Milking Nature's Bottom Line

A Full-Cost-Accounting of Proposed CAFO Operations in Jo Daviess County, Illinois

LandenConsulting
Appreciating Nature's Value℠

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This report has been prepared
on behalf of,
and is dedicated to,
the land and people of
Jo Daviess County, Illinois.

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Executive Summary

Overview

An "industrial mega-dairy" (named Tradition Investments, LLC or Tradition Family Dairy, LLC) is attempting to site itself in the rolling hills of Jo Daviess County, a picturesque region of northwest Illinois, U.S.A., with a unique geology, geography, and ecology. The region retains a strong small-family-farming traditional rural identity. The project has been the subject of much controversy, with numerous objections having been raised on ecological and socioeconomic grounds. Like many business and public-policy decisions that are not explicitly being made with a sustainable 'triple bottom line' focus, the community's economic cost-benefit conversation has focused primarily on the economic benefits the facility could bring to the region. However, Concentrated Animal Feeding Operations, or CAFOs, frequently arrive with significant ecological and social costs. This report is aimed at bringing balance to the local policy-making conversation by explicitly accounting for the regional economic costs associated with CAFO-related ecological and social degradation.

By establishing an "ecosystem services risk model," we estimated the risk of CAFO-related impacts to the ecosystem services being examined. We also projected the economic consequences that could be expected to affect the community, supporting businesses, and its workers. The analysis showed that the TID CAFO would have a significant impact, resulting in a net one-time loss of $2.30M and annual losses of $5.07M every year thereafter to the community (see Table 1).

The rolling hills of Jo Daviess County (P.Fraterdeus)

Table 1. The Balance Sheet

One-Time Benefits	Annual Benefits
$7,012,403	$2,115,400
Avg. One Time Cost	**Avg. Annual Cost**
($9,307,508)	($7,187,073)
Net One-Time Impact	**Net Annual Impact**
($2,295,105)	($5,071,673)

The Integrated Accounting Approach

In the past, economic progress was measured purely in production-driven measures such as Gross Domestic Product. However, these measures do not account for the costs (and benefits) of the natural and social capital embodied in the ecosystems and people that help generate the economic output being measured. Nor do measures such as GDP account for degradation to natural and social capital, which if left unchecked, could impact the ability of the economic system to continue producing. In particular, the value of externalities (impacts to other stakeholders beyond the immediate entity being measured) are often not accounted for in making either a project design or management decision or a go/no-go decision for a new development.

However, continuing developments in ecological and economic science are changing this situation. We can now more accurately assess the effects of the ecological damage that unsustainable development inflicts. Furthermore, on the economic accounting side, numerous private- and public-sector initiatives are underway which are integrating a full-cost-accounting approach that incorporates economic, ecological, and social factors into the decision-making process. This report brings this integrated perspective to the Tradition Investments CAFO, examining the

potential economic costs associated with CAFO-related ecological and social degradation.

The regional context

The Tradition Investments Dairy (TID) CAFO would be situated in Jo Daviess County, Illinois, which is a rural county characterized by thin top soil and fractured bedrock that is particularly picturesque, due partly to its location in the Driftless Region, a unique geological area known for its scenic views, rolling hills, thriving tourism industry, and rural family-farming character. In Illinois, the average dairy herd is 116 cows (Leavitt 2010). The TID site is planned to contain 6,850 head, and would be located in Nora, a small village that is located alongside the Stage Coach Trail which is a historic scenic drive and tourist destination. Site construction for TID began in 2008 and leachate discharges into a tributary of the popular Apple River have been detected four times according to area residents (on one occasion the discharge turned the tributary bright purple). State and federal agencies have now become involved (along with a local nonprofit opposition group that formed specifically to keep the facility out of the region) and at the time of this writing the TID purple discharge case is now being prosecuted.

Our Approach for this Study

To examine the CAFO's risks and negative effects on ecosystem sustainability, human health, and community economic development, we use an ecosystem services framework. We examine the following ecosystem services: freshwater provisioning, water purification & waste treatment, air quality regulation, global climate regulation, tourism, recreation, ecotourism, biodiversity, and various cultural and social services impacted by ecological degradation. The research approach included an extensive review of the literature, along with analysis of primary and secondary extant data, contingent valuation studies and benefits-transfer calculations, localization of non-local data, regression analyses and risk estimates. In order to solidify the assumptions made in this analysis, we have prepared a list of future research items that can be undertaken to narrow the range of uncertainty involved in our estimates.

Our CAFO Risk Model

We created an "ecosystem services risk model" where we arrived at a set of basic assumptions that were used to estimate the risk of CAFO-related impacts to each of the ecosystem services being examined. For situations where the relationship between the CAFO and a particular ecosystem service has been established qualitatively but not previously quantified, we utilized a sensitivity analysis which modeled a 1% decrease or degradation (dependent on the ecosystem service) in the ecosystem service. Many of our risk estimates can be viewed as lower-bound or conservative.

Environmental costs of the TID CAFO

We modeled the risks presented by the TID CAFO to the following ecosystem services: Freshwater provisioning (groundwater availability and quality), water purification and waste treatment (effluent impacts to biodiversity-based tourism & recreation), air quality regulation (health impacts) for CAFO workers and the surrounding communities, global climate regulation, tourism, property values and tax revenue, recreation and ecotourism (fishing and wildlife watching), biodiversity and habitat/refugia (threats to endangered/threatened species populations). The total one-time economic cost to the community associated with these environ-

mental risks was between $2.71M – 2.74M, with an additional annual cost between $2.25M – 10.06M.

Cultural and social costs of the TID CAFO

We modeled the cultural and social costs posed by the CAFO, in the following areas: environmental identity and the psychological health of the community, the cost of social upheaval, independent dairy displacement, road repairs, and stewardship expenditures. The total one-time economic cost to the community associated with these cultural and social risks was $5.42M – 7.75M, with an additional annual cost between $0.91M – 1.17M.

Economic benefits

CAFOs do have economic benefits associated with them. To provide a balanced assessment of the full costs and benefits of the TID CAFO project, we reviewed the projected economic benefits, to allow us to put economic, ecological, and social costs and benefits for this project all on the same balance sheet. Our analysis shows total one-time benefits to the community, supporting businesses, and workers from the CAFO of $7.01M with annual benefits of $2.12M from new income, jobs, and taxes.

Conclusion: Putting Nature on the Balance Sheet

In the short run, if ignoring the ecological and social costs, the implementation of TID may appear to have economic value. However, the long term environmental, social, and economic costs associated with the CAFO do not support this view. Even with a highly conservative estimate of a 1% impact for several of the ecosystem services affected, TID still demonstrated a one-time cost ranging from $8.13 to $10.48 million (avg. of $9.31M), and annual community impact costs ranging from $3.15 million to $11.22 million (avg. of $7.19M). The benefits derived from the TID operations are estimated to be $7.01 million in one-time investment and $2.12 million in annual economic benefits from new income, jobs, and taxes. This totals up to an average net regional economic one-time cost of $2.30 million, and an average net annual cost of $5.07 million.

The Integrated Accounting Approach

In the past, "progress" was measured purely in terms of economic benefits – in macroeconomic terms, the corresponding measure is Gross Domestic Product. The situation of externalities (costs that an economic activity exacts on actors beyond the scope of the immediate economic actor) were not accounted for. In earlier times, when more of the biosphere and ecosystem was intact, and humans were but a blip on the radar screen compared with the immensity of the surrounding environment, perhaps this narrow-focused system of economic accounting was sufficient. A market failure, yes, but Nature had plenty of capacity to absorb the ecological costs inflicted, so the externality was never accounted for and this narrow method of accounting, along with the unrestrained development it supported, continued apace.

Today, the situation is different. Recent scientific assessments (such as the Millennium Ecosystem Assessment and the Heinz Center's State of the Nation's Ecosystems report) are informing us that Nature's ability to absorb our impact is limited, with 60% of global ecosystem services having been significantly degraded over the past 50 years. Even in the resource-rich USA, with the world's strongest environmental laws, at least 30% of our nation's biodiversity and species are at risk. Recent estimates suggest that unsustainable development is

chipping away at the base of "natural capital" that our economy and society depend on – however in the past we have received the benefits of this natural capital (also known as ecosystem services) for free, so we have not valued them nor included them in our statements of accounts, when in fact the benefits that nature provides us are priceless.

However, this classic market failure is in the process of being corrected: as policymakers are becoming increasingly aware of the economic and social costs of ecosystem degradation, they are beginning to adopt a more integrated approach to decision-making, one that takes a full-cost-accounting perspective, to put all factors on the table, to put natural and social capital on the decision-making balance sheet.

This move towards integrated/full-cost accounting is happening at many levels: the Prince of Wales's Accounting for Sustainability project brought new focus to the idea of corporations including environmental and social costs (and benefits) in their mainline financial reporting. This pilot project has been extended with the work of the International Integrated Reporting Committee, which is reforming global standards for corporate financial accounting and reporting, to include the costs of natural and social capital on a company's main balance sheet. Similarly, the Global Reporting Initiative (the global standard for companies to report on sustainability issues) includes economic, environmental, and social reporting components. And, the World Bank has initiated a pilot project where national governments will start including the value of natural ecosystems on their journal of national accounts.

A bit closer to the immediate CAFO issue, the U.S. National Sustainable Agriculture Standard (under development at the time of this writing) is adopting a "triple-bottom-line" approach, where the economic aspects of farm-related ecological and social factors are being put on the farmer's balance sheet. Indeed, a recent study of global agriculture (International Sustainability Unit 2011) concluded that the market price of food does not reflect the true costs of its production, once subsidies and environmental & social damage are taken into account. These costs to society and the ecosystem need to be accounted for when setting policies for continuing or expanding agricultural operations.

As the scientific and economic aspects of ecological sustainability (or un-sustainability) are coming to light, enlightened policymakers are responding by including environmental and social costs (or benefits) into their policy-making decisions. For example, the "Genuine Progress Indicator" used by the State of Maryland, which includes environmental and social factors in the index used to report the state's development progress.

It is this modern full-cost-accounting perspective that this report brings to the Tradition Investments project – a review of public presentations to date indicates that proponents of the project are only pitching the assumed economic benefits to the community – however the economic costs of the ecological and environmental issues associated with CAFOs have not been adequately addressed in the local policymaking conversation. Since the CAFO in question is currently mired in regulatory challenges, this report is aimed at giving policymakers a full set of data with which to make a go/no-go decision that is in the best economic, ecological, and social interests of the region that the CAFO would directly impact.

Regional Context

Jo Daviess County is located in the northwestern corner of Illinois in the Driftless Region. The area is known for its scenic views and rolling hills, is a popular tourism and recreation destination, and retains a rural small-town family-farming character where the average dairy herd size is approximately 116 cows (Leavitt 2010). The entire region sits atop a geological foundation known as karst, which is a permeable and fractured limestone rock formation that is particularly porous and susceptible to water quality issues. This region was not glaciated and thus has very thin topsoil, as do other similarly unglaciated regions in Wisconsin. In such regions, well contamination issues have resulted in water from one in three wells not being fit for consumption (Alschuler 2012).

The Tradition Investments Dairy (TID) is a Concentrated Animal Feeding Operation (CAFO) planned to contain 4,464 milk cows and 1,000 heifers or 6,850 animal units (AU). The US EPA defines a dairy CAFO as an operation containing at least 700 mature dairy cattle (EPA 2011). In 2011 the average Illinois dairy herd was 116 cows (Leavitt 2010). The TID CAFO was originally planned as two separate dairies (North and South), containing twice as many total cows, and while plans for the North dairy have since been withdrawn, expansion of the CAFO remains a concern (Alschuler 2012). The TID CAFO would be located in Nora, a small village in Jo Daviess County, Illinois, located on the historic Stage Coach Trail, a popular scenic drive and tourist destination.

TID would be immediately proximate to two villages in Jo Daviess County, Nora and Warren, IL. Nora is a small village, 0.9 miles away from TID, with 69 households (an estimated population of 113). The entire village of Warren, a slightly larger village with 765 households (1,356 people) is located within a three mile radius of TID.

Site construction for TID began in June 2008 and according to area residents the CAFO has since

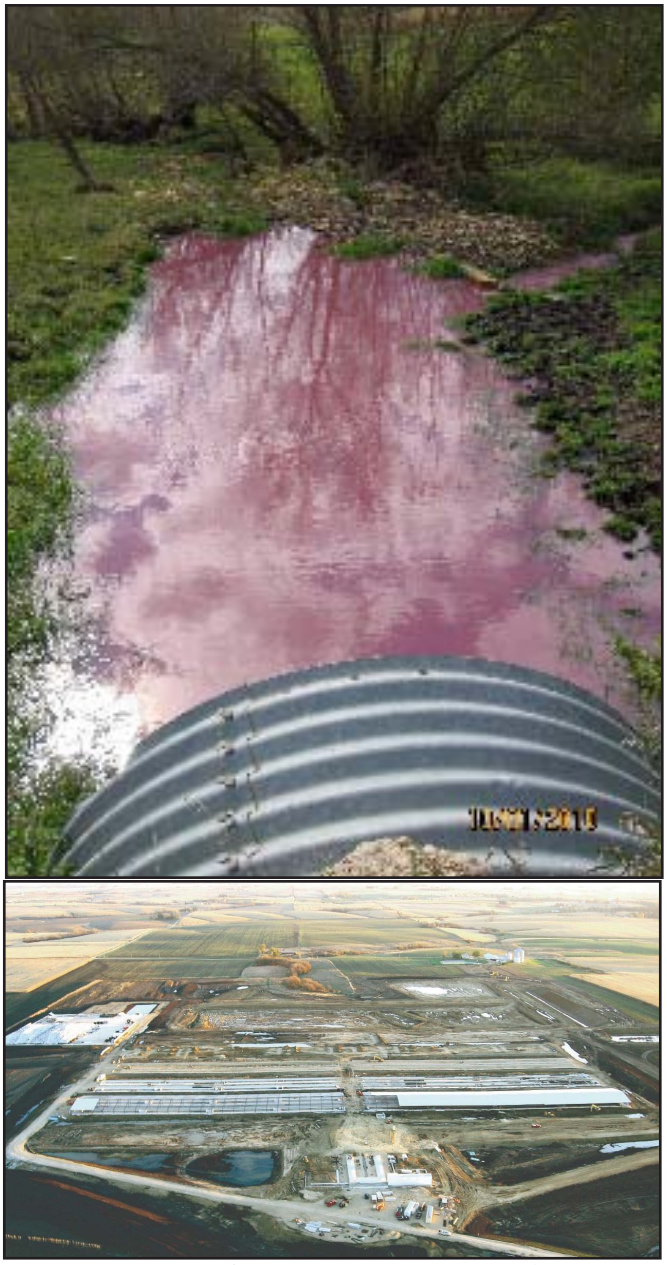

Figure 2. Images from (HOMES 2008; Brunwasser 2011)

discharged silage leachate into a stream leading into the Apple River Tributary four times (Hardin 2008; Brunwasser 2011) attracting the attention of both the state and federal government. Since April 2011, the IL Attorney General has gotten involved, requesting a discharge permit and levying a significant fine. The US EPA has also begun asking questions of the facility and is asking for a dye-

tracing test. To-date the requests have not yet been fulfilled. (Brunwasser 2011).

Our Approach For This Study

The following analysis addresses the true cost of TID by examining the risks and negative effects on ecosystem sustainability, human health, and community economic development, using the ecosystem services framework as the lens for our analysis. Ecosystem services (which gained increasing visibility with the publication of the Millennium Ecosystem Assessment in 2005) are the benefits that natural ecosystems provide to human society and industry. Healthy ecosystems provide a range of benefits (including water purification, flood control, biodiversity and wildlife habitat, pollination, and recreation), and as ecosystems are degraded, the ecosystem services they provide are degraded as well, which can impact a region's social and economic well-being. Ecosystem services are increasingly being used as a corporate and public sector policymaking tool, as the ecosystem services approach frames environmental issues in terms that are directly relevant to other regional stakeholders.

The ecosystem services examined in this analysis include:

- Freshwater provisioning
- Water purification & waste treatment (for human health and biodiversity/recreation)
- Air quality regulation (human health)
- Global climate regulation
- Tourism
- Recreation & ecotourism (angling and wildlife watching)
- Biodiversity
- Cultural and ethical values (the social costs of ecosystem degradation)
- Cultural services – existence value

CAFO Risk Model

This section of the analysis provides the assumptions used to estimate the risk/likelihood of environmental and social effects associated with TID. The assumptions we used in this CAFO risk model are being used as the inputs to the cost calculations in the following sections. In this section we will review some of the literature surrounding each risk area/ecosystem service, and will then explore local factors that helped us target our risk estimates. In many cases, there exists uncertainty surrounding ecological thresholds and the conditions that result in sudden changes to an ecosystem's state. This limited knowledge surrounding both the external circumstances that may lead alternative ecosystem state and the manner in which individuals and communities may react (Knight 2002 in Daly 2004) necessitates a risk model approach to this study.

It should be mentioned that there is ample support in the scientific literature that CAFOs often cause impacts to the ecosystem services discussed here. However, this preliminary study has not attempted to rigorously model the precise impacts that the specific TID site could cause for every service affected – instead for this preliminary analysis, we conservatively estimated the ecological impacts, many of the following estimates can be viewed as lower-bound. Particularly, for many of the ecosystem services, we chose to estimate conservatively and assumed that any negative impacts of the CAFO would cause only a 1% decrease in the level of ecosystem services provided by the surrounding ecosystem. (When the relationship between the CAFO and ecosystem service has been established qualitatively, but not previously quantified, this study used a sensitivity analysis in which the effects of a 1% change in the

service provided were calculated to determine the potential incremental cost to the community.) All estimates based upon willingness to pay surveys were adjusted for inflation and per capita income. Furthermore, there are also some intrinsic and sacrosanct dimensions of nature that some believe should remain outside the purview of humanity.

Healthy ecosystems provide a range of benefits (including water purification, flood control, biodiversity and wildlife habitat, pollination, and recreation), and as ecosystems are degraded, the ecosystem services they provide are degraded as well, which can impact a region's social and economic well-being.

It is important to acknowledge that such cultural and landscape values exist to certain aspects of the population even if a dollar value is not provided for them.

See the "Further Research Goals" section below for additional discussion.

Tradition Investments, LLC presents the following risks to the people and land of Jo Daviess County:

FRESHWATER PROVISIONING – WATER TABLE DRAW-DOWN:

The TID CAFO is part of a growing movement of large-scale dairy operations from further west into the Midwest and High Plains regions. These operations are now expanding beyond California into more nontraditional dairy states for a variety of reasons including: stronger air and water quality regulations in California, more space, ample land availability (with the potential for expansion) for manure handling in the Midwest and High Plains, feed and transportation costs (it costs $1/bushel to transport cattle feed-grain west), and a more suitable climate (Harrington 2010; Hardin 2011). Indeed, there has already been discussion of other California CAFOs joining Bos in the area should TID prove successful, according to local knowledge and belief (Alschuler 2012).

However, one of the most significant drivers of the eastward migration of large-scale dairy operations, from the west, is water requirements. In some coastal areas of CA, the unsustainable mining of the water table is becoming a significant problem (Alvis 2008). Furthermore, dairy CAFOs necessitate great deals of water, especially in extreme climates, and eastern states can more readily provide for these water needs, at least in the short-term (Reisner 1986; Harrington 2010). These water needs include drinking water for cows, and water for waste management and for cooling the animals off in the summer months. Harrington et al. (2010) estimate that, in certain parts of Kansas, the state has the ability to support such dairy expansion for several decades, or until the 2020s when the authors hypothesize that the issue of groundwater depletion will overtake other economic challenges within the dairy industry.

A.J. Bos has estimated the scope of his TID operations at 6,500 AU consisting of 3,500 milking cows (4900 AU), plus dry cows and replacement heifers (Bos 2008). Assuming the remainder of Bos' operation is evenly divided amongst dry cows

and heifers, we can estimate the direct water usage at:: 147,250 to 212,125 gallons per day in direct (drinking water for animals) and indirect water usage (milking system and parlor clean-up, milk bulk tank clean-up, prepping cows for milking, and milk pre-cooling) (Thomas). Furthermore, waste flushing practices will also require in excess of 150 gal/d/cow (Soil Conservation Service 1992) or 810,600 gallons per day for a total range of 957,850 – 1,022,725 gallons per day. Indeed, this range is consistent with the estimate arrived at by Pete Hardin, editor and publisher of The Milkweed - a dairy reporting publication, who has written that TID will require up to 1 million gallons of water per day from the local water tables in Jo Daviess County (Hardin 2008). This withdrawal rate is more than the nearby towns of Nora, Warren, and Stockton combined (Alschuler 2011) and has been described by some as "sink a well and pump like hell."

This rate of groundwater extraction is of particular concern to area residents due to fears of a significant, disruptive, and long-lasting impact on their water supply (O'Neil 1990). Such concerns are not unfounded. The northeastern section of Jo Daviess County in which Nora, Warren, and TID are located are served primarily by shallow bedrock aquifers within 500 ft. of land surface and by deep bedrock aquifers at depths of more than 500 ft of land surface. Both of these aquifers are considered principal Illinois aquifers and are defined as having potential yields exceeding 100,000 gallons per day per square mile (gpd/mi2) and covering more than 50 mi2 (ISWS 2011). The potential yield of an aquifer is the amount of groundwater that can be consistently withdrawn without (a) surpassing the recharge rate and (b) establishing a dangerously low water level. In the northeastern section of Jo Daviess County we estimate the aquifer yield at between 100,000-200,000 gpd/mi2; areas with this level of yield are colored red in the figure below (ISWS 2011). Even with this seemingly plentiful water supply, with an estimated demand of 1M gallons per day over 1,400 acres (2.19 mi2), this withdrawal rate is 2-5x that of the safe and sustainable yield determined by the Illinois State Water Survey (ISWS 2011) and would mine the region's groundwater immediately (Interagency Coordinating Committee on Groundwater 2000). Indeed, many of the private wells in Nora and the surrounding area are older and shallower than most and thus would likely be more easily depletedby CAFO-related extraction (Alschuler 2012).

Furthermore, climate change models have indicated higher temperatures and rates of moisture

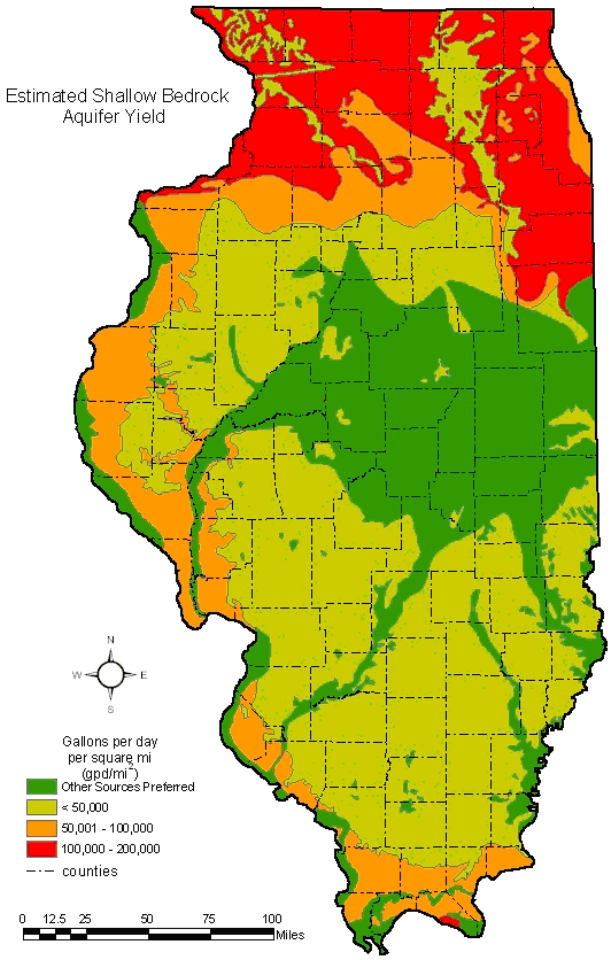

Figure 3. Illinois Estimated Aquifer Yields

loss and decreased regional precipitation in the next thirty to one hundred years which could further decrease groundwater availability for both resident populations and independent dairy producers (Harrington 2010).

Risks to the ecosystem service of water provisioning (availability):

We estimate TFD's ground water withdrawal rate at two to five times the established safe and sustainable rate.

FRESHWATER PROVISIONING – DAMAGE TO REGIONAL WATER QUALITY:

Yet another risk to the environment is the leakage of wastewater from holding ponds/lagoons which is both allowed (Weida 2000) and expected at TID and could expose communities to pathogens, sediments, hormones, antibiotics1, and nitrates (Elgethun 2007; Hribar 2010). Senior agriculture engineer, James Evans, has estimated an initial loss of approximately 1,000 gallons per acre per day for the TID holding ponds (Evans, 2008 in Francis 2008; HOMES 2008). This would equate to 42,000 gallons per day or over 15 million gallons per year of waste leakage from the 42 acres of manure ponds planned for TID, though Evans has stated that this may be mitigated to 50 gallons/acre per day (2,100 gallons per day or 766,500 gallons per year) over time. Furthermore, Warren Goetsch, Bureau Chief of Environmental Programs for the Illinois Department of Agriculture, has stated that the design standard to which the TID holding ponds have been constructed would correspond to seepage of 0.25 to 1.00 inch per year (Mapes 2008) or 0.02 – 0.07 mm/day. However, a recent study by Kansas State University of 20 animal waste lagoons (14 swine, five cattle, and one dairy) showed that 75% of the lagoons had seepage rates of 0.3 - 1.6 mm/day (Ham 2002), 15 - 22x greater than Goetsch's estimates (Ham 2002).

Nitrogen

Plumes of ammonium-N have been documented beneath multiple older dairy and cattle feedlot sites, in Kansas, to depths over 10 feet (Volland 2003; Hribar 2010) and researchers at Kansas State University (Ham 2001 in Volland 2003) have estimated that wastewater lagoon seepage at cattle feedlot impoundment or dairies could accumulate 15,200 lbs. of ammonium-N per acre over 25 years (Ham 2002; Volland 2003).[2] At 15,200 lbs. per acre, this would translate to a total build-up of 638,400 lbs. of ammonium-N beneath TID across 42 acres. As of December 2009, in New Mexico, 57.1% of dairies had nitrate-nitrogen contamination in their groundwater resulting from sources at the facility itself (New Mexico Environmental Department 2010). Increased levels of nitrates in drinking water can have deleterious health effects on both infants and adults. Elevated nitrates can cause blue baby syndrome (shortness of breath and blueness of skin) and possible death in infants; similarly, nitrates can lead to low blood oxygen in adults and subsequently birth defects, miscarriages, and decreased overall health (US EPA 1995; Hribar 2010). In one study, the odds of a Minnesota's resident's well having elevated nitrate levels (> 10 mg/L) (versus not having elevated levels) was increased by a factor of 6.13 in wells where

1 In Iowa and Ohio, 31-67% of water samples taken near CAFOS had antibiotics in them (Henning, L. (2011). Factory Farm Impacts: Fact Sheet.), however the US EPA has no maximum level associated with antibiotics.

2 The average depth of these lagoons (from five cattle feedlots and one dairy) was 5.5 ft. or about one quarter of the depth of the 20 ft. deep TID lagoons. This estimate assumes an average leakage rate of 1.1 mm/day for 20 animal waste lagoons (14 swine and six cattle) measured.

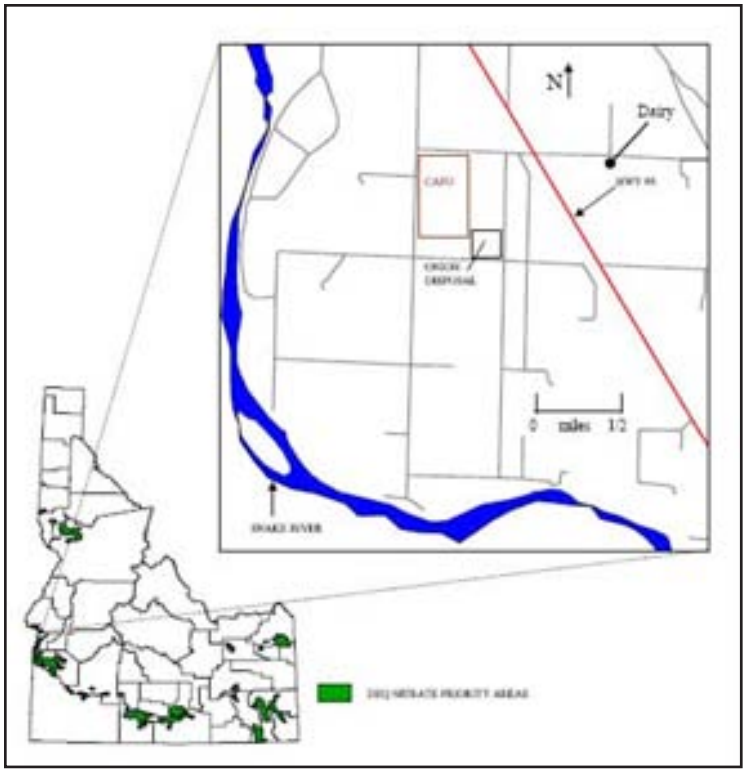

Figure 4. Sunnyside CAFO Project Area

proximate (within 0.25 miles) principal land use was agricultural (Lewandowski 2008). Similarly, in a health consultation by the Idaho Department of Health and Welfare, researchers found that 2/3 of the 36 wells tested within a 1 by 3 mile area (see Figure on right) surrounding a CAFO in the Sunnyside area had elevated nitrate levels (Elgethun 2007). Furthermore, a 2011 study of by the MPCA (Minnesota Pollution Control Agency) showed that nutrient plumes of nitrogen and phosphorous are capable of traveling horizontally up to 200 ft. from CAFOs that utilize earthen basins (Fairbairn 2011; Lewandowski 2011). Elevated nitrates in animal's drinking water can also lead to miscarriages in livestock and the death of calves (Alschuler 2012).

Pathogens

Fecal waste from TID cows may contain pathogenic microorganisms that can have severe health and economic impacts upon the surrounding community. Indeed, according to multiple surveys, as many as 10-50% of cattle may contain Salmonella, Listeria, E. coli O157, Campylobacter, Giardia and Cryptosporidium at any one time. Wells that are located near a manure application area face a greater risk of fecal bacterial contamination (Conboy and Goss, 2002 in US EPA 2005) and even wells further away may be at risk as bacterial pathogens can move great distances both beneath land surfaces and downstream of a lagoon (Withers 1997 in US EPA 2005). Indeed, a study in Iowa conducted by the Center for Disease Control (CDC) found that amongst nine swine CAFOS, cryptosporidium parvum oocysts was detected in lagoon monitoring wells proximate to the waste lagoons of 1/3 of the CAFOs, though these wells were not in locations in which negative human health outcomes could be assumed. Similarly, c. parvum oocysts were found in a river adjacent to 1/9 of the CAFOs (CDC 1998 in US EPA 2005). In another comparative study of water quality patterns near CAFO waterways and reference sites, the highest levels of fecal coliform densities were found at the agriculturally impaired sites near CAFOs (West 2010). Indeed, a WI rivers report found that the field application of manure further away from a CAFO is a reason often found to contribute to well contaminations in the state (Alschuler 2012).

Given the controversy of whether or not TID is sited atop karst bedrock, a landscape marked by a porous, fractured rock, sinkholes and caves (Hardin 2008), any wastewater leakage into groundwater sources could be especially problematic. If the site does sit atop karst (like the rest of the region), spills or seepage could contaminate groundwater, miles away, in only a few hours (Panno in HOMES 2008). Furthermore, as illustrated by Figure 5 below, a great deal of Jo Daviess

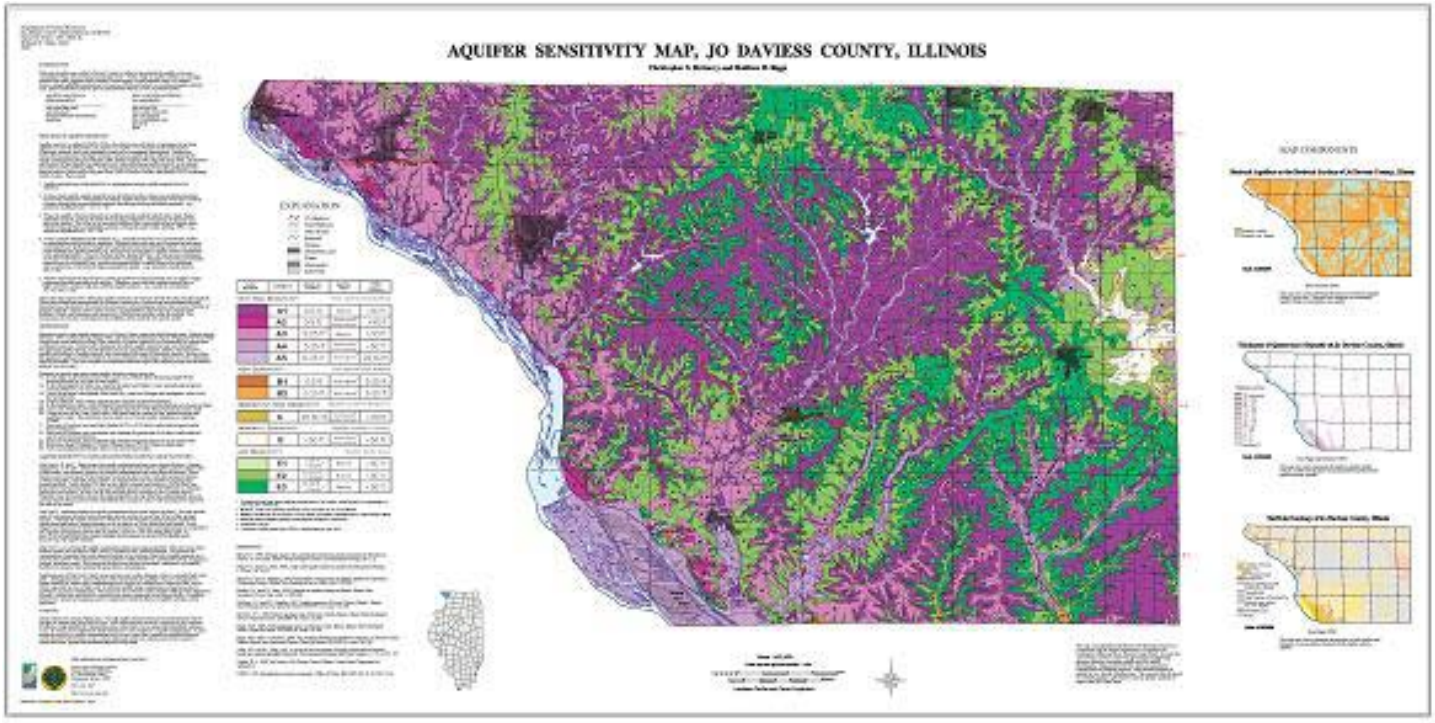

Figure 5. Aquifer Sensitivity Map, Jo Daviess County, Illinois

County has very high aquifer sensitivity due to fractured and exposed dolomite bedrock and sand and gravel aquifer materials located close beneath land surfaces. Much of the upper right quadrant of this map, in which TID lies, contains very high sensitivity geologic materials that can enable contaminants to enter into an aquifer with ease. Such very high sensitivity aquifers may only be 0-25 feet beneath land surfaces, well within the reach of TID waste lagoons. Furthermore, soil levels onsite are estimated to be only 8-20 feet deep, while comparatively, some areas of southern Illinois are estimated to have 150-200 feet of clay over bedrock (Alschuler 2012)s. Very high sensitivity aquifers in this county are depicted as purple and low sensitivity aquifers as green (Shilts 2000; Hardin 2008).

Of immediate concern are households in Nora and Nora Township which are all served by private wells (Hardin 2008). Subsequently, residents of these areas may be forced to take reactive measures to ensure their water from private wells remains below the EPA health standard maximum of 10 mg/L nitrate-nitrogen, though the cost of many of these measures may be unaffordable. These may include installing a nitrate removal system, drilling a deeper or new well, or purchasing bottled water for drinking and cooking (Lewandowski 2008; Portage County 2008), though the latter would be impractical for livestock-related uses. Further complicating the situation is the fact that many of the existing wells in these areas are not up to code, i.e. they are too old, too shallow, or both, and thus if the wells become contaminated as a result of CAFO-related activities, the owners will likely have no recourse (Alschuler 2012).

Risks to the ecosystem service of water provisioning (quality):

There exists a 75% risk of approximately 638,400 lbs. of ammonium-nitrate seepage (over 25 years), a significant odds increase (by a factor of 6.13) in the likelihood of a well within 0.25 miles of the CAFO containing elevated nitrate levels above federal drinking water standards (>10 mg/L), and an esti-

mated 67% chance of elevated nitrate levels within three miles of TID. We also estimate an 11% likelihood of cryptosporidium parvum contamination (6 oocysts per L) within the Apple River, directly adjacent to TID (CDC 1998).

Water purification and waste treatment:

The overfill of CAFO lagoons from storms or floods and water traveling through ditches, drainage or flushing systems could also contaminate surface water, causing increased nitrogen, phosphorous, ammonia, hormones, and antibiotics. Indeed, ammonia levels from animal waste in TID holding ponds could generate tons of ammonia compounds annually leading to oxygen depletion and nutrient overloads in local water bodies [3] (Hardin 2008; Hribar 2010). In 2008, the EPA's National Water Quality Assessment Report estimated that 838.7 miles of rivers and streams were threatened or impaired by animal feeding operations (634.1) and livestock grazing or feeding operations (204.6) (EPA 2008) with the number having more than doubled since 2002. This same 2008 report estimated that 1,283 acres of lakes, ponds, and reservoirs in Illinois were currently impaired by livestock grazing or feeding operations(EPA 2002). These impairments included several pollutants associated with CAFOs (Hribar 2010) including: nitrates, pathogens, nitrogen, phosphorous, ammonia, sedimentation, and metals (EPA 2002). Some or all of these pollutants may continue to enter into the Apple River Tributary through a stream on the TID site (Weibel 2011); the effect of repeated discharges since 2008 have resulted in elevated biological oxygen demand (BOD) levels (2,200, 150, 50, 400 mg/L) in the tributary (Alschuler 2011).

Figure 6. Major Watersheds of Illinois

Arrow shows approximate location of proposed CAFO.

Though it is recommended that the liquid level in a manure lagoon be kept no higher than within one foot of an emergency spillway (University of Minnesota Extensions 2012) there have been over 1,000 violations and discharges in Michigan's Hudson-area CAFOs alone since 2000. One of these CAFOs, the Vander Hoff Haley Dairy was cited in 2004 for a discharge to Rice Lake Drain due to a "control structure" that significantly concerned Michigan's Department of Environmental Quality (ECCSCM 2012). Overflow tiles have also been reportedly installed into the TID site such that if a lagoon fills up to a certain height the tile may discharge directly into the waterway (Michigan Sierra Club 2011). Furthermore, as can be seen in Figure 6, TID (identified by the red arrow in Figure 6) is directly

3 In Boardman, Oregon, where another AJ Bos plant is located, until Y2008 there was no ammonia discharge monitoring at all (Hardin, P. (2011). Pete Hardin call notes 6/14. E. Landen.).

on the boundaries, and topographical highs, of two major watersheds, the Mississippi River Watershed (containing Apple River) to the west and the Rock River Watershed to the east causing further drainage concerns (McConkey 2000; Hardin 2011; McConkey 2011).

Risk of a chronic & consistent low-level manure or effluent leak:

100%. This is estimated at 42,000 gallons/day or 15 million gallons/year initially with potential for mitigation to 2,100 gallons/day or 766,500 gallons/year over time.

AIR QUALITY – ONSITE (WORKER DISEASE RISK)

CAFOS can also have deleterious effects on human capital in rural areas in the form of negative health impacts to workers (Ikerd 1999). Workers may be exposed to air pollutants such as ammonia, dust, and endotoxins, all of which have been correlated with negative health effects (Cole 2000). Researchers in Iowa found that almost 70% of U.S. swine CAFO workers showed signs of respiratory illness (2002 in Hagerbaumer 2006)[4]. Donham (2000 in Glasgow 2004) reported that 20-40% of all CAFO workers experience serious respiratory problems including chronic bronchitis, organic dust toxic syndrome, and sinusitis.

According to Kellogg Schwab, director of the Johns Hopkins Center for Water and Health, CAFOS are also exceptionally good incubators of resistant pathogens (Keiger 2009). The evidence of this can be found in over three decades of research into the association between resistance and antimicrobial growth promotants (Gilchrist 2007). 11.2 million kg of antibiotics are administered to livestock as growth promoters every year (The Union of Concerned Scientists in Gilchrist 2007) and at CAFOS, such antibiotics are often administered at low levels or at subtherapeutic doses. Administering these antibiotics for an extended period of time and in this low-level approach can build resistance in the bacteria; over time, the resistant genes may be passed to other types of bacteria (Levy 1998 in Gilchrist 2007), and colonize workers, co-workers, and friends and family, as the bacteria is transmitted (Gilchrist 2007). A major concern of Ellen Silbergeld, a professor of environmental health sciences at the Bloomberg School of Public Health, is that industrial agriculture is building a further enabling these microbes to resist various drugs and, thus strengthening resistance in animals, people, and the overall ecosystem. Furthermore, such resistance can be spread through air, water, animals, house flies, vehicles, and manure spreaders (Keiger 2009).

In addition, CAFOS may contribute to increase the risk of zoonoses, or diseases spread from animals to humans. Zoonoses are spread in much the same way as resistant bacteria: via air, water, consumption or handling of meat, and direct transmission from animal to human (Gilchrist 2007). Indeed, a study from 2002 to 2004 showed that water downgradient from a swine farm, when compared to water upgradient from it, had 17x the enterococci, 11x the E.Coli, and 33x the fecal coliforms (Keiger 2009). Dutch researchers have also reported on a young mother being treated for mastitis and whose cultures revealed MRSA: when her husband (a pig farmer) and daughter were also found to have MRSA, researchers took a random sample of ten of the husband's pigs from a population of 8,000 and 80% of the pigs along with three farm workers were found to have genetically identical MRSA (Keiger 2009).

4 Conditions such as whether the facility is enclosed or not, may differ at swine and livestock CAFOS and affect the health risks present at the site.

Risks to the ecosystem service of air quality regulation, manifested via onsite worker disease risk:

20-40% of TID workers could experience serious respiratory problems. Workers likely are at an increased risk of developing resistance to antibiotics utilized at the facility and of contracting zoonoses, though at this point there is not enough research to provide an estimate of risk attributable to the CAFO.

Table 2. Estimated WTP to avoid a 1% decrease in water use

Population	Personal Per Capita Income (2009)	Annual WTP	Total Annual Cost
Nora	$23,581	$0.78	$88.13
Warren	$21,437	$0.71	$961.41
Total			$1,049.54

Note. WTP and Cost columns in 2011$.

Note. Raleigh 2009 personal per capita income = $28,775 (McMahon 2011)

AIR QUALITY – REGIONAL (RESPIRATORY HEALTH)

While extended exposure to CAFO emissions can present an occupational hazard to workers, (Wall 2007; O'Connor 2010), such effects cannot simply be extrapolated upon neighboring communities as air pollutants may disperse or become less concentrated (Merchant 2002). However, any resulting health issues due to CAFO air emissions could become problematic given that rural populations can have more poor and elderly residents, two vulnerable subgroups (Merchant 2002; Hart 2005). One study of farmers and rural residents living next to a livestock CAFO in Iowa were found to have significantly higher rates (than a control group) of symptoms including sputum, cough, breath shortness, wheezing, chest tightness, nausea, weakness, dizziness, fainting, headaches, and plugged ears (Thu 1997). A recent systematic review of the association between animal feeding operations and community health found that there is evidence of up to a 300% increase in the likelihood of having a self-reported wheeze if one is strongly averse to odor and that individuals with a personal or family history of allergies could have up to a 10% increase in self-reported wheeze (O'Connor 2010). Mirabelli et al. (2006) also documented that lower socio-economic status was associated with proximity to a CAFO and strength of odor, putting poorer children and adults at risk for asthma-related health issues as a result of increased exposure to chemicals, dusts, and other airborne effluent. All of these studies, however, examined CAFOs with fewer AUs than TID.

Risks to the ecosystem service of air quality, manifested via regional respiratory health issues:

Estimated 1% increase in the asthma lifetime prevalence rate for the villages of Warren and Nora. The village of Warren, under three miles from the proposed TID site, is the location of a high school and a senior citizen/retirement home, both considered vulnerable populations (Pew p. 17 in Henning 2011).

AIR & WATER QUALITY – IMPACTS ON OTHER ECOSYSTEM SERVICES (NATURE-BASED TOURISM & RECREATION, CULTURAL & ETHICAL VALUES)

CAFOs negatively impact air quality in other ways as well, with odors detectable from up to six miles away (Hribar 2010). Indeed, odors and insects from CAFOs can limit the use and benefits accrued from a park or property negatively affecting its value (Kilpatrick 2001). It is apparent that CAFOs have hampered tourism in a number of cases. Researchers in Iowa believe that CAFOs may have disrupted tourism, recreation, and retirement

development in areas of Iowa with both natural amenities and high animal density and that recreational amenities and CAFOs cannot coexist (Flora 2007). In North Carolina, news of pollution in the Neuse River, resulting from CAFO waste, caused out-of-state residents to cancel plans to visit the state (Burns 1996). Another study of North Carolina public schools located near CAFOs concluded that livestock odors could negatively affect recreation opportunities at the school facilities. In order to mitigate such negative externalities, a circuit court judge in Missouri ruled that a CAFO could not be constructed within 15 miles of a state park, however, this decision was later amended to two miles and eventually overturned (Kennedy 2010). Jim Riedel, President of the Roaring River Parks Alliance of Missouri believes a 5-10 mile buffer from state parks would be appropriate for a livestock CAFO due to concerns over smells and the spreading of manure proximate to creeks, streams, rivers, and lakes, as most manure is spread within 10 miles of where it originated. However, even with such a buffer, given the karst topography in the region, water concerns with regards to state parks and recreation areas are pervasive (2011).

...lower socio-economic status was associated with proximity to a CAFO and strength of odor, putting poorer children and adults at risk for asthma-related health issues as a result of increased exposure to chemicals, dusts, and other airborne effluent.

Risks to nature-based tourism based on impacts to air & water quality:

Conservatively estimating a 1% decrease in visitor attendance at Apple River Canyon State Park, Le-Aqua-Na State Park, Ward's Grove Nature Preserve, and Weir White Oaks State Natural Area.

GLOBAL CLIMATE REGULATION (GHG EMISSIONS):

Yet another serious air pollutant emitted from CAFO dairy systems are greenhouse gases (GHGs) which may come from several sources: enteric and manure methane emissions[5], nitrous oxide emissions from grazing and manure management, and carbon dioxide emissions from fertilizer creation, crop management and transportation.

In a study of Wisconsin and California dairy systems, the authors showed that the annual CO_2 equivalent emissions produced was approximately 5.444 mt (5,444 kg) of CO_2 equivalent emissions per dairy cow (Phetteplace 2001). A more recent study by the USDA of the GHG emissions associated with large-scale dairy facilities concluded that the average daily GHG emissions of a 10,000-cow dairy were 33092 lbs of methane, 409 pounds of nitrous oxide, and 3,575 lbs of ammonia (Sustainable Food News 2011), i.e. 0.037 mt (37 kg) per cow per day or and 13.5 mt per cow per year of CO_2 equivalent emissions. Indeed, these numbers confirm that pasture raised dairy emits fewer GHGs than manure stored underwater in waste storage ponds.Some CAFO proponents have indicated that a methane digester would remove the GHG risk, however the state of California recently closed down the

5 For example, lagoons put manure underwater to decompose anaerobically and ruminant manure, when it decomposes in this way, produces 23x more methane than aerobic decomposition Hardin, P. (2011). Pete Hardin call notes 6/14. E. Landen

methane digesters in their state due to (a) leakage concerns, and (b) the digesters minimize methane emissions (assuming proper operation without leaks), however they substitute the methane with CO_2 and NOx (nitrous oxides); both of these are also greenhouse gas forcing agents.

Risks to global climate regulation:

Estimated 5.4 to 13.5 mt of CO_2 equivalent emissions per cow per year or between 35,386 and 87,782 mt of CO_2 equivalent emissions annually.

BIODIVERSITY (ENDANGERED/THREATENED SPECIES AS A DRIVER OF NATURE-BASED TOURISM)

Lastly, the creeks, streams, rivers, and lakes of Jo Daviess County provide refuge and reproductive habitat for a range of threatened and endangered animals, including the river otter, lake sturgeons, western sand darters, pallid shiners, and three species of mussels (de Groot 2002; Thomas 2008). This habitat may be threatened by waste discharges and decreased water quality and could have could have negative effects on direct use benefits accrued by the tourism and fishing industries. Fewer people may see these animals while wildlife watching, or while engaged in water-based recreation and anglers' recreational experiences may decline (Kroeger 2005). A decrease in the local fishing and tourism industry could lead to further declines in associated industries including outfitters and the hospitality industry.

Risks to wildlife watching-related nature tourism:

Estimating a 1% decrease in the number of wildlife-watching-related visitor days within a 10 mile impact radius.

CULTURAL & ETHICAL VALUES: NATURE/ECOSYSTEM IMPACTS ON PROPERTY VALUES AND ASSOCIATED TAX REVENUES

Jo Daviess County is also a popular tourist destination and a number of Chicagoans have second homes in the area (Thomas 2008; USA Today 2011). There have been several studies that suggest that a CAFO can cause decreases in property values (Kilpatrick 2001; Weida 2004; Gurian-Sherman 2008; Hribar 2010) depending on the type of property, distance to the CAFO, insects, odors, air quality, and property use impacts, among others (Kilpatrick 2001). For example, in North Carolina, news of pollution in the Neuse River, resulting from CAFO waste, caused out-of-state residents to cancel plans to move to the state (Burns 1996).

Several studies have attempted to quantify these impacts of CAFOs on property values; Hagerbaumer (2006) estimated that neighboring property values can decrease from 10-35% depending on distance and wind direction from the CAFO. A study from the University of Missouri found that the property value of an average vacant parcel decreased in value by 6.6% within three miles of a CAFO, while lots with a residence and within 0.1 miles decreased by 88.3% (Hamed, Johnson, and Miller, 1999 in Kilpatrick 2001). Higher value properties, e.g. vacation homes, have also been found to lose a greater percentage of their value than utilitarian homes (Alschuler 2012).

Risks to property values due to degradation of the rural ecosystem:

Conservatively estimating a 6.6% decrease in property value in the towns of Nora and Warren.

CULTURAL SERVICES: RECREATIONAL FISHING & WILDLIFE WATCHING

Another ecosystem service at risk as a result of the continued implementation of TID is

consumptive and non-consumptive recreation such as fishing and wildlife watching. Fishkills due to CAFO-related water contamination have been documented in Illinois, Iowa, Michigan, and other nearby states (Flora 2007; Rhodes 2009; Yeagle 2009; ECCSCM 2011), including a recent high-profile fishkill (June 2011) caused by the CAFO owned and operated by Wayne Demmer, chairman of Dubuque County Board of Supervisors. This manure spill killed over 100,000 fish along 10 miles of stream and the fish were valued at over $96,000.[6] Fishkills often result from waste spills in streams,

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rivers, or estuaries (Gurian-Sherman 2008) causing nutrient overloads, algae blooms, and eutrophication of water bodies (Hribar 2010). In addition to depriving fish of oxygen, these algae blooms can cause changes to the taste and smell of drinking water, contaminate beaches, and harm peoples' skin, nerves and liver. Exposure to high enough cyano-bacteria counts can lead to rashes, stomach aches, and the tingling in the distal extremities and can also be fatal to household pets such as dogs (Environmental Law & Policy Center 2011).

Another recent example of a CAFO-related fishkill occurred on September 7, 2010 when a faulty septic system belonging to a CAFO in Belleflower, IL resulted in a total fishkill. Six weeks later, the fish population was still zero, measured both three and six miles downstream. One of two previous fishkills originating from this same contaminant source, had impacts 11.5 miles downstream and similar fishkills in Illinois have been shown to have lasting effects for as many as five years (Thomas 2011).

From 2003-2009, there were 18 livestock related fishkills in IL and according to IEPA officer, Bruce Yurdin, there has been approximately one agricultural discharge of toxic animal waste per month for the last 2 to 3 years (Alschuler 2010). Assuming 12 such discharges per year and 84 discharges from 2003-2009, the % chance of a fishkill, given a TID waste discharge, would be 21.4%. Essentially, one out of five such discharges would result in a fishkill.

While aggregate data suggests that the percent likelihood is small that any one of the 500 regularly inspected CAFOs operating in Illinois would cause either a toxic agricultural discharge (2.4%)[7] or a fishkill (0.5%)[8] in any given year, the track record of TID, with four toxic agricultural discharges in four years has been nearly 40 times the average for such a discharge event which may indicate negligence and/or a lack of planning, oversight, and adequate management. According to the IL EPA, from 2003-

6 Demmer's manure runoff control system was regarded as one of the best, however, it still resulted in a manure spill after only 1-2" of rain and a fishkill involving over 20 species. Matt Alschuler of HOMES attributes this to poor pond management with the implication being that if a key political figure and local resident cannot properly manage the waste on his property, then even less may be expected from Bos, who fulfills neither of these roles (Alschuler, M. (2011). Demmer Spill? DC Staff Report (2011). DNR traces fish kill origin to Peosta area. Dyersville Commercial.).

7 An estimated 12 discharges per year across 500 CAFOs in IL equals a 2.4% probability of a discharge for any given CAFO.

8 0.5% is calculated as 2.4% likelihood of a toxic agricultural discharge *a one-in-five chance that the discharge results in a fishkill.

2009, with 226 dairy livestock facilities surveyed, an average of 75% of these facilities had at least one regulatory violation in a given year. Furthermore, 72% of regulatory violations that occurred at livestock facilities in Illinois concerned waste handling/storage, runoff control, water quality, NPDES permit, field application of waste, or effluent standards, all violations that could have a direct or indirect effect on rivers, lakes, streams, and other regional water bodies (IL EPA 2011). When one considers estimates that there may be as many as 3,500 CAFOs operating in Illinois (Webber 2012) (there is no official database of CAFOs) the scale of these violations becomes even more significant.

As a deterrent to such violations, the Illinois Pollution Control Board has the ability to fine, those who violate their NPDES pollution permits, up to $10,000 per day of violation. In addition, under the Clean Water Act, the maximum penalty increases to $25,000 per day, though these maximum values are infrequently levied (Dexter 2012).

Risks to recreational fishing/wildlife watching due to an effluent spill event (a.k.a. fishkill):

Given the already poor discharge record demonstrated by TID, this analysis assumes a 54% probability (72% of 75%) of a dairy-livestock facility committing a water-related regulatory violation in any given year as a proxy for the likelihood of a toxic agricultural discharge, and an 11.6% probability (21.4% of 54%) of a fishkill in any given year. These probabilities would correspond to a water-related regulatory violation every 1.85 years and a fishkill every 8.62 years.

CULTURAL & ETHICAL VALUES: ENVIRONMENTAL IDENTITY AND THE PSYCHOLOGICAL HEALTH AND CULTURAL FABRIC OF THE COMMUNITY

The natural environment affects identity development both among children and adults. The physical environment is influential as a child develops a sense of self. Indeed, children's identities are rooted in and enriched by relationships to natural places and to other living things. Children express concern and distress when harm occurs to an animal or environment they know, suggesting an extended sense of environmental identity. This emotional connection to the natural environment carries through to adulthood and many adults use natural settings to reflect on personal matters as well as to regulate one's emotional state and self-concept. The natural environment also fulfills basic identity needs; the literature describes the phenomenon of place identity as the component of identity that is associated with feelings about a particular locale. Identity comes from the way in which memories are intertwined with that place, so that it takes on emotional connotations and symbolic significance. Physical environments contribute to a person's sense of distinctiveness, self-esteem, self-efficacy, and continuity. Place identity is closely affiliated with the psychological phenomena of place dependence and place attachment, whereby certain physical surroundings are considered to be a component of one's extended self. Specific places and environments can contribute to one's sense of well-being or security, and one's place identity can be affected by specific environmental threats or the threat that one might have to leave that place. Negative environmental changes can cause feelings of personal loss and 'spoiled identity'. (Kempton et. al 1996, Clayton and Opotow 2003, Clayton and Myers 2009). Indeed, environmental disturbances, such as changes in the landscape, exposure to air pollution/emissions, loss of biodiversity (flora and fauna), and increased fears of pollution-related asthma and

other illnesses, have been shown to lead to significantly higher degrees of environmental distress including solastalgia. Solastalgia is defined here as the pain/distress caused by the perceived negative transformation of one's environment, often by elements apparently beyond one's control (Higginbotham 2006). Solastalgia has resulted from unwelcome changes such as droughts, open-cut coal mining, power station fallouts, toxic pollution, and particulate fallout from mines and has led to stress, weight- and sleep loss, threatened wellbeing, and depression (Albrecht 2007). Depression can have deleterious effects on one's work capabilities resulting in lost concentration, more instances of repeating a task, and working slower than usual. Indeed, lost labor time costs associated with depression have been estimated to cost US employers $24 billion per year. A national Work and Health Interview survey found that workers who were depressed averaged 4.1 hours per week more of lost productivity time (LPT) than those who were not depressed (Stewart 2003).

Furthermore, many residents of Warren and Nora have lived in these towns their whole lives, some across generations (Thomas 2008). When a CAFO is sited nearby, this can lead to not only feelings of anger and depression (Mirabelli 2006), but also a sense of social upheaval. CAFOs are often sited near small, rural towns with low population densities (Gurian-Sherman 2008; Thomas 2008). For some in these towns, moving may not be a challenge but for those who now want to move away from TID but cannot, whether due to family history, mobility, employment, costs, or regional aesthetics (Thomas 2008), accounting for social upheaval is a must.

While incorporating a CAFO into one's migration decisions is one approach to coping with these

The natural environment affects identity development both among children and adults. The physical environment is influential as a child develops a sense of self.

feelings of social upheaval, another approach is to develop an organized response, as the non-profit organization HOMES (Helping Others Maintain Environmental Standards) did in response to the TID project. HOMES is an example of previously loosely-connected individuals forming a new group identity and exhibiting consensus-based social cohesion in order to mobilize against a threat to their local environment – evidence that TID is impacting the social fabric of the region even before the site is brought online. Indeed, HOMES has established an extensive network beyond their immediate communities. HOMES has also filed lawsuits and appeals against TID since 2008 (Alschuler 2011) and this litigation is a further example of a divisive issue tearing at the social fabric of the community. Litigation following events such as natural disasters can be a significant and lingering source of stress to residents and their families. For example, in 2006, 17 years after the Exxon Valdez Oil Spill (EVOS), almost a quarter (23.1%) of residents surveyed from a random sample of Cordova, Alaska (N=298) agreed that the litigation process was still a source of stress (Picou 2007). Stress, subsequently, has been shown in one study to be a strong predictor of lost work productivity (Riedel 2009). Other familial impacts from EVOS have included increased anxiety, and more divorces and reports of domestic abuse

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(Clayton 2011).

Risks to environmental identity and regional psychological well-being:

We assumed a 1% increase of environmental distress, solastalgia, stress and depression within Nora and Warren, which was modeled as 4.1 hours/week per person of lost work productivity, along with a 1% increase in individuals within Nora and Warren (at or below the poverty line) who desire to move away from TID but are not able to.

CULTURAL & ETHICAL VALUES: THE SOCIOECONOMIC IMPACTS OF CAFOS TO THE REGIONAL ECONOMY:

As agriculture becomes more industrialized, the marketshare of CAFOs is increasing, while that of independent producers is decreasing (Weida 2000). Indeed, CAFOs are displacing family farms, which averaged only 99 cows per dairy herd in 2007 (Hutjens 2008). A study conducted at the University of Missouri found that three independent farmers were displaced per one job created by a CAFO (1994 in Hagerbaumer 2006). Assuming milk processing plants are currently running at capacity, the milk provided to the processors by TID would displace approximately 35 independent milk producing farms (3500 milking cows/99 cows per farm). While some of these farms may be able to locate a processor further away to take their milk, additional transportation costs will further reduce profits and competitiveness, and others may even shut down (Alschuler 2011). This displacement of local family farms is already happening with other Bos-owned dairies: recently, a new dairy in Bakersfield, CA, owned by Bos, established a deal to sell to the local Land O'Lakes processing plant and soon afterwards, the local dairy co-op had their contract non-renewed. Similarly, Bos also established a deal with the country's largest dairy processor and distributor, Dean Foods, in Nevada; soon thereafter Nevada producers were also pushed out of the picture (Dean Foods 2008; Hardin 2011).

"Losing the farm" could have negative socio-economic effects on dairy farmers in Illinois and around the region, as farmers are known to have a strong kinship and psychological attachment to their land and livestock (Waddington 2009). Past crises suggest that when farmers encounter economic hardships, e.g. increased fuel costs and plunging milk prices, and are struggling to financially stay afloat, negative outcomes such as stress and tension, domestic problems, and even suicides have been shown to increase (Steffey 2009; Walker 2010). Indeed, frustration and despair have led

to dairy farmer suicides becoming more common in states like California, Maine and Colorado (Waddington 2009) and two years ago a suicide hotline was implemented for dairy farmers in Wisconsin. While CAFOs are not the sole problem facing independent dairy farmers; these large-scale operations are contributing to an already challenging economic environment marked by difficulties in obtaining adequate credit and depressed milk prices (Steffey 2009; Alschuler 2011).

Risks to the regional economy:

We will assume that 20-40% of independent livestock producers have lower costs of production than industrialized operations (Ikerd 1999) and that the TID CAFO would therefore economically displace 60%-80% or 21 to 28 of the 35 farms mentioned above. Increased feelings of socioeconomic distress and frustration contributed to our decision to model for a 1% increase in depression within Nora and Warren, manifested as lost work productivity.

CULTURAL & ETHICAL VALUES: THE COST TO SOCIETY'S BUILT CAPITAL

Local expenses for "built capital" items like road maintenance (which are borne by the surrounding community in the form of tax revenue being spent on road upkeep) have been shown to increase in the presence of CAFOs. Large dairies in rural Ohio have been shown to require three quarters of their tax liabilities for road upkeep and a CAFO in Iowa resulted in increased gravel costs of 40% due to truck traffic (Motavelli, 2004 in Hagerbaumer 2006).

Risks to regional society:

Bos has estimated the traffic associated with TID at 40 trucks and 40 passenger vehicles/day with up to 200 trucks/day throughout the corn silage harvest traveling over Highway 78 and East Mahoney Road (Jo Daviess County 2008). This will result in significantly increased road maintenance and increased traffic and noise may cause stress and anxiety amongst area residents (Clayton 2011).

CULTURAL SERVICES – EXISTENCE VALUE

Several conservation-related organizations in Jo Daviess County have active memberships that donate time and money to ensure the protection of the county's natural amenities. For example, the Jo Daviess Conservation Foundation (JDCF) uses member and foundation funds/donations to acquire property and host conservation programs in the local community. The inherent character of the regional ecosystem is what motivated the founding of organizations such as JDCF, and the expenditures of these organizations is intended to preserve and conserve these natural landscapes and the associated aesthetic, ethical, and existence values. Money spent to protect ecosystems is one method used to measure non-used benefits such as existence value, intrinsic value, and the bequest values of knowing that a place, animal, or resource will be passed on to future generations.

Risk to existence value:

The physical footprint of the CAFO facility (estimated at 180 acres) would have a distinctly different character than the biodiversity-rich and high-amenity-value small family farms that the CAFO would displace, thus voiding JDCF's efforts and expenditures to "protect the natural heritage, spectacular scenery, and agricultural character of Jo Daviess County, Illinois, this extraordinarily beautiful piece of the Midwest." This acreage would be unavailable and unprotected for future generations.

The above "CAFO risk model" explored the

assumptions we are making as to the likelihood of various ecological and social impacts of the TID facility. Next, we will explore the economic costs of this ecological and social degradation.

Environmental Costs of the TID CAFO

FRESHWATER PROVISIONING - WATER TABLE DRAW-DOWN:

The incremental cost of TID's withdrawal of up to one million gallons of water per day (Hardin 2008) has led to fears of a significant, disruptive, and long-lasting impact on the local water supply (O'Neil 1990). For this analysis, we provide an estimated cost per 1% decrease in water availability in the surrounding water table.

A survey of Raleigh, North Carolina residents found that consumers would pay up to $5 per year per household to avoid a 10% reduction in water use and would pay even more to avoid larger reductions. Based on this ratio, a 1% reduction in water use would correspond to a value of $0.50 per year per household. Given a 1% reduction in the local water table, the cost of decreased water availability to Nora and Warren would total approximately $1,050 per year, in 2011 dollars (cumulative inflation = 90.34%).

FRESHWATER PROVISIONING – DAMAGE TO REGIONAL WATER QUALITY:

Yet another concern surrounding groundwater in Jo Daviess County is the potential for contamination (Hardin 2008). CAFOs can affect groundwater quality through manure runoffs, leaching and waste-storage leaks and breaks.

Nitrates

A study of nitrogen in well water, conducted by the Kansas Geological Survey found that 42% of nitrogen in their 112 samples had derived from animal waste (Townsend and Young 1999b in Volland 2003). A survey by Lewandowski et al. (2008) showed that, in cases where nitrate concentrations were found to exceed the US EPA health standard maximum of 10 mg/L nitrate-nitrogen, an additional 16% of the population bought nitrate treatment systems, 16% bought bottled water, and 25% installed a new well. Reactions to elevated nitrate levels (>10 mg/L) and associated costs from Lewandowski (2008) can be seen in Table 3 below.

While Warren has a municipal water supply, with approximately three deep lake wells, the surrounding houses all have private wells as does everyone in Nora (Alschuler 2012). Assuming one well per household in Nora and Warren, if the TID CAFO resulted in 2/3 of wells in these villages containing elevated nitrate levels, this would correspond to 46 homes in Nora and 510 homes in Warren or about 556 total homes/wells affected. Costs associated with the reactive steps to address elevated nitrate levels in these eight wells would cost $1,071,412 upfront and $25,576 annually in 2008$ or $1,117,804 upfront and $26,683 annually in 2011$.

Pathogens

In 1993, suspected cattle manure contamination resulted in a waterborne outbreak of cryptosporidiosis affecting 403,000 individuals in in Milwaukee, WI with an estimated $31.7M in medical costs and $64.6M in productivity losses (Corso 2003; Rose 2005; Larsen 2011). This amounted to approximately $239/person in medical and work-related costs. A review of manure-related pathogenic human health impacts revealed that such incidents can also carry the risk of death, though such events were far less frequent (Rose 2005). Based on a 1998 CDC study of nine Iowa CAFOs we estimate an 11% likelihood of a pathogenic contamination in the Apple River, directly adjacent to TID. Such

a contamination could impact the regional water supply of Nora and Warren placing the estimated 1,469 residents of the two villages at risk. Assuming a cost/person of $239, we and an 11% risk of TID directly causing a cryptosporidium waterborne outbreak we estimate associated costs of up to $351,091. We assign an economic value of $38,620 ($351,091*0.11) to such an event. While this study sampled nine CAFOs over a three month timeframe, because of the lack of longitudinal data, we estimate this as a one-time cost.

Other costs associated with allowed leakage at TID, are based upon projections of remediation costs from the leaching of ammonium-N under dairy CAFOs in Kansas. Dairy CAFOs surveyed in one study were comparable to TID in terms of size (5,580 AU) and wastewater lagoon depth (median 20 ft.) and estimated costs assume a cleanup standard of 25 mg/kg of NH-N (accounting for the costs of design, testing, supervision, inspection, and reports) (Volland 2003). Dependent on the depth (7-14 feet) of a resultant ammonium-N plume, remediation costs for TID manure ponds, using the least costly method of excavate and spread, could range from $694,215 to $1,422,757 in 2011$.

As an alternative to such remediation efforts Weida (Colorado Springs Utilities, 1998 in 2000) points out that the cost of treating livestock waste, if it was treated at the same law and sanitation standards required for human waste, would be $173 per head annually in 1998$ or $1,614,986 per year in 2011$.

WATER PURIFICATION AND WASTE TREATMENT:

Wastewater from TID lagoons has contaminated surface water and elevated BOD levels in Jo Daviess County at least four times. If TID operations

While CAFOs are not the sole problem facing independent dairy farmers; these large-scale operations are contributing to an already challenging economic environment marked by difficulties in obtaining adequate credit and depressed milk prices

continue to develop and grow, lagoon overfill could affect biodiversity and recreational opportunities in the area. The economic impact upon recreation and biodiversity opportunities resulting from changes in BOD and ammonia levels has been estimated using contingent valuation and contingent ranking methodologies. One study of residents in Birmingham, UK found that households were willing to pay £3.06 annually per mg/L decrease in BOD and £5.05 annually per 1 mg N/L decrease in the River Tame (1999$). The average distance from the River Tame amongst the sample population was 2.45 (N=675) (Georgiou 2000). Transferring these data to the populations of Warren and Nora, one arrives at annual estimated costs of $1.45 and $1.21 (2011$) per 1 mg/L change in BOD levels for the two villages respectively. These costs total $164 for Nora and $1,641 for Warren for a total of $1,805 per year.

AIR QUALITY – ONSITE (WORKER DISEASE RISK)

The air quality inside CAFO facilities and in surrounding communities may also be negatively affected by TID operations. A study of 164 farms in northwestern Iowa found that on average, the annual number of respiratory illnesses was 0.14 with an associated cost of (both out of pocket and

to insurance companies) $15 per year (Donham 2007) corresponding to $129.85 in 2011$. Assuming 40 workers at TID (Bos 2008), if 20-40% of these workers experience serious respiratory problems, the cost of workers' respiratory illnesses at TID could range from $520 to $1,454 per year.

AIR QUALITY – REGIONAL (RESPIRATORY HEALTH)

Residents living close to CAFOs have also been shown to have increased instances of shortness of breath, wheezing, and coughing, and asthma-related health issues. Costs associated with asthma can be significant and may include medications, hospital visits, and missed school or work (Bahadori 2009). A two year study of Iowa residents with asthma found that estimated annual costs incurred per patient ranged from $149 per year for mild cases to $789 per year (1991$) for severe cases (Li 1995); in 2007, Jo Daviess County had a 10.4% asthma lifetime prevalence rate (Illinois Department of Public Health 2009). To estimate the incremental cost of CAFO-related negative health impacts this analysis assumes a 1% increase in the asthma lifetime prevalence rate to 11.4% for the two villages and an annual cost-range per patient of $244 (mild case)- $1,291 (severe case) in 2011$. This 1% increase in the asthma lifetime prevalence rate would result in 15 additional people incurring additional health-related costs of $3,660 - $19,365 per year.

AIR & WATER QUALITY – IMPACTS ON OTHER ECOSYSTEM SERVICES (NATURE-BASED TOURISM & RECREATION, CULTURAL & ETHICAL VALUES):

Jo Daviess and its surrounding counties are rich with natural amenities that stand to be affected by the implementation of the TID CAFO. This analysis assumes a 10 mile impact radius for state parks and examines attendance figures within this radius. Given the karst topography in the region, however, water contamination beyond 10 miles remains a real possibility. Figure 7 presents the 10 mile impact radius used in the following calculations as well as the state parks, recreation areas, and villages considered within this analysis.

Action	Increase Prevalence from Nitrate > 10 mg/L in well	One Time Cost	Annual Cost
Install treatment system	16%	$798	$100
Drink bottled water	16%	$0	$190
Install a new well	25%	$7,200	$0

Note. Data from (Lewandowski 2008) and is in 2008$.
Note. The weighted sum of these costs was $1,927 in one-time costs plus $46 per year annually.

Table 3. Responses to elevated nitrate-nitrogen in MN study: All well owners.

Apple River Canyon State Park (ARCSP) and Le-Aqua-Na State Park (LSP), both located about five miles away from TID, will likely have reduced attendance figures if TID reaches 6,500 AU. This analysis estimates the average tourism expenditure per state park visitor at $11.17 (2011$) and recreation area employment at one job per 6,462 visitors.[9]

9 In 2008, three state parks within 35 miles of TID (ARCSP (3.5 miles west), Upper Mississippi River National Wildlife & Fish Refuge (30 miles west), and Mississippi Palisades State Park (35 miles southwest) brought in a total of 840,000 visitors and $9 million annually (2008$) or approximately $10.71 per visitor ($11.17 in 2011$) and provided for 130 jobs or approximately one job per 6462 visitors.

The Bureau of Labor Statistics estimates the average annual wage of Forest and Conservation Workers in the U.S. at $27,740 in 2011$ (US Bureau of Labor Statistics 2011). Table 5 presents the likely affected recreati on areas, the distance from TID, the acreage and estimated attendance figures at each location, and the revenue lost (in 2011$) from a 1% decrease in visitorship. Table 6 below, shows the impact on recreation area employment, also from a 1% decrease in attendance.

GLOBAL CLIMATE REGULATION (GHG EMISSIONS):

Yet another serious air pollutant emitted from TID is greenhouse gases. TID can be expected to emit approximately 35,386 – 87,782 metric tons of CO_2 equivalent emissions, annually, given its 6,500 AU operation. Providing a precise market value for CO_2 equivalent emissions is difficult given that existent markets are, in many cases, voluntary, regional, or limited in scale and/or scope.[10] To ensure that this ecosystem service is appropriately accounted for in our valuation, we provide a working price range for CO_2 equivalent emissions, a generally accepted practice within the scientific community (Grant 2010). This range is based upon a lower-bound estimate from the IPCC Climate Change: Synthesis Report (2007), which provided an average price of $12 per tonne of CO_2 (estimated from 100 peer reviewed journal articles in 2005$) and the Stern Review, which provided our upper-bound estimate of $85 per tonne of CO_2 (in 2006$) (Stern 2006). A mid-range estimate can be seen in the European Union Emission Trading System (EU ETS), the largest international GHG emission allowance trading market in the world (European Commission 2010), whose December 2011 EU Allowance (EUA) futures contracts have remained in the €12 to €14 range since falling to a one-year low in June 2011 (Watson 2011); As of the writing of the document, December 2011 EUA futures are currently trading at €12.22 or $16.90/mt (Google 2011; Point Carbon 2011).

Given these values, one can estimate the annual costs of greenhouse gas emissions to be between $490,365 (35,386mt*$12/mt*1.1548) and $8,286,709 (87,782mt*$85/mt*1.1106) annually in 2011$ (McMahon 2011).

Table 4. Estimated WTP to prevent 1 mg/L increase in BOD and Ammonia

Population	Avg. Household Size	Annual Cost	Total Annual Cost
Nora	2.2	$1.45	$164
Warren	2.4	$1.21	$1,641
Total			$1,805

Note. Annual fees account for inflation, GNPPPP, differences in per capita income (Warren/Nora vs. US), and household size.
Note. Data from (City-data.com 2009; 2010; US Department of Commerce 2010; McMahon 2011; World dataBank 2011)

10 For example, the Chicago Climate Exchange is a voluntary GHG emissions trading market, and the average price/mt for a Carbon Financial Instrument (CFI) is now only a nickel since October 2010 (Chicago Climate Exchange (2011). Historical Pricing Data 2003-2010 **2011**.)

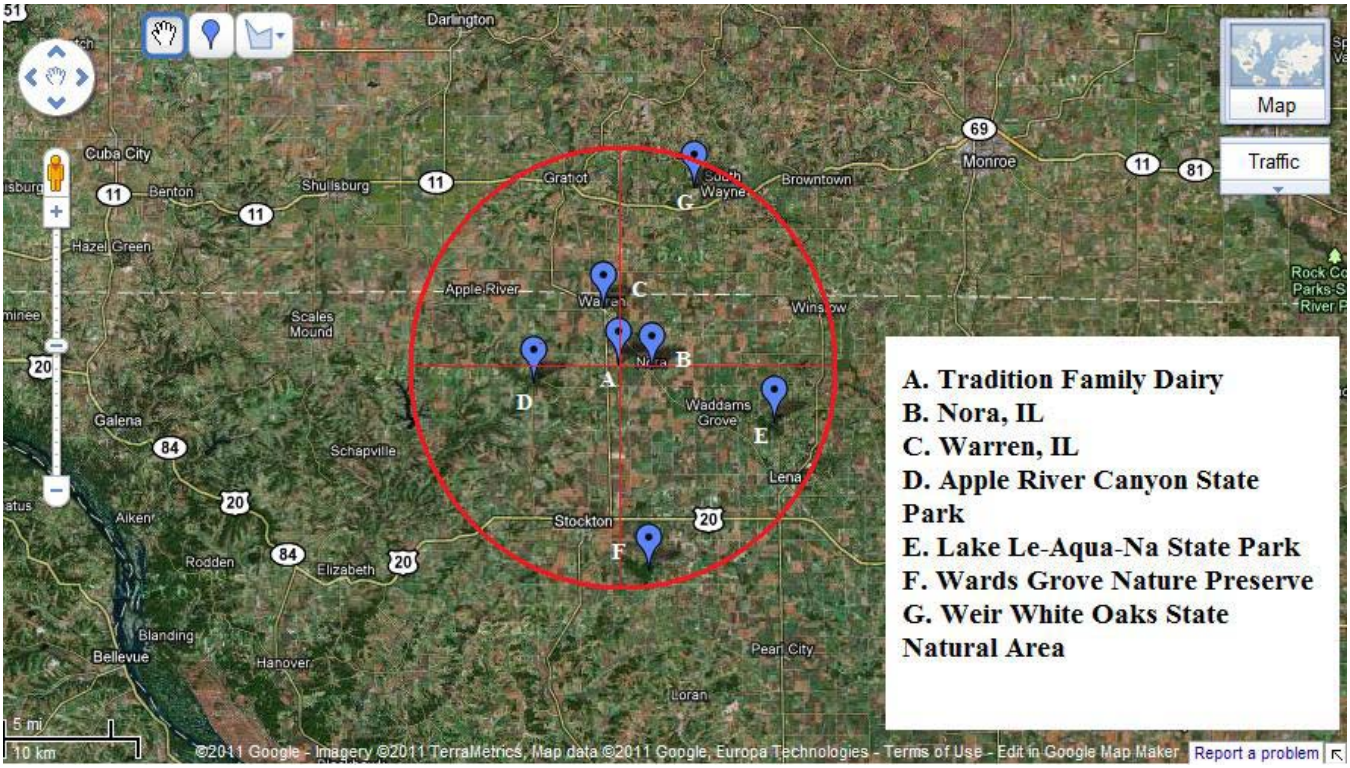

Figure 7. TID CAFO Ten Mile Impact Radius

BIODIVERSITY (ENDANGERED/THREATENED SPECIES AS A DRIVER OF NATURE-BASED TOURISM)

At least seven threatened and endangered species inhabit this area including river otters, lake sturgeons, western sand darters, pallid shiners, and three species of mussels (Thomas 2008). Placing a value on biodiversity and the spaces in which threatened and endangered (T&E) animals live their lives can achieve greater awareness of the importance of the variability of and within species (a.k.a. biodiversity) as well as encourage eco-tourism. Using a reduced form linear model, estimated using regression techniques, a function transfer methodology outlined in (Loomis 1996) two estimates of the population-specific costs resulting from a 1% and 10% decline in these current populations are presented in Tables 7 and 8 below in 2011$. The regression equation utilized was as follows. Variables included change in population size, expressed as a percent and dummy variables included pay frequency, expressed as one-time (1) or annual (0), visitors (yes=1), marine (yes=1), and bird (yes=1).

WTP = -49.43 + (.61)Change in Size + (42.01) Pay Freq + (23.55)Visitor + (35.76)Marine + (21.72)Bird

Equation 1. Reduced Linear Regression Model (Loomis 1996)

Total estimates for recreation visitors are based upon an estimated 1% decrease in the annual number of wildlife watchers in Jo Daviess County, estimated at 140 people. The economic costs to the region's biodiversity range from $1,392 - $1,848 for a 1-10% decrease in a single T&E fish species to $31,921- $37,603 for a 1-10% decrease in a single T&E marine species such as river otters or mussels. Given the T&E fish species (lake sturgeons, western sand darters, and pallid shiners), costs in Table 7 would triple to $4,176 – $5,547 in one time costs. Similarly, given the status of the river otter and three species of mussels, costs in Table 8 would quadruple to $127,684 – $150,412. Total costs associated with a 1-10% loss in biodiversity in Jo Daviess

County would, therefore, total $131,860 - $155,959 in 2011$.

CULTURAL & ETHICAL VALUES: NATURE/ ECOSYSTEM IMPACTS ON PROPERTY VALUES AND ASSOCIATED TAX REVENUES:

Assuming a 6.6% decrease in all residential property values in Nora and Warren, IL, Table 9 estimates lost property value and lost annual property tax revenue for the two villages. Total estimated lost property value for the two villages, adjusted for inflation, would be approximately $5,047,186 and total estimated lost tax revenue would be approximately $60,239 annually in 2011$.

CULTURAL SERVICES: RECREATIONAL FISHING & WILDLIFE WATCHING

In 2006, there were 293,000 anglers who fished rivers or streams in IL for a total of 5,088,000 days or 17 days per angler per year (US Fish and Wildlife Service 2006). River and stream fishing in Illinois is approximately a 230 million dollar industry[1] (US Fish and Wildlife Service 2006) which may be significantly affected by fishkills resulting from CAFO-related water contamination. From 2003-2009, the average cost of a fishkill was $6,287 with a range of $0 to $63,782 per kill. The assumed probability of a fishkill for TID, in any given year, is estimated at 11.6%. Therefore, this analysis estimates the cost for fishkills, as a result of TID operations, at $0 to $7,399 per year in 2009$ or $0 to $7,717 in 2011$ (cumulative inflation = 4.30%).

In 2006, there were 837,000 individuals who went wildlife watching away-from-home (further than a mile) in IL for a total of 5,686,000 days or approximately seven days per person per year. The average expenditure per participant for all wildlife watchers (at home and away from home) was $419 per year (US Fish and Wildlife Service 2006) or approximately $60 for each away-from-home participant per day.

Even a 1% decrease in the number of days in which individuals went wildlife watching away from home, or a decrease in 56,860 days, could cost the state of Illinois $3,411,600 annually. Any land area that would experience a decrease in wildlife watching would likely fall within the 10 mile impact radius shown in Figure 7 above. This impact radius covers approximately 100 sq. miles in Jo Daviess County or approximately 1/6 of the county area and is estimated to cost $60,623 in annual revenue losses and affect approximately 140 people.

Figure 8. Fish kill in Little Bear Creek, Michigan (Image from (ECCSCM 2011)

Cultural & Social costs

CULTURAL & ETHICAL VALUES: ENVIRONMENTAL IDENTITY AND THE PSYCHOLOGICAL HEALTH OF THE COMMUNITY:

Impacts to individual psychological well-being related to environmental degradation can include impacts to a person's sense of distinctiveness, self-esteem, self-efficacy, continuity, well-being, security, and feelings of personal loss and spoiled identity.

Table 5. Tourism Revenue Impact from 1% Decrease in Recreation Area Attendance

Recreation Areas	Distance from TID	Acreage	Attendance Figures	Lost Revenue
Apple River Canyon State Park	3.5 miles	297	225,000	$25,133
Lake Le-Aqua-Na State Park	5.0 miles	715	200,000	$22,340
Wards Grove Nature Preserve	9.3 miles	335	253,787 a	$28,348
Weir White Oaks State Natural Area	8.6 miles	10	7,576 a	$846
Total		1357	686,354	$76,667

Note. annual attendance figures for ARCSP and LSP (2006-2007) from (Alschuler 2011). Data from (Google Maps, 2011;IL DNR 2010; IL DNR 2011; WI DNR 2011)
Note a. Attendance figure based upon acreage-visitor ratio from ARCSP

Table 6. Tourism Employment Impact from 1% Decrease in Recreation Area Attendance

Employment	Attendance Lost	Jobs	Wage Assumption	Lost Income
Jobs lost	6863.54	1	27,740	$29,464

Furthermore, environmental degradation can lead to feelings of environmental distress and solastalgia, and subsequently, stress, weight- and sleep loss, threatened wellbeing, and depression (Albrecht 2007). Using a national Work and Health Interview survey (Stewart 2003), we modeled a 1% increase in depression within Nora and Warren manifested as 4.1 hours/week per person of lost work productivity (LTP). The costs associated with this LPT totaled $33,924 in 2011$.

One approach to evaluating the economic impact of social upheaval is to look towards migration patterns of wealthier individuals away from other waste and pollutant concentrated sites similar to CAFOs. Gawande et al. examined whether or not there was a per capita income threshold at which individuals incorporated hazardous waste sites into their migration decisions and found that there was a turning point of $17,670 in 1992$ (Gawande 2000) or $27,015 in 2009 (cumulative inflation = 52.89%). During President Barack Obama's 2008 presidential campaign, he expressed support for categorizing CAFOs as direct point source Superfund polluters, the same category as other hazardous waste dumps (Williamson 2008).

In 2009, approximately 19 Nora residents (11%) and 162 Warren residents (7.6%) had an annual income less than the poverty level. Assuming that a per capita income threshold amongst residents proximate to a CAFO is similar to the threshold of $27,015 (adjusted for inflation) found amongst counties near hazardous waste sites, the estimated cost of allowing for even 1% of these residents to incorporate the CAFO into their migration decisions would equal $33,071 in 2011$.

CULTURAL & ETHICAL VALUES: THE SOCIOECONOMIC IMPACTS OF CAFOS TO THE REGIONAL ECONOMY:

In Illinois, the benefits associated with a 100 cow herd are estimated to provide $34,300 in annual wages across 1.2 jobs (Hutjens 2008). Assuming that 20-40% of independent livestock producers have lower costs of production than industrialized operations (Ikerd 1999) and that the TID CAFO would therefore economically displace 60%-80% or 21 to 28 of the 35 firms mentioned above, this would amount to an annual cost for economic displacement equal $751,489 to $1,001,985 in 2011$.

CULTURAL & ETHICAL VALUES: THE COST TO SOCIETY'S BUILT CAPITAL

Local expenses for items like road maintenance have been shown to increase in the presence of CAFOs. Large dairies in rural Ohio have been shown to require three quarters of their tax liabilities for road upkeep and a CAFO in Iowa resulted in increased gravel costs of 40% due to truck traffic (Motavelli, 2004 in Hagerbaumer 2006). Duncan et al. found that for a 20,000 head cattle feedlot that the annual cost (to local roads) of operating 25 trucks 365 days per year was $6,447 per mile in 1996$ (Tolliver, 1996 in Duncan 1997) or approximately $0.46/mile per cattle head when adjusted for inflation (1996-2011). Assuming a linear decrease in costs per head of cattle, a cost estimate for the 6,850 AU TID facility can, therefore, be approximated at $3,149 in 2011$ (cumulative inflation = 42.63%). This may be regarded as a conservative estimate given that Bos has estimated the traffic associated with TID at 40 trucks and 40 passenger vehicles/day with up to 200 trucks/day throughout the corn silage harvest (Jo Daviess County 2008).

Table 7. WTP to avoid a decrease in T&E fish species

Population	Avg. Household Size	One Time Payment	Total Cost per species	One Time Payment	Total Cost per species
Nora (pop 113)	2.2	$0.00	$0.00	$0.00	$0.00
Warren (pop 1,356)	2.4	$0.00	$0.00	$0.00	$0.00
Recreation Visitors (140)	2.6	$9.94	$1,392.01	$13.20	$1,848.53
Total			$1,392.01		$1,848.53

Note. Assumed population for recreation visitors equal to 140 visitors.
Note. Adjusted for inflation from 1993-2011 and household size

Table 8. WTP to avoid a decrease in T&E marine species (otters and mussels)

Population	Avg. Household Size	One Time Payment	Total Cost per species	One Time Payment	Total Cost per species
Nora (pop 113)	2.2	$20.32	$2,296.34	$24.18	$2,731.81
Warren (pop 1,356)	2.4	$18.63	$25,259.73	$22.16	$30,049.92
Recreation Visitors (140)	2.6	$31.18	$4,365.62	$34.44	$4,822.14
Total			$31,921.69		$37,603.86

Note. Assumed population for recreation visitors equal to 140 visitors.
Note. Adjusted for inflation from 1993-2011 (cumulative inflation = 54.33%) and household size (City-data.com 2010; City-data.com 2011; McMahon 2011)

Table 9. Estimated Property Value and Tax Revenue Losses by Village

Variable	Town	
	Nora	Warren
Median House/Condo Value	$90,639	$87,640
Houses/Condos	69	765
Property Tax %	1.20%	2.30%
Property Tax	$450	$1,103
Total Property Tax Revenue	$31,050	$843,795
Lost Property Value	412,770.01	4,424,943.60
Lost Annual Tax Revenue	2,049.30	55,690.47

Note. 2009 data from (City-data.com 2010) and (Hamed, Johnson, and Miller, 1999 in Kilpatrick 2001)

Table 10. Total Cost from Lost Productivity Time due to Depression

Population	Est. Per Capita Income (2009)	Est. Hourly Wage	Weekly LPT Cost per person	Annual LPT Cost per person	1% of pop.	Annual Cost of LPT
Nora (113)	$23,581	$12.54	$51.43	$2,417.05	1.13	$2,731.27
Warren (1356)	$21,437	$11.40	$46.75	$2,197.29	13.56	$29,795.29
Total						$32,526.56

Note. Assumes 40 hour work week, 47 weeks/year and 1880 hours per year
Note. Est. Lost Productivity Time (LPT) equal to 4.1 hours/week (Albrecht 2007)
Note. Income data from (City-data.com 2011)

CULTURAL SERVICES – EXISTENCE VALUE

Money spent to protect an ecosystem or species is one method used to measure non-use benefits such as existence value and the bequest values of knowing that a place, animal, or resource will be passed on to future generations (Krutilla, 1967 and Prato, 1998 and Freeman, 2003 in Kroeger 2005). Mechanisms to incentivize conservation and preservation efforts may include land easements, land rentals, and stewardship payments (Kroeger 2007).

Several organizations in Jo Daviess County currently have active memberships that donate time and money to ensure the protection of the counties' natural amenities. One example is the Jo Daviess Conservation Foundation (JDCF) which provides for a range of local expenditures from conservation programs to property acquisitions and has an annual operating budget of about $300,000. The JDCF has preserved approximately 2,827 acres since 1994 (avg. 157 acres/year) with 530 acres owned in fee and 2,297 in conservation easements (Helgerson 2011). Assuming a county-wide population of 22,188 (U.S. Census Bureau 2008), and no contributions from out-of-county, we have estimated that the average Jo Daviess resident has preserved 0.13 acres total or 0.0071 acres per person per year over the last 18 years. Average WTP for land conservation in Jo Daviess County can be estimated as $13.52 per person per year or $1,904 per acre. The benefits associated with protecting the existence and bequest value of the 180 acre "footprint" for the proposed TID operation can therefore be estimated at: $342,720. A second estimate may utilize the 1,400 acre parcel purchased by Bos on which the dairy will be located (Bos 2008). The benefits associated with protecting the existence and bequest value of these 1400 acres can be estimated at: $2,665,600. [11]

This estimate of WTP for the existence and bequest values associated with agricultural land in Jo Daviess County is supported by existing WTP research; A 1984 study of Massachusetts residents found that respondents were willing to pay $28-60 per year to avoid low-level development and $70-176 per year to avoid high-density development on agricultural farmland in their counties (Halstead 1984 in McConnell 2005). Similarly, a 1985 WTP study in South Carolina found that individuals would pay between $5.70 and 8.94 annually

11 Our valuation-range should be viewed as a high-end estimate as community-scale studies of WTP for land preservation are expected to be greater than WTP for land preservation within a state program. This higher-end estimate may be attributed to (a) a closer proximity between the community residents providing payments and the land they are preserving and (b) an expectation that community residents will visit/derive some use-value from the land, given their proximity, as compared to people from the rest of the state Johnston, R. a. D., J. (2009). "Willingness to Pay for Land Preservation across States and Jurisdictional Scale: Implications for Benefit Transfer." Land Economics.

Table 11. Summary of Ecosystem Service Unit Impacts and Associated Costs in 2011$

Ecosystem Service	Impact	Cost	Cost Basis	Timeframe
Provisioning Services				
Freshwater provisioning (water availability)	Water Table Draw-Down: 1% reduction in water table	$1,050	Unit	annual
Freshwater provisioning (water quality)	Damage to regional water quality (Human health): Lagoon leakage remediation (one-time) vs. treatment to human waste standards (annual)	$1,422,757 (one-time) - $1,614,986 (annual)		one-time
Freshwater provisioning (water quality)				annual
Freshwater provisioning (water quality)	Damage to regional water quality (Human health): Reactive measures/costs of elevated nitrate levels in 67% of wells	$1,117,804 one-time and $26,683 annually		one-time and annual
Freshwater provisioning (water quality)	Damage to regional water quality (Human health): cryptospo-ridium waterborne outbreak from Apple River contamination.	$38,620		one-time
Regulating Services				
Water purification & waste treatment	Biodiversity and recreation: 1mg/L incr. BOD levels	$1,805	Unit	annual
Air quality regulation	Human health (onsite): CAFO workers respiratory symptoms	$520 - $1,454		annual
Air quality regulation	Human health (regional) : Local community 1% increase in asthma	$3,660 - $19,365	Unit	annual
Air & Water Quality	Impacts on nature-based tourism & recreation, cultural & ethical values: Decrease in park and natural area tourism by 1%	$106,131	Unit	annual
Global climate regulation	Carbon equivalent emissions	$490,365 - $8,286,709		annual
Supporting Services				
Biodiversity and Habitat/refugia	Decline in T&E species (7) by 1-10%	$131,860 - $155,959	Unit	one-time
Cultural Services				
Cultural & ethical values:	Nature/ecosystem impacts on property values: Property value decrease by 6.6%	$5,047,186		one-time
Cultural & ethical values:	Nature/ecosystem impacts on property-related tax revenues: Tax revenue losses decrease by 6.6%	$60,239		annual
Recreation & ecotourism	Cost of fish kill in Apple River Tributary	$0 to $7,717		annual
Recreation & ecotourism	Decrease in wildlife watching in JD County by 1%	$60,623	Unit	annual
Cultural & ethical values	Environmental identity and the psychological health of the community: 1% increase in depression/stress and associated lost work productivity	$33,924	Unit	annual
Cultural & ethical values	Social upheaval: 1% increase in poor with unmet desire to move away	$33,071	Unit	one-time
Cultural & ethical values	Independent dairy displacement	$751,489 - $1,001,985		annual
Cultural & ethical values	Social costs (road repairs/upkleep)	$3,149		annual
Existence values	Stewardship expenditures	$342,720 - $2,665,600		one-time
Total Costs		Range		
Total One Time Cost (no cultural)		$2,711,041		one-time
Total Annual Cost (no cultural)		$2,245,200		annual
		Range		
Total One Time Cost (cultural only)		$5,422,977		one-time
Total Annual Cost (cultural only)		$906,275		annual
		Range		
Grand Total One Time Cost		$8,134,018		one-time
Grand Total Annual Cost		$3,151,475		annual

Table 12. Estimated Local (In-State) Investment from Subcontracting

Descriptions	Cost	Assumed Subcontractor Category	% IL	Est. Local Inv.
General Req.	$517,000	Misc (2 IL, CA, IA)	50%	$258,500
Site Work	$3,388,323	Excavators (2 IL), Stone Quarry (IL), Wells (IL)	100%	$3,388,323
Concrete	$5,751,191	Ready Mix (IA), Concrete Contractors (WI), Finished Concrete Forms (IA), Weiser Concrete Bunker Walls (WI),	0%	$0
Metals	$157,600	Metal Building Manufacturer (2 WI)/Erection (WI), Coverall Building Systems (IL),	25%	$39,400
Wood and Plastics	$762,000	Coverall Building Systems (IL), Scale	100%	$762,000
Thermal Moisture Protection	$42,264	Coverall Building Systems (IL)	100%	$42,264
Doors and Windows	$170,024	Metal Building Manufacturer (2 WI)/Erection (WI), Coverall Building Systems (IL),	25%	$42,506
Finishes	$46,000	Coverall Building Systems (IL)	100%	$46,000
Special Construction	$6,603,161	Head Locks and Loops (ID), Coverall Building Systems (IL), Metal Building Manufacturer (2 WI), Scale	25%	$1,650,790
Mechanical	$1,294,143	Mechanical (2 IL)	100%	$1,294,143
Electrical	$2,009,000	Electrical (WI)	0%	$0
Management	$1,000,000	Misc. (2 IL, CA, IA)	50%	$500,000
Total	$21,740,706			$8,023,926
Est. % Local Inv. Expenditures	36.91%			

Notes. % Local Inv. Expenditures based upon expenses for Metal Tunnel Ventilation Project (Overby 2008; Tradition Dairy 2008)

to protect increasing levels of undeveloped agricultural land (Bergstrom).

SUMMARY OF COSTS

Table 11 summarizes the estimated and incremental costs associated with the continued implementation of the TID CAFO in Jo Daviess County, IL. We modeled two types of costs: annual vs. one-time. Annual costs will occur each year the CAFO remains in operation (and possibly afterwards, depending on the extent of degradation and the ecosystem's rate of recovery). One-time costs may have actual effects beyond one specific point in time (for example, property value declines are sometimes only realized when the property is sold), however we modeled these items as one-time expenditures to enable the value to be quantified in one lump sum.

One-time costs for non-cultural ecosystem

services (freshwater provisioning, water purification & waste treatment, air quality regulation, air and water quality impacts on tourism and recreation, global climate regulation, and biodiversity totaled $2.71M – 2.74M. Annual costs for non-cultural ecosystem services totaled $2.24M – 10.06M. One-time costs for cultural ecosystem services totaled $5.42M – 7.75M. Annual costs for cultural ecosystem services totaled $0.91M – 1.17M. Overall, the ecosystem service costs associated with the proposed TID operations totaled $8.13M – 10.48M in one-time costs and $3.15M - 11.23M in annual costs.

Economic Benefits

CAFOs do have economic benefits associated with them. To provide a balanced assessment of the full costs and benefits of the TID CAFO project, we will review the projected economic benefits, to allow us to put economic, ecological, and social costs and benefits for this project all on the same balance sheet.

EMPLOYMENT, SPENDING AND TAX REVENUE

AJ Bos assumed the following benefits when describing the TID project to the Jo Daviess County Board Chair: increased taxable property assessments, 40 new jobs at $10 per hour (per dairy), new and increased business for existing support and local businesses, construction period job creation and spending, road upgrades, and milk provision. Alschuler (2012) has estimated that the majority of workers were from out of state with the exception of electrical, concrete delivery, and excavation workers. Table 12 estimates the percent of local investment expenditures that can be expected based upon a $21 million Metal Tunnel Ventilation Project planned for the two TID dairies. Table 13 provides the total investment cost as estimated by Bos to build both the North and South Dairy initially proposed and Table 14 estimates the total economic benefits associated with these assumptions.

Construction period spending is estimated in Table 13 below for two TID CAFOs. Bos also estimated that the endeavor would require approximately $70 million in investments for two dairies, or an estimated $35 million per dairy. Construction Costs per dairy for facilities and equipment are estimated to be $19 million of which 36.91% or $7,012,403 are assumed to be spent in Illinois. This estimate is significantly greater than other research showing that a CAFO is estimated to distribute about 20% of its expenditures within the local community (Dowding 2008).

The economic benefits associated with TID based upon the above assumptions are presented in Table 14 below. CAFOs do contribute to the local tax base (Ikerd 1999) and Bos has estimated the annual tax generations of $170,000 for his two CAFOs, or $85,000 annually per operation (Porter 2009). In 2001, dairy operations across Illinois had an employment multiplier of approximately 1.69 Assuming 1.69 jobs created outside the dairy industry for every job created by TID, this would provide for an estimate of between 34 and 48 jobs

Table 13. Estimated Investment Costs for 2 TID CAFOs

Investment for 2 dairies	$ (million)
Land (1400 acres)	9.5
Facilities	35.0
Livestock	30.0
Equipment	3.0
Total	77.5

Note. Data from (Bos 2008)

outside of the dairy industry or 68 jobs using Bos' initial estimate (Goldsmith 2001). Assuming the same hourly wage rate and 1,880 hours of work per year in businesses supportive of TID, this analysis estimates another $1,278,400 in annual economic benefits. Bos also claimed milk production as one of the benefits that would be provided to Jo Daviess County. Even assuming that the efficiency of milk production at the TID CAFO would exceed that of some of the current independent dairies, and that such increased efficiency would lead to an increase in the supply of milk, there is no evidence that an increase in supply for milk in Jo Daviess County would lead to any sort of increase in demand within the community. Any economic benefits derived from an increased capacity of milk produced in Jo Daviess county would likely lead to an increase in out-of-state milk sales and increased profits for TID, not for the county or community. One-time benefits are estimated at $7.01 million and annual benefits at $2.12 million.

Conclusion: Putting Nature on the Balance Sheet

While in the short run, the implementation of TID may appear to have economic value, the long term environmental, social, and economic costs associated with the CAFO do not support this view. Even with a highly conservative estimate which estimated a 1% impact for several of the ecosystem services affected, TID still demonstrated one-time community impact costs ranging from $8.13M – 10.48M and annual costs ranging from $3.15M - 11.22M. The benefits derived from TID operations

Table 14. Economic Benefits from TID

County Benefits	Assumptions	Benefits ($)	Timeframe
Increased taxable property assessments [c]		$85,000	annual
40 new jobs at $10 per hour	Assumes 1,880 hours per year	$752,000	annual
Construction period job creation and applicable spending [a]		$7,012,403	one time
East Mahoney Road upgrades	N/A given assumption of necessary road repairs(road repairs costs excluded from final analysis)	$0	
Dairy employees support/patronize local businesses (multiplier effect), New ongoing business for existing support businesses	68 jobs at 1.69 multiplier [b] effect assumed $10/hr	$1,278,400	annual
Milk Production	N/A given that increased capacity for milk production in county would not lead to increased demand.	$0	
Total One Time Benefits		$7,012,403	one time
Total Annual Benefits		$2,115,400	annual

Note. County benefits based upon (Bos 2008)
Note a. Construction spending based upon cost per dairy for facilities and equipment * 36.91%
Note b. Multiplier from (Goldsmith 2001)
Note c. Data from (Porter 2009)

Table 15. The Balance Sheet

One-Time Benefits	Annual Benefits
$7,012,403	$2,115,400
Avg. One Time Cost	**Avg. Annual Cost**
($9,307,508)	($7,187,073)
Net One-Time Impact	**Net Annual Impact**
($2,2 95,105)	($5,071,673)

are estimated to be $7.01M in one-time investment and $2.12M annually from new income and taxes. These benefits are dependent on the assumption that approximately 64% of all investment expenditures are spent out of state (the out-of-state proportion we assumed, based on written and verbal statements from the project owner, is lower than the average out-of-state expenditure ratios for CAFOs in general). It is evident that the apparent benefits from this CAFO are fully negated when one accounts for the full costs of environmental, social, and community economic impact. This analysis does not recommend the continued implementation of TID CAFO in Jo Daviess County, IL.

WHAT'S NEXT

This information can be considered by elected officials and policy makers who seek to better understand the effects that a current or planned CAFO is having or may have on their community. While the surrounding region and/or ecosystem may differ depending on where a facility is sited, the ecosystem services surveyed and the approaches used can be applied and adjusted to fit changing circumstances and available information. It is our hope that those policy makers currently involved in TID proceedings, or those who may become involved, will consider utilizing this document to assist in any future decisions made regarding the Jo Daviess facility.

It is evident that the apparent benefits from this CAFO are fully negated when one accounts for the full costs of environmental, social, and community economic impact.

Future Research Topics

The research approach used in this analysis was based upon primary and secondary extant data, contingent valuation studies and benefits-transfer calculations, localization of non-local data, regression analyses and risk estimates. This required an extensive review of the literature concerning environmental, social, and community impacts resulting from previous CAFO implementations, along with some degree of customization/localization of these effects to arrive at preliminary risk estimates for potential CAFO impacts.

In order to solidify the assumptions made in the above analysis, future research should include:

- A willingness-to-pay survey for ecosystem services affected by IL CAFOs and adjacent communities.
- A study of migration from CAFO-impacted regions and income level thresholds of residents.
- An evaluation of property sales and changes in value over time in communities surrounding IL CAFOs.
- A study on the impacts of projected groundwater extraction upon the local water table.
- An analysis of the impact radius of water contamination occurring within karst topography.
- A residual-impact study of CAFO-related water contamination on BOD levels and fish populations.
- A health-impact quantification of illnesses and patient treatment costs in the vicinity of Illinois CAFOs.
- A survey of Illinois state parks within 10 miles of a CAFO, resulting olfactory and health-related effects, and specific attendance declines over time.
- A survey of property/income tax records in counties where CAFOs have become a major part of the local economy. Determine if income or property tax rates have dropped — not total tax collections but percentage for sales taxes or tax rates per $1,000 of real-estate or personal property. If not, then try to make some assessment of whether the quality of public services, i.e. schools, law enforcement, roads, and public health care, have increased. Increases in public expenditures do not mean increase in quality of public services if there have been increases in crime, sick people, damaged roads, and such. If CAFOs have actually contributed to the economic tax base of rural communities, tax rates for existing residents should have gone down or the quality of public services should have increased. (Ikerd, 2011)

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(Footnotes)

1 Anglers who fished in freshwater (excluding the Great Lakes) spent an average of $786 annually including food and lodging, transportation, equipment, and other costs US Fish and Wildlife Service (2006). 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Illinois.. Assuming river and stream anglers spent the same amount per year, this would amount to $230,298,000 annually

Notes on the Type

Set in Adobe *Jenson Pro,* Robert Slimbach's faithful adaptation of the first true Roman typeface, designed and cut in the late 15th century by Nicolas Jenson printing in Venice. The related italic is based on Ludovico Vicentino degli Arrighi's italic designs of the same era.
http://en.wikipedia.org/wiki/Adobe_Jenson

Display and headlines are set in Linotype *Syntax,* a modern sans-serif designed by Hans Eduard Meier.
http://en.wikipedia.org/wiki/Syntax_(typeface)

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