelphia and Beyond	Valderrama, Alisa et. Al.	NRDC	2012
Emissions Trading to Reduce Acid Deposition	Van Dyke, Brennan	The Yale Law Journal	1991
An Awakening in Energy Efficiency: Financing Private Sector Building Retrofits	White, Peter	Johnson Controls	2010
Microsoft Taxes Itself	Winston, Andrew	Harvard Business Review	2012
Interview with Walt Disney Company Senior Vice President Beth Stevens	Young, Eric	NRDC Switchboard	2010

Appendix C

Summary of Cross-Basin Institutional Identification and Classification Research Collaboration

As a major component of our exploration of the "policy response" category, as opposed to technological and management responses (see "Determining the Approach"), we undertook a basin-scale water governance research project in collaboration with The Nature Conservancy (TNC). Through this work, the team set out to explore the potential for policy responses to meet the goals of our project, while also contributing to the policy analysis work of TNC as part of the broader TNC-Dow collaboration. The team worked with TNC to define a set of research questions that would inform a larger cross-basin institutional analysis that was then getting underway at TNC. While the team's work on this particular research subject did not end up being integral to our pursuit of a creative approach to corporate water scarcity management as informed by natural resource management analogues, we learned a lot from this research endeavor and therefore include a summary of our work in this Appendix.

Aim of the Research Collaboration

The purpose of our cross-basin analysis was to provide an idea of potential future institutional and market price conditions for water in a specific set of locations. We set out to accomplish this by analyzing and categorizing the different institutional arrangements in basins with different water scarcity and general governance conditions. Our work involved the following general steps, as informed by a selection of existing journal articles on institutional and governance systems categories, and our own research into the governance, institutional, legal and community context of each specific location:

1. Define the categories for water institutions and pricing mechanisms
2. Categorize institutions and pricing mechanisms in the selected basins
3. Compile a detailed summary of how these different water institutions and pricing mechanisms work and what the implications may be for businesses

Research Outcomes

Our research revealed a wide range of institutions governing freshwater access and use. We began by placing each relevant institution into one of three governance categories:

- Regulatory authority over water use and treatment (access, distribution, discharge, quality)
- Water provisioning (i.e., infrastructure & maintenance--usually municipal or public-private partnership)
- Water advocate / influencers (e.g., citizens groups, watersheds protection NGOs; often the drivers of collective action, the ones who hold others accountable or the ones who

facilitate coalitions)

Further, we found that regulatory aspects are usually addressed at local, state and national levels and sometimes internationally, as well. Even at the local and state level, we found that governance may be controlled by an individual entity or a group of entities (e.g., Great Lakes Council of Governors). Regulatory authority is usually driven by the government, but is occasionally agreed upon as part of a voluntary agreement amongst watershed inhabitants or other stakeholders. We also found that regulations have different authority and accountability depending on how the regulation was enacted, such as by decree, treaty, or legislation.

As well, we found that "governance" categories themselves are not usually collective, market or state as discussed in the literature, but rather a combination of state plus one of the others (we did not encounter a situation in which the state is entirely uninvolved). Thus we re-defined our governance categories to be:

- State-collective
- State-market
- State-collective-market
- All of the above with different combinations of local, national, international

Additionally, we discussed how broadly water governance should be defined. A governance regime could encompass just the actors and institutions that have direct control over water resources or it could also be considered to include non-authoritative actors, e.g., related advisory bodies, or stakeholder groups.

Key Challenges Encountered

In the course of conducting this research and categorization work, we found it difficult to access available information on each basin's specific institutions at the level necessary to inform our project. With many overlapping jurisdictions and numerous governance regimes possible within any single basin, it was difficult to identify Dow-relevant governance information from a basin-level approach. As a result, we shifted from a basin-level approach to a site-outward approach, in which we sought information specific to each Company site, starting first with local institutions and moving out to more broad scales as necessary.

In addition, many water governance institutions are often not spatially compatible with the ecologically relevant spatial extent. This mismatch further complicates the utility of making policy-based recommendations because Dow itself operates at a totally different spatial level that also does not match either ecological or political boundaries.

The information we were able to collect (displayed in Table C 1, below) shows incredible variety in the governance of water. These results incited further discussion within the team and with our collaborators at TNC to explore the strength of the research collected, and the usefulness of the result for our overall project goals.

Ultimately, we determined that the time required for the team to pursue policy-based responses would detract from our ability to achieve the objectives of our project. As made clear by the diversity of institutions we documented governing freshwater access, any policy-based solution would only be applicable in one location and only while that specific layering of policies was in effect. We determined this was contrary to our goal of developing an organization-wide strategy that would also have longevity. Thus, the outcomes of this cross-basin governance research exercise provided further basis for the team to pursue management-based solutions, which the team felt provided stronger promise of developing recommendations that would be relevant across a multinational corporation and over time, regardless of any changes in the many layers of policies that govern freshwater access. However, we also recognize that the local institutional setting for any site can affect the options available within a management-based response. For example, the menu of options for addressing water scarcity through investment at a given corporate site may or may not include expanding access to the resource, such as via purchasing additional water rights, depending on the institutional regime in place.

Table C1: Summary of basin-level institutions and governance research results

Site Name / Basin	Water Distributor (Self / public utility / private utility / public-private utility)	Water Allocation (rights / market / state / hybrid)	Quantity Extracted (restricted / unresticted)	Basin Authority (law/agreement, municipal, state/province, international, state-federal, inter-agency)	Price Set By (utility / trading / state / withdrawal rights)
1	Public Utility	Rights	Restricted	Coalition	Withdrawal rights
2	Public Utility	Rights	Unrestricted	International law	Member states as governed by government directive
3	Public Utility	State	Restricted	State law	state (use charges for withdrawal from state-operated storage facilities)
4	Industrial partnership, Self	PPP agreement, rights	limited by WW source, limited surface water withdrawal rights	Mix of water agencies oversee portfolio of local surface water withdrawal	Surface water rights, maintenance and production costs paid by industrial users
5	Self	Rights: industrial use permit for withdrawals	Unrestricted (?)	State Division of Water, plus eight investor-owned water companies, 22 water associations, 117 water districts, and 92 municipal water utilities	Water district or association
6	Assumed Self	Rights	Restricted: per rights if riparian owner	Riparian rights owners or State (via Cooperative Endeavour Agreement)	Use rights or "Fair market value" deemed by State. Free if use demonstrated "public interest"
7	Assumed Self	Rights	Restricted	Riparian rights owners or State (via Cooperative Endeavour Agreement)	Use rights or "Fair market value" deemed by State. Free if use demonstrated "public interest"
8	Public Utility	State	Unrestricted	International agreement, multi-state law	Utility (?)
9	Public Utility	State	Unrestricted	International agreement, multi-state law	Utility (?)
10	Public Utility	State	Unrestricted	State-federal agency agreement	PUC
11				International law	

Site Name / Basin	Water Distributor (Self / public utility / private utility / public-private utility)	Water Allocation (rights / market / state / hybrid)	Quantity Extracted (restricted / unrestricted)	Basin Authority (law/agreement, municipal, state/province, international, state-federal, inter-agency)	Price Set By (utility / trading / state / withdrawal rights)
12				International law	
13			Unrestricted	State	River basin committee
14	Public Utility	State	Unrestricted	International agreement	Utility
15	Public Utility	State	Restricted	None	Utility
16	Utility	Rights	Unrestricted		Utility
17	Utility	Rights			Withdrawal rights
18	Self	Rights	Restricted		Withdrawal rights
19	Utility				Withdrawal rights
20	Public Utility	Rights	Restricted		Utility
21				Multi-state coaltion	
22	PPP Model	Hybrid	Unrestricted	International coalition	Utility

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