Implementation of Sustainability Improvements at the Facility Level: Business Motivations and Impact of P2 Intern Recommendations

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IMPLEMENTATION OF SUSTAINABILITY IMPROVEMENTS
AT THE FACILITY LEVEL: BUSINESS MOTIVATIONS
AND IMPACT OF P2 INTERN RECOMMENDATIONS

by

Vincent D. Kuppig

A THESIS

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IMPLEMENTATION OF SUSTAINABILITY IMPROVEMENTS
AT THE FACILITY LEVEL: BUSINESS MOTIVATIONS
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University of Nebraska, 2015

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Many sustainability and pollution prevention (P2) technical assistance programs exist across the United States. There is a need to quantify the actual impact using various metrics and, in addition, to identify the driving forces behind a company’s decision-making process. The University of Nebraska-Lincoln Partners in Pollution Prevention and the Kansas State University Pollution Prevention Institute intern programs partnered to complete 30 reassessments in 2014 to obtain specific information related to each P2 recommendation. After being reassessed, the clients were surveyed concerning their motivations for implementing and not implementing each recommendation; 23 clients responded to the survey.

The clients surveyed were slightly more engaged in sustainability activities than another national study. Of the clients reassessed in 2014, the overall implementation rate of recommendations was 54%. Clients that received more in-depth assistance implemented a higher percentage of recommendations and reported more benefit in savings for cost, energy, and solid waste than the clients that received assistance for part of a summer. Recommendations with paybacks of less than one year and implementation
costs of less than $1,000 were implemented at a higher rate those with longer paybacks and higher initial costs, but other factors beyond finances were important.

The survey data showed finances were less of a reason for implementation than a barrier to implementation. Finances were most important for equipment/process modification recommendations and least important for training/policies. Availability of capital was more of a financial barrier than poor payback, with other priorities for capital investments more important than a lack of capital. Financial motivations were not as important in the decision making for public institutions as for private sector entities. The relative unimportance of payback in the decision-making process suggests other indirect and intangible benefits often impacted the implementation of recommendations. Social motives were especially important for recycling and training/policies. Health and compliance factors were important for recommendations that directly reduced or eliminated toxins.
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CHAPTER 1: INTRODUCTION

1.1 Background

The United States Environmental Protection Agency (US EPA) defines pollution prevention as any practice that reduces, eliminates, or prevents pollution at its source. Pollution prevention (P2) “protects the environment by conserving and protecting natural resources while strengthening economic growth through more efficient production in industry and less need for households, businesses and communities to handle waste” (US EPA, 2015a). Sustainability is based on the fact that everything we need for our survival and well-being depends on our natural environment. Sustainability is important to make sure that we continue to have the water, materials, and resources to protect human health and our environment (US EPA, 2015b).

In order to help accomplish those goals, many sustainability and pollution prevention (P2) technical assistance programs exist across the United States, with a growing number of the programs using student interns to provide direct assistance to businesses and other organizations. The University of Nebraska-Lincoln (UNL) Partners in Pollution Prevention (P3) program and the Kansas State University (KSU) Pollution Prevention Institute (PPI) intern program have been promoting pollution prevention and encouraging sustainable business practices in their respective states for more than a decade.

The P3 program has worked with both area college students and Nebraska businesses since 1997. P3 is an outreach assistance program operated by the University of Nebraska Extension and College of Engineering and funded by the U.S. Environmental Protection Agency Region 7, the Nebraska Department of Environmental Quality, and a wide variety of businesses and industrial partners. After receiving several days of intensive pollution prevention training,
student interns provide one-to-one pollution prevention assistance to Nebraska businesses by performing waste assessments or other waste reduction and resource conservation projects, and providing each client with a written report detailing source reduction suggestions. The interns also give oral presentations at the end of the summer to the clients, faculty, fellow students, and funding sponsors along with question-and-answer sessions.

Established in 1989 within the College of Engineering at Kansas State University, the PPI intern program provides technical and regulatory compliance assistance. The program, funded in part by the Environmental Protection Agency, helps businesses advance sustainable practices. After attending several days of pollution prevention training, the interns work at their host company locations for a period of about 10 weeks over the summer.

The UNL and KSU programs have offered assistance modes for projects of varying complexities and depths. The programs both utilize three modes of assistance: partial summer, single summer, and multiple summer. Partial summer assistance is the least intense of the modes, where a student provides assistance to similar clients (often in the same sector). For example, the UNL program has had interns based out of county extension offices work with agriculture producers throughout the state of Nebraska, as well as interns work with wastewater plants around the state, providing “partial” assistance. The interns typically spend part of the summer (anywhere from a few days to a few weeks) at the business, and then prepare a technical assistance report for the client.

Single summer assistance and multiple summer assistance are similar, and are often referred throughout the thesis as “full” assistance. Full summer clients are those that are assisted by a student intern for a full summer. These clients receive in-depth assistance, oftentimes
focused on one or two specific projects or areas, throughout the summer. At the end of the summer, the clients receive a technical assistance report. The report often is more detailed and in depth than for clients that receive partial assistance. Single summer assistance includes clients that have participated with the UNL or KSU program for just one full summer during the period studied, while multiple summer assistance refers to clients that collaborated with one of the programs by hosting a student multiple times during the study period. Oftentimes with multiple summer assistance, the projects are related or a continuation of the previous summer, and the UNL or KSU programs are able to gain a greater relationship with these clients. The two programs and modes of assistance are further detailed in Section 4.1.1 (Technical Assistance Models).

1.2 Purpose for the Study

Understanding the business motivations and barriers in the implementation of sustainability improvements at the facility level is valuable. Knowing what drives a client to implement a P2 recommendation or keeps a client from implementing a P2 recommendation can help improve a technical assistance provider, and thus lead to a higher level of sustainability. The goal of this study was to evaluate the impact of two P2 intern programs in neighboring states to shed light on the possible range of differences as well as compare modes of client assistance that vary in depth, and identify the motivations and barriers to implementing P2 recommendations, which led to the following hypotheses:

- The mode (intensity) of assistance a client receives affects implementation rate and total savings (money, energy, solid waste, etc.) realized by a client.
• Most of the savings (impact) realized by a P2 intern program come from a small percentage of the clients assisted.

• A high percentage of implemented recommendations have a persistence (reoccurrence or longevity) of benefits of at least five years.

• The initial cost and projected payback period of a P2 recommendation has an effect on the implementation rate, and the types of motivations for implementation or non-implementation are affected by the initial cost and projected payback period.

• Sector of the client has an effect on implementation, engagement and motivations.

• Financial benefits are important in the implementation of P2 recommendations, but other indirect and intangible benefits cannot be ignored.

• Financial reasons are the main barrier to implementation of P2 recommendations.

• Financial reasons for implementation are least important for clients in the public sector.

The scope of this study included: (1) reassessments of previously assisted clients within the UNL P3 and KSU PPI programs to determine the implementation status and quantify the impacts of each P2 recommendation; (2) a survey of the reassessed clients to identify the motivations and barriers to implementing P2 recommendations; and (3) an analysis of the results from the reassessments and the surveys.

1.3 Thesis Overview

This thesis has six chapters and nine appendices. Chapter 1 provides an introduction and background information for the research. Chapter 2 is a review of technical literature related to the research topic. Chapter 3 describes methods used for both the reassessments and surveys, as well as the methods of the analysis. Chapters 4 and 5 both include results from the reassessment
and survey analyses, with Chapter 4 focusing on impacts of P2 intern recommendations and Chapter 5 focusing on the motivations and barriers to implementation of sustainability improvements. Chapters 4 and 5 are organized such that with limited modification each can be submitted to a journal for possible publication. Chapter 6 presents the conclusions of the research. Appendices include supporting documents and tables that are not included in the discussion but are referenced and/or would be useful as a source of additional information.
CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

To place this study in context, an overview of several related topics is presented in Chapter 2: first, a review of studies that examined companies’ engagement in sustainability activities; next, a summary of the findings from studies on the implementation and impact of pollution prevention assistance programs; and last, a overview of several studies that have focused on the motivations and barriers to implementation of sustainability improvements.

2.2 Engagement in Sustainability Activities

One way of understanding a company’s perception of sustainability and pollution prevention is to explore its self-reported engagement in various P2/sustainability activities. This was done in recent years in two large-scale national surveys by Massachusetts Institute of Technology (2011) and United States Department of Labor (2012). The MIT survey respondents included 3,107 manager and executives, representing every major industry and region of the world. According to the MIT results, waste reduction and energy efficiency were activities in which the respondents’ organizations engaged more frequently. Using a 1-to-5 Likert scale, “improving efficiencies and reducing waste activity” had the highest average response rate (3.69), and “revising compensation approaching and management incentives to promote sustainability-related strategies” had the lowest average response rate (2.39) (MIT, 2011).

The Green Technology and Practices (GTP) survey, conducted by the US Department of Labor, had a statistical sample size of 35,000 establishments and was designed to collect data on business establishments’ use of green technologies and practices during the pay period that included August 12, 2011. Of the businesses surveyed, 75% reported the use of at least one green
technology or practice during that pay period. The two most frequently reported types were those that improve energy efficiency (57%), and those that reduce the creation of waste materials as a result of operations (55%). The least commonly used green technology or practice was generating electricity, heat, or fuel from renewable sources primarily for use within the establishment (about 2%) (USDL, 2012).

2.3 Implementation and Impact of Benefits

Several P2 and energy efficiency (E2) driven organizations have conducted studies to determine their programs’ impacts. Oak Ridge National Laboratories focused on the impact of the U.S. Department of Energy’s Industrial Assessment Center (IAC) Program, an energy efficiency program at 30 university-based industrial assessment centers, and found an average implementation rate of $44 \pm 4\%$ (Martin et al., 1999). Guillemin and Goldberg (1999) found that the average implementation rate of P2 suggestions by clients of 16 P2 programs in the New England area was 44%. Lindsey (1999) found that a program run by a full-time professional obtained a 62% implementation rate when focused on getting implementation of a specific P2 technology, membrane filtration for in-process recycling. The US DOE (2015) has tracked the implementation rate of its IAC Program through an updated database, and has reported an average implementation rate of 50% dating back 1981. Two previous studies on the UNL P3 program have found an implementation rate of 42% for P3 reassessments from 1997-2004 (Youngblood et al., 2008a) and 44% for reassessments from 2005-2011 (Kekilova et al., 2014).

In terms of monetary savings, the National Pollution Prevention Roundtable tabulated yearly savings totals from 27 P2 programs across the United States and found per client savings ranged from $900 to $900,000, though it appears different assumptions were used when the
programs calculated their savings and it is unclear if clients reported potential or actual savings. Guillemin and Goldberg (1999) reported that 67% of 351 Massachusetts firms previously receiving P2 assistance said that P2 activities had saved them money. Andrews et al. (2002) found that 51% of 145 small- and medium-sized Australian businesses surveyed reaped financial benefits from implementing cleaner production. Youngblood et al. (2008a) found an average annual savings of $22,000 per client for the UNL P3 program from 1997-2004. Youngblood et al. (2008b) found that for the UNL P3 program from 1997-2004, in-depth complex technical assistance projects resulted in highest implementation rate and largest savings, whereas simpler projects and short-term assistance for clients resulted in the lowest savings and waste reductions.

When receiving P2 technical assistance, clients often report benefits outside of monetary savings or direct waste savings, or do not even realize the savings. An analysis of 614 publicly traded U.S. manufacturing firms constituting 2,837 firm-year observations for the year 1991-1996 led to the conclusion that managers underestimate the value of pollution prevention and thus underexploit waste prevention (Lenox and King, 2002). Guillemin and Goldberg (1999) reported that 66% of 351 Massachusetts firms said that P2 activities had employee health and safety benefits. Although the benefits were not directly reported, the results of a study on the P3 program illustrated that indirect savings, such as time and labor savings, reduced operating cost and cost of future liability, which may have substantial additional financial savings that often are not quantified (Youngblood et al., 2008a). A survey of 145 clients participating in the P3 program from 1997-2001 found that the most beneficial aspects of participating in the program were assistance in waste reduction and time saved for the waste-related issues (Dvorak et al., 2008).
2.4 Motivations for Implementation

It is important for technical service providers to understand what the driving forces are that lead businesses to implement sustainability improvements. Conventional wisdom would lead one to believe that finances are important, that if a company is going to make a profit by making an inexpensive change that involves pollution prevention, that company will implement that change. While finances clearly are important, a review of literature found there are other factors that also play a role in the decision-making process for sustainability improvements.

When making sustainable manufacturing decisions, the Manufacturing Engineering Division of American Society of Mechanical Engineers (ASME) noted that factors such as time, quality, resources, and costs have to be considered along with environmental performance (Haapala et al., 2013). Two previous studies (Huppe et al., 2006; Hoof and Lyon, 2013) both found that small and medium enterprises tend to implement pollution prevention projects with simple payback periods shorter than two years at a higher frequency. The US DOE has reported that implemented recommendations have a shorter projected payback period on average than recommendations not implemented for its IAC Program, 1.0 years vs. 1.3 years over the 35 years the program has been in place (US DOE, 2015).

A survey of 21 SME manufacturing facilities in the Toronto region found the top three drivers to participate in a program were: mandatory P2 requirements, 50% funding support, and environmental stewardship. Further, it found that cost savings and return on investment were important but not the primary consideration for implementing P2 projects (Granek et al., 2006). From the MIT survey, financial expectations from sustainability-related investments were the same as any other investment in 21% of the responses, whereas 19% of respondents reported that
intangible factors influenced decisions. Further, 10% of respondents allowed for longer expected returns in sustainability investments compared to other investments (MIT, 2011). For the P3 program from 1997-2004, Youngblood et al. (2008b) found that when implementation cost of a P2 recommendation is more than $1,000, other factors outside of finances were often important to the client when considering implementation.

Lyon and Maxwell (2002) examined voluntary approaches to environmental regulation in the United States and Europe through a review of then-existing literature and found that implementation was determined by the willingness and ability of firms. Even if direct profitability could be realized, the indirect effects associated with the action eventually determined whether it was profitable. Literature suggested that large firms implement voluntary corporate environmental actions because they make good business sense, but the mechanism linking environmental and financial performance was unclear (Lyon and Maxwell, 2002).

Williams et al. (1993) conducted a study on environmental pressures and their potential impacts on businesses, basing the results on a survey of the expenditures made by 117 firms in the United Kingdom in 1988 and a survey of future development of 25 firms of the West Midlands of the United Kingdom in 1991. It identified the following pressures: governmental, consumer and supplier, investor, community, and workforce. The motivations to implement sustainable practices fit one of two models: a “normative” model in which best management practices were conducted with social responsibilities of companies; and a model built around environmental standards with the use of economic instruments, such as effluent charges and taxes. Large multinational companies adopted the normative model because of their wider exposure to pressures. The larger companies also were more likely to value social issues
A study based on nine P2 programs in five regional and district councils of New Zealand found all councils reported participants benefit mainly via indirect benefits related to reduced potential fines or environmental actions, such as potential cleanup costs (Hughey and Chittock, 2011).

Sharfman et al. (2000) presented four case studies undertaken as part of a larger EPA-funded study that described environmentally conscious product and process innovations in high- and low-regulation environments. Among the key findings were: economic incentives have always been motivators for innovation, as was the case for environmental innovation, however regulation provided institutional pressure in addition to economic incentives; participative regulatory relations were helpful in the development of new products; autonomy and/or flexibility of operations was a major motivating factor in two cases when the firm used innovation to be able to pursue its business operations the way it so chose; and the market was beginning to view environmental factors as increasing important business factors, in that the market may force a firm to change its product, the market may see a product as an answer to future problems, or the market may perceive a product to have an advantage over competing products (Sharfman et al., 2000).

2.5 Barriers to Implementation

While several studies have examined what leads to the implementation of sustainability improvements, the barriers to implementation of those improvements have largely been unexplored. But, in order to understand the driving forces behind companies investing in sustainability, it is important to also realize what leads companies to not implement recommendations.
The Community Innovation Survey (CIS) conducted in Spain in 2012 examined the obstacles facing 6,553 firms from 44 industries involved in environmental innovations and how they still managed to achieve the innovations, finding that main difficulties for innovation were (ranked in order from first to fourth): lack of funds in the firm, high innovation costs, lack of external funding sources, and uncertain demand for innovative goods and services. Other obstacles, ranked from most important to least important among the remaining options, were: market dominated by established firms, lack of qualified staff, lack of information on technology, lack of information on markets, difficulty in finding cooperation partners for innovation, lack of innovations demand, and lack of need for previous innovations (Souto and Rodriguez, 2015). Blanchard et al. (2013) and D’Este et al. (2012) also found financial needs, high innovation costs, lack of qualified staff, lack of information, and uncertainty as the major constraints to the generation of innovation.

An analysis of studies and surveys related to energy-efficient investments in the United States identified some barriers to profitable investments in energy savings technologies: managerial compensation is tied to recent performance, explaining why managers prefer the projects with short payback periods; difficulties exist in monitoring the savings because of a lack of historical data for comparison; high costs exist for expanding management teams; and projects with higher anticipated rates of return are more likely to be selected, and some projects also will be selected because their actual returns have been overestimated (DeCanio, 1993).

Trianni and Cagno (2012) performed an investigation of 128 non-energy intensive manufacturing small and medium-sized enterprises (SMEs) in Northern Italy to identify the most relevant barriers to energy efficiency that limit a widespread implementation of the best available
technologies and practices. Lack of capital (access to capital) was perceived as very critical. Other major barriers were lack of information on cost-efficient energy efficiency interventions, and the form of information. In addition, awareness of personnel and management did not really represent a barrier. The study also found SMEs of different sizes and sectors exhibit different behaviors with respect to the perception of the barriers. The smaller companies (fewer than 50 employees) suffered more from lack of time or lack of internal skills than larger companies (100-249 employees) because of a less structured organization that typically has few people in charge of activities for enhancing energy efficiency (Trianni and Cagno, 2012).

Rohdin and Thollander (2006) investigated barriers to the implementation of energy efficiency measures in the Swedish non-energy intensive manufacturing industry through a case study using semi-structured interviews of eight companies. The major barriers found were (ranked in order): cost/risk of production disruption/hassle/inconvenience; lack of time or other priorities; cost of obtaining information on the energy consumption of purchased equipment; other priorities for capital investments; lack of sub-metering; and split incentives with energy service companies (Rohdin and Thollander, 2006).

Doniec et al. (2002) identified the broad “finance” category (lack of financial resources, high investment cost related to new technology implementation) as the top barrier to implementation of cleaner production strategies in Polish industrial organizations. Other main barriers were the “human factor” (low awareness level, inadequate mentality, employees’ habits) and “organizational” (problems related to changes, restructuring problems, lack of cooperation between relevant services within the enterprise, small scale activity) categories (Doniec et al., 2002).
Shi et al. (2008) examined the barriers to adoption of cleaner production by small- and medium-sized enterprises in China from the perspectives of government, industry and expert stakeholder groups. The researchers identified 20 barriers and grouped them into four major categories: policy and market barriers; financial and economic barriers; technical and information barriers; and managerial and organizational barriers. The policy and market barriers category was found to be most prominent barrier category, with the financial and economic barriers category following closely behind. Those two external barrier categories were found to be the most significant ones hindering the adoption of cleaner production, while the two internal barrier categories were less of a hindrance. The top three individual barriers were found to be: lack of economic incentive policies; lax environmental enforcement; and high initial capital cost (Shi et al., 2008).

2.6 Summary

A review of literature found that companies appear to be most engaged in waste reduction and energy efficiency in terms of pollution prevention activities, while they seem to be least likely to generate electricity, heat, or fuel from renewable sources. Several P2 technical assistance providers report an implementation rate around 40 to 50%, and most clients that receive assistance realize financial savings. They also report receiving benefits outside of monetary savings or direct waste savings, such as indirect or intangible benefits. While finances clearly are important in driving companies to make sustainability changes, other factors also play a role. Funding and high costs often are barriers to implementation of those sustainability improvements, though there are other external and internal barriers.
CHAPTER 3: METHODS

3.1 Introduction

Data used in this study are a result of reassessments of past clients of the University of Nebraska-Lincoln (UNL) Partners in Pollution Prevention (P3) program and the Kansas State University (KSU) Pollution Prevention Institute (PPI) intern program. The methods of this study include: (1) collection of data from reassessments, where clients previously assisted are interviewed to determine the implementation status and quantify the impacts of each P2 recommendation; (2) collection of data from a survey of reassessed clients; and (3) analyses of the reassessment and survey results.

In order for this study to be performed, UNL’s Institutional Review Board (IRB) process had to be completed. The IRB reviews research projects that involve human subjects to ensure that subjects are not placed at undue risk, that they give informed consent to their participation, and that their rights and welfare are protected throughout the project (UNL, 2015). This study was certified as exempt in January 2014, with the approval letter shown in Appendix D. Appendices B and C include the informed consent that was given to each client reassessed and surveyed.

The UNL P3 program has worked with both area college students and Nebraska businesses since 1997. The Pollution Prevention Institute intern program was established in 1989 within the College of Engineering at Kansas State University. Both programs assist a wide variety of businesses and industrial partners through undergraduate student interns providing one-to-one P2 assistance over the summer by performing waste assessments or other waste
reduction and resource conservation projects. The two programs and the varying forms of assistance they provide are further detailed in Section 4.1.1 (Technical Assistance Models).

3.2 Sampled Populations

The UNL P3 program performed reassessments of 13 past clients that originally were assessed from 2008 to 2013 and the PPI program performed reassessments of 17 past clients that originally were assessed from 2006 to 2013 for this study. KSU selected its reassessments randomly, dividing its pool of clients that received assistance into sectors to make sure each sector was represented and then using a random number generator. UNL contacted all of its previously assisted clients that had not yet been reassessed and then reassessed those that responded and agreed to be interviewed. On average for both programs, the reassessments performed in 2014 occurred 4.0 years after the initial assistance (maximum of eight years, minimum of one year); it should be noted that some clients for KSU had been at least partially reassessed previously when receiving follow-up assistance via the multiple summer mode of assistance, which is described in Section 4.1.1 (Technical Assistance Models). Of the 30 reassessed clients, surveys were sent to 28 clients; a few clients requested to not be surveyed. Of the 28 clients that received a survey, 23 responded.

Along with the clients reassessed in 2014, this data analysis in some instances also includes 25 UNL clients that were reassessed from 2005-2011 and subsequently surveyed as part of a study by Kekilova et al. (2014). Most of the clients that were reassessed from 2005-2011 received their primary original assistance between 2003 and 2010, though two received assistance before then (with the earliest being 1999). Those reassessment and survey results are included in this paper’s analyses when applicable to increase sample size. In some cases, because
some survey questions were not the same and because of the multiple years between when the reassessments were conducted, only reassessments from 2014 are included in some analyses. It is noted when those results are included and when they are not. All of KSU’s 2014 reassessments were from clients that received original assistance between 2006 and 2013. UNL’s 2014 reassessments were from clients that received original assistance between 2009 and 2013. A detailed breakdown of the clients reassessed and surveyed is in Section 4.2 (Overview of Clients Reassessed and Surveyed).

3.3 Reassessment of Past Clients

The KSU PPI and UNL P3 programs worked together to ensure the reassessments were performed in the same manner and followed the standard operating procedures described in the Quality Assurance Project Plan approved by the US EPA (Appendix A). PPI secured and trained an environmental technician to conduct the reassessments, with direct supervision from the PPI staff. P3 used a graduate student to conduct or head up the reassessments, with direct supervision from the P3 staff. The P3 and PPI teams also met on a regular basis to collaborate, cross-train, and share data.

The cover page for the reassessment forms, which is included in Appendix A and Section 4.1.2 (Reassessment Methods), has some basic information, such as each individual recommendation, if the recommendation was implemented (as suggested or with modification) or not implemented (investigated, not investigated, or the client contact doesn’t know if the recommendation was considered) and some brief comments. The reassessment forms (Appendix A and Section 4.1.2) include the specific annual savings realized from each recommendation, along with some key information, such as the initial cost of the recommendation, when it was
implemented, and how long the client expects it to continue (referred to as reoccurrence or persistence).

The main parameters reassessed include: initial cost; cost savings; recurring years of benefit; solid wastes diverted from landfill; hazardous wastes diverted from landfill; reduced hazardous materials use; reduced water use; and reduced energy use. Table 3.1 lists the parameters reassessed, along with the units for each category.

Table 3.1. Parameters Reassessed.

<table>
<thead>
<tr>
<th>Savings Information</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost savings</td>
<td>$/year</td>
</tr>
<tr>
<td>Initial cost</td>
<td>$</td>
</tr>
<tr>
<td>Electricity reduced</td>
<td>kWh/year</td>
</tr>
<tr>
<td>Natural gas reduced</td>
<td>therms/year</td>
</tr>
<tr>
<td>Other energy</td>
<td>gallons/year (propane, diesel)</td>
</tr>
<tr>
<td>Hazardous materials/waste reduced</td>
<td>lbs/year</td>
</tr>
<tr>
<td>Water use reduced</td>
<td>gallons/year</td>
</tr>
<tr>
<td>Solid waste reduced</td>
<td>lbs/year</td>
</tr>
<tr>
<td>GHG emissions reduced</td>
<td>MTCO₂E/year</td>
</tr>
</tbody>
</table>

Other parameters/general information:
- recommendation description
- recurring years of benefit
- expected reoccurrence
- releases prevented
- additional indirect/intangible benefits

In addition, a client/intern profile form was created for each company reassessed. This form included some basic information about the company reassessed and the intern who performed the original assistance, such as the company contact and position, the number of employees at the company site, the intern’s major and school, the intern’s GPA, and the intern’s extracurricular activities. The QAPP (Appendix A) and Section 4.1.2 (Reassessment Methods) further detail the methods of the reassessments, including example forms and an example reassessment narrative.
3.4 Motivation Survey

After the clients were reassessed, they were sent a mail or email survey to further determine their motivations and justifications for the implementation and non-implementation of specific P2 opportunities presented to them in the original assistance. Of the 30 businesses reassessed by the P3 and PPI programs, 28 verbally agreed to complete a future survey. Of those, 23 completed and returned the survey to the P3 or PPI program.

The survey, which is further detailed in the QAPP (Appendix A) and Section 4.1.3 (Survey Methods), consisted of three parts:

- Summary with brief information on the original assessment and the reassessment, including descriptions and benefits of the implemented and non-implemented recommendations.
- A definition of pollution prevention and a general question relating to engagement in P2 activities.
- Four specific questions on the motivations for each implemented and non-implemented recommendation.

The one general question assessed each client’s level of engagement in various sustainability and P2 activities on a Likert scale (1 to 5). For the specific questions, the clients were given a dozen reasons to select from and were asked why they either implemented or did not implement each recommendation. They were asked to select all the reasons and the top reason in two separate questions for both the implemented and non-implemented recommendations, for a total of four specific questions. The questions are listed in Table 3.2.
Table 3.2. Survey Questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>To what extent is your organization engaged in each of the following activities? Rate on a scale of 1 to 5, with the following assumptions: 1 – not considered; 2 - under consideration; 3 – sometimes applied; 4 – frequently applied; 5 – always applied.</td>
</tr>
<tr>
<td>Question 2</td>
<td>For each implemented P2 opportunity, what reasons were important to your organization in implementing the opportunity? Please check all that are appropriate.</td>
</tr>
<tr>
<td>Question 3</td>
<td>For each implemented P2 opportunity, what was the top reason/justification for implementation? Please write the letter (A – L) that was the top one reason/justification the P2 opportunity was implemented.</td>
</tr>
<tr>
<td>Question 4</td>
<td>For each P2 opportunity that has not yet been implemented, what are the reasons? Please check all that are appropriate.</td>
</tr>
<tr>
<td>Question 5</td>
<td>For each P2 opportunity that was not implemented, what was the top reason for not implementing it? Please write the letter (A – L) that was the top one reason the P2 opportunity was not implemented</td>
</tr>
</tbody>
</table>

The purpose of the first general question was to explore the clients’ self-reported engagement in different types of P2 activities, and to compare those responses to previous large-scale surveys: Second Annual Sustainability and Innovation Survey of Global Corporate Leaders (MIT, 2011), and Green Technologies and Practices Survey (USDL, 2012). The first general question was modeled from those two surveys and was the same as a previous P3 survey (Kekilova, 2013). The purpose of the specific questions was to better understand what was driving the implementation of specific recommendations as well as what barriers there were to recommendations that weren’t implemented. Section 4.1.3 (Survey Methods) further details the goals of the survey and the possible responses for the survey questions. The survey was approved by UNL’s Institutional Review Board as exempt in January 2014 (Appendix D).

Surveys were sent shortly after the clients were reassessed, typically within a few weeks. To increase the response rate, follow-up phone calls or emails were anticipated and a
phone/email script was prepared. Phone calls and/or emails were made about two weeks after the surveys were sent.

3.5 Data Management

A database was generated based on the reassessment reports from the UNL P3 and KSU PPI programs. The database includes both implemented and non-implemented opportunities, and includes data from both the reassessments and the surveys. The main parameters from the reassessments are listed earlier in Table 3.1. The database was kept electronically by the UNL P3 program and shared with the KSU PPI program at the conclusion of the study. The database spreadsheets can be found in Appendix H and I, with the company names omitted for anonymity.

3.5.1 Sector Categories

The sectors for the clients were categorized using the North American Industry Classification System (NAICS) code (United States Census Bureau, 2015). The sectors were generalized into the following groupings: manufacturing, public, health care, hospitality, and other. Clients in the “other” sector were those that did not fit in the rest of the sectors and typically were offices or warehouses. A sector breakdown of the clients reassessed and surveyed is included in Section 4.2 (Overview of Clients Reassessed and Surveyed) and Section 5.2 (Overview of Clients Surveyed).

3.5.2 P2 Categories

As part of the analysis, each individual recommendation was grouped into categories based on the similarities of the recommendations. The P2 categories were developed in part from a handout “P2 Approaches and Methods” (Appendix E) given to P3 interns at the beginning of each summer. The specific categories are defined below:
- **Energy efficiency**: reduction in energy usage for lighting, equipment, motors, insulation, control systems, sensors. This includes purchasing or equipment/process modification if energy efficiency is the main driving force, but generally does not include policies/training related to energy efficiency. It includes a one-time modification, such as reducing compressed air pressure, but not thermostat management, which falls under “training/policies.”

- **Equipment/process modification**: replacement of old or inefficient equipment; upgrading capability of existing equipment; process optimization; changes to improve efficiency (e.g., alternative testing for wastewater contamination, reducing operating pressure). This typically does not include energy efficiency-specific modifications, if energy efficiency is the main motivating factor for the modification.

- **Improved housekeeping/preventative maintenance**: minimize leaks, spills, and overflows, and improve housekeeping. This includes leak detection and repair for compressed air and water, routine inspection and maintenance of equipment, and spill prevention programs.

- **In-process recycling/modifying waste stream**: recycling of waste materials onsite (e.g., burning used oil for heat) or modifying the waste stream to become a product.

- **Material substitution**: using less hazardous, toxic or more environmentally friendly materials in a process.

- **Off-site recycling**: any recycling that is done off site. This typically involves more challenging materials such as batteries, solvents, used oil, oil filters, plastics, wood, and pallets.
• **Purchasing:** procedures that lead to purchase of less toxic/hazardous products; purchasing of green/recycled products; purchasing to reduce packaging, spillage, etc.

This category depends on the driving force to the P2 opportunity, as in purchasing is the main barrier or there is a barrier associated with the purchasing department.

• **Training/policies:** spill prevention practices; pollution prevention and environmental management system polices and plans; formation of pollution prevention and sustainability teams; inventory tracking; and education materials. This includes policies or training related to energy efficiency, such as instructing employees to turn off computers at night or placing reminders to turn off lights. It does not include purchasing of motion sensors or timers.

• **Water sensor/flow meter:** the installation of water sensors or flow meters or the continued use of them, specifically related to agriculture producers.

For some analyses, because of similarities, the above P2 categories were combined into broader groupings. When that is done, it is noted.

### 3.6 Statistical Analysis

When possible and/or applicable, an analysis of the reassessment and survey results was performed using SAS output and a Chi-square test with an alpha of 0.05 to determine if a statistical relationship existed. With a 0.05 alpha level (or 95% confidence level), there is a 5% probability that a true null hypothesis will be rejected (Type I error). A Chi-square test was used to identify relationships between two categorical variables in two related studies (Institute for Digital Research and Education, 2013; Kekilova et al., 2014).
CHAPTER 4: RESULTS – P2 INTERN ASSISTANCE PROGRAMS

4.1 Introduction

Sustainability and pollution prevention (P2) technical assistance programs exist in many jurisdictions in the United States. A growing number of the programs utilize student interns to provide a portion of the direct one-on-one assistance to businesses and other organizations. There is a need to quantify the actual impact of such technical assistance using various metrics. In the center of the United States, two states have relatively similar programs that utilize interns to assist business clients.

The Kansas State University (KSU) Pollution Prevention Institute (PPI) and the University of Nebraska-Lincoln (UNL) Partners in Pollution Prevention (P3) programs have each operated pollution prevention intern programs for more than a decade. Many businesses and public entities lack internal expertise and resources needed to identify and implement P2 opportunities that result in cost savings, waste reduction, energy savings and/or water savings. The KSU and UNL programs have worked with many organizations that have acted as host companies for interns completing assessments. In the past, both KSU and UNL have completed follow-up assessments, referred to as reassessments where previously assisted clients are interviewed to determine the implementation status and quantify the impacts of each P2 recommendation, with intern host companies to determine recommended project implementation rates and outcomes.

Several P2 organizations have conducted studies to determine their programs’ impacts. Oak Ridge National Laboratories focused on the impact of an energy efficiency program (Martin et al., 1999). Goldberg (2000) reported on P2 progress in 16 state and local agencies throughout
the New England area. The National Pollution Prevention Roundtable published results of an impact survey of 63 American P2 organizations (Spector and Roy, 2003). Youngblood et al. (2008) and Kekilova et al. (2014) both examined the UNL P3 program. The US Department of Energy has tracked the implementation rate of university-based industrial assessment centers, which also use student interns, for energy-oriented assistance (US DOE, 2015). The objectives of Chapter 4 are to evaluate the impact of two P2 intern programs in neighboring states to shed light on the possible range of difference and to evaluate modes of client assistance that vary in depth and intensity.

4.1.1 Technical Assistance Models

The University of Nebraska-Lincoln has offered pollution prevention/sustainability technical assistance to businesses in the state of Nebraska through the Partners in Pollution Prevention program since 1997. The program has student interns assist businesses by conducting assessments of waste streams and then developing suggestions to minimize waste generation. The program is operated by the University of Nebraska Extension and College of Engineering and is funded by the US EPA Region 7, the Nebraska Department of Environmental Quality, and industrial partners. The businesses come from varying sectors ranging from agricultural producers to manufacturers.

Established in 1989 within the College of Engineering at Kansas State University, the Pollution Prevention Institute intern program provides technical and regulatory compliance assistance. The program, funded in part by the Environmental Protection Agency, helps businesses advance sustainable practices. The program matches top-level engineering and environmental science students with Kansas business and industry. After attending several days
of pollution prevention training, the interns work at their host company locations for a period of about 10 weeks over the summer. The interns work on well-defined P2 projects to reduce energy use, emissions, and wastes, benefiting the company bottom line and the environment. Throughout Chapters 4 and 5, the programs are referred to by their university (KSU or UNL).

The two programs each have less than one full-time equivalent staff supervising the program. The interns who assisted businesses primarily were upper level undergraduate engineering students, with some environmental science and business majors as well. At the end of the summer, the interns provide the assisted clients with a written report that includes an analysis of the costs and benefits for each P2 recommendation. Over the years, UNL has offered assistance to a larger percentage of smaller businesses than KSU, though both programs have assisted businesses ranging from small to large and from varying sectors. UNL has specifically assisted several agriculture producers/irrigators, while KSU has worked with several businesses in the hospitality sector. UNL has had some solid waste-specific grants over the years, while KSU has had some grants focused more on energy efficiency in addition to having energy monitoring equipment available for its assessments.

To meet the needs of different clients, the KSU and UNL programs have offered assistance modes for projects of varying complexities and depths. The programs both have had three modes of assistance, with varying levels of intensity: partial summer, single summer, and multiple summer. Table 4.1 highlights the differences in the three assistance modes. Partial summer assistance is the least intense of the modes, where a student provided assistance to similar clients (often in the same sector). For example, KSU has had interns provide “partial” assistance to clients in the hospitality sector in the Kansas City metropolitan area; UNL has had
interns based out of county extension offices work with agriculture producers throughout the state of Nebraska, as well as interns work with wastewater plants around the state, providing “partial” assistance. The interns typically spent part of the summer (anywhere from a few days to a few weeks) at the business, and then prepared a technical assistance report for the client.

Table 4.1. Client Characteristics of Three Assistance Modes. (Percentages in Parentheses are for Clients Reassessed by the UNL and KSU Programs for this Study)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Partial Summer</th>
<th>Single Summer</th>
<th>Multiple Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost to client</td>
<td>None</td>
<td>Required cost share</td>
<td>Required cost share</td>
</tr>
<tr>
<td>Typical business sector for clients</td>
<td>Smaller businesses (62%)</td>
<td>Manufacturing (80%)</td>
<td>Manufacturing (55%)</td>
</tr>
<tr>
<td>Description</td>
<td>Client receives assistance from an intern for part of the summer</td>
<td>Client receives assistance from an intern for the entire summer</td>
<td>Client receives assistance from an intern for part the entire summer for multiple years in a row, often with the projects continued from or related to the previous summer</td>
</tr>
<tr>
<td>Primary supervision/ support</td>
<td>Program staff and cooperative extension staff</td>
<td>Client’s staff</td>
<td>Client’s staff</td>
</tr>
<tr>
<td>Number of clients per student intern</td>
<td>3-10</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Full summer clients were those that were assisted by a student intern for the full summer. These clients received in-depth assistance, oftentimes focused on one or two specific projects or areas, throughout the summer; at the end of the summer, the clients received a detailed technical assistance report. Full summer assistance is divided into two groups, single summer and multiple summer, for some analyses. Single summer assistance is similar to multiple, but refers to clients that participated with UNL or KSU for just one full summer during the period studied from 2005 to 2013. Multiple summer assistance refers to clients that collaborated with the UNL or KSU program by hosting a student multiple times during the study period. Oftentimes with the multiple summer assistance, the projects were related or a continuation of the previous summer, and the UNL or KSU programs were able to gain a greater relationship with these clients.
4.1.2 Reassessment Methods

The UNL and KSU programs conducted open-ended reassessment interviews in 2014 of 30 clients previously assisted by interns. The KSU and UNL programs worked together to ensure the reassessments were performed in the same manner and followed the procedures described in a Quality Assurance Project Plan approved by the US EPA (Appendix A). KSU secured and trained an environmental technician to conduct the reassessments, with direct supervision from the KSU staff. UNL used a graduate student to conduct or head up the reassessments, with direct supervision from the UNL staff. The UNL and KSU teams also met on a regular basis to collaborate, cross-train, and share data.

Reassessments consisted of:

1. Contact the client to arrange for a visit and discuss what a reassessment is with the client.
   Visit the client for several hours and discuss the status of each original P2 suggestion.

2. Review the original technical assistance report submitted to the client and review the hierarchy of data sources that will be used when collecting data, trying to obtain data from the highest quality sources possible (Tier 1: High-quality direct measures; Tier 2: Moderate-quality indirect measures; Tier 3: Low-quality indirect measures; and Tier 4: Non-Peer Reviewed Low-quality indirect measures).

3. Obtain the client’s description of the actual impact of implementing specific P2 recommendations, using the hierarchy of data sources, along with the client’s answers to several other questions that are part of the reassessment forms.

4. Ask the clients to consult purchasing orders, utility bills and waste disposal manifests to accurately quantify savings (Tier 1). If the purchasing and disposal records are not available,
ask the client to estimate an impact (Tier 2, assuming the client is of the experienced production staff/management). If the client asks for help in making an estimate, offer the potential savings estimated during the original assistance to derive a valid estimation. If necessary, use Tier 3 (equipment data from vendor specifications, or estimated data based on published industry standards, external calculation tool or outside expert opinion) or Tier 4 (estimated data based on non-peer reviewed published industry standards, external calculation tool or outside expert opinion, or estimates of use by new or inexperienced production staff/management) measures to estimate the savings.

5. Prepare a narrative feedback report for the client (and the UNL and KSU programs) that is first reviewed by the UNL or KSU staff and then by the client to confirm the findings.

A filled-out example of the reassessment questionnaire forms for a fictitious client are provided in Table 4.2 and Figure 4.1. Table 4.2 is a portion of the cover page for the reassessment forms and includes some basic information, such as each individual recommendation, if the recommendation was implemented (as suggested or with modification) or not implemented (investigated, not investigated, or the client contact doesn’t know if the recommendation was considered) and some brief comments. Figure 4.1 is a portion of the reassessment form for an implemented recommendation, the first recommendation from Table 4.2. It includes the specific annual savings realized from the recommendation, along with some key information, such as the initial cost of the recommendation, when it was implemented, and how long the client expects it to continue (referred to as reoccurrence or persistence).
Table 4.2. Example of a Filled-in Reassessment Form Cover Page.

<table>
<thead>
<tr>
<th>P2 Recommendation (Brief Description)</th>
<th>Implemented</th>
<th>Not Implemented</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As Suggested</td>
<td>With Modification</td>
<td>Investigated</td>
</tr>
<tr>
<td>Replace high bay lighting with T5 fluorescent in Building 3</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Install low-flow toilets in the conference complex</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch from pentachlorophenol to copper naphthenate for treating wood</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
### Company Information

<table>
<thead>
<tr>
<th>Company Name, Location &amp; Sector:</th>
<th>Company ABC; City, NE;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visitation Date:</td>
<td>June 1, 2014</td>
</tr>
<tr>
<td>Company Contact:</td>
<td>Jim</td>
</tr>
<tr>
<td>Contact Position:</td>
<td>Environ.</td>
</tr>
<tr>
<td>Assessor:</td>
<td>John Doe</td>
</tr>
</tbody>
</table>

### Intern Information (only on 1st page of Reassessment)

Intern Name(s) & Date(s) of Internship: Jack Student, 2010 summer

Notes:

### Benefits for Implemented

<table>
<thead>
<tr>
<th>Description: Replace high bay lighting in Building 3</th>
<th>Progress: Implemented as suggested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantification Possible: Yes</td>
<td>No</td>
</tr>
<tr>
<td>If no, why not?</td>
<td></td>
</tr>
<tr>
<td>When Benefits Started: June 2011</td>
<td>Reoccurrence so far (check time period): 3 Years</td>
</tr>
<tr>
<td>Is Benefit Still Occurring? Yes</td>
<td>No</td>
</tr>
<tr>
<td>If no, when ended?</td>
<td></td>
</tr>
</tbody>
</table>

If yes, estimate of how long it will continue: 5-15 more years

<table>
<thead>
<tr>
<th>Cost Savings</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings ($/yr): $21,000/yr</td>
<td>Electricity Reduced (kWh): 380,000 kWh/yr</td>
</tr>
<tr>
<td>Initial Cost ($): $50,000</td>
<td>Other Energy (Type, Quantity, Units):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hazardous Materials</th>
<th>Water Use</th>
<th>Water Pollutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds Reduced:</td>
<td>Gallons Reduced:</td>
<td>Pollutant Reduced (lbs. and type):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hazardous Waste</th>
<th>Solid Waste</th>
<th>Air Emissions (GHG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds Reduced:</td>
<td>Pounds Reduced:</td>
<td>Emissions Reduced (type): 412.5 MTCO2e/yr</td>
</tr>
</tbody>
</table>

### Releases & Intangible/Indirect Benefits

<table>
<thead>
<tr>
<th>Releases Prevented (avg): None</th>
<th>Material Prevented from Release:</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much will be prevented from release (lbs.)?</td>
<td>Where would release have gone?</td>
</tr>
</tbody>
</table>

Additional Indirect/Intangible Benefits: Potential for increased productivity from better lighting

Figure 4.1. Example of an Implemented Recommendation from a Filled-in Reassessment Form.

During the reassessment visit, any comments on implementation and quantification from conversations with clients were documented. Information gathered through the reassessments, in part, was used to understand the clients’ perception of the value of the assistance. Although P2 implementation performed by the client beyond the initial technical assistance was documented, it was not included in this analysis (to be conservative) if it was not directly based on interns’ work. The Quality Assurance Project
Plan (QAPP) in Appendix A includes the reassessment standard operating procedures and an example reassessment.

The cost savings discussed in this thesis are only client-provided direct operating costs (e.g., reduced purchasing of raw materials, disposal of waste, direct labor costs). Some of the cost savings are based on actual measurements by the clients and some are the clients’ estimate. Waste reduction metrics (hazardous, solid, etc.) were also collected in the same manner. The greenhouse gas (GHG) emissions reductions were calculated by the UNL and KSU staffs based on reductions in energy use (electricity, natural gas, diesel, and propane) and municipal water use. In calculating the greenhouse gas emission reductions, conversion factors for each specific energy source were used from the 2014 EPA GHG spreadsheet based on state-specific data from the US EPA eGrid (US EPA, 2012), and US EPA (2013). The calculator uses global warming potentials (GWPs) from the Intergovernmental Panel on Climate Change’s Fourth Assessment Report (AR4) (US EPA, 2014). Region/state-specific electricity conversion factors were used: for each 1,000 kWh, 1.086 metric tons of carbon dioxide equivalent (MTCO$_2$E) was reduced in Nebraska and 0.978 MTCO$_2$E for Kansas. For water conservation of non-heated water where actual energy use for treatment and pumping is not available, the conversion factors used were 3.583 MTCO$_2$E for Nebraska and 3.228 MTCO$_2$E for Kansas per 1,000,000 gallons water. Other factors used were: 5.32 MTCO$_2$E per 1,000 therms; 5.63 MTCO$_2$E per 1,000 gallons propane; and 10.5 MTCO$_2$E per 1,000 gallons diesel. No greenhouse gas emission calculations were calculated for solid waste diverted from a landfill. Example greenhouse gas calculations and assumptions are included in the calculations sections of the QAPP.
(Appendix A). The cost savings do not include the value of indirect benefits (e.g., reduced environmental liability, improved worker health and safety) because of the difficulty many clients had in providing estimates of these indirect benefits, but those benefits were documented when given by the client. To complete all of the reassessment steps for one client, on average about 20 work hours were spent.

4.1.3 Survey Methods

After being reassessed, in order to learn more about the clients’ thought process in implementing or not implementing recommendations, the clients were sent by postal mail or email (depending on their preference) a five-question survey. An example survey, with recommendations taken from Table 4.2 for the fictitious company, is shown in Table 4.3 and Table 4.4. The survey included one general question to assess each client’s level of engagement in various sustainability and P2 activities on a Likert scale (1 to 5), and four questions that were specific to each client’s recommendations. The survey respondents also were given a definition of pollution prevention for the survey: “Pollution prevention (P2) is reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less-toxic substances, implementing energy efficiency and resource conservation, and re-using materials rather than putting them into the waste stream.” This preceded the first general question. For the specific questions, the clients were given a dozen reasons to select from and were asked why they either implemented or did not implement each recommendation. They were asked to select all the reasons and the top reason in two separate questions for both the implemented and non-implemented recommendations, for a total of four questions as detailed in Tables 4.3 and 4.4. For
### Table 4.3. Example Survey Form.

<table>
<thead>
<tr>
<th>General Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) To what extent is your organization engaged in each of the following activities? Rate on a scale of 1 to 5, with the following assumptions: 1 – not considered; 2- under consideration; 3 – sometimes applied; 4 – frequently applied; 5 – always applied.</td>
</tr>
<tr>
<td>Building awareness of pollution prevention in the organization</td>
</tr>
<tr>
<td>Building culture of innovation by pursuing sustainability/P2 strategies</td>
</tr>
<tr>
<td>Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)</td>
</tr>
<tr>
<td>Reducing greenhouse gas emissions</td>
</tr>
<tr>
<td>Generating electricity, heat, or fuel from renewable sources</td>
</tr>
<tr>
<td>Improving energy efficiency</td>
</tr>
<tr>
<td>Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)</td>
</tr>
<tr>
<td>Reducing or eliminating the creation of waste materials</td>
</tr>
<tr>
<td>Reducing the creation or release of pollutants or toxic compounds</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2) For each implemented P2 opportunity, what reasons were important to your organization in implementing the opportunity? Please check all that are appropriate.</td>
</tr>
<tr>
<td>Replace high bay lighting with T5 fluorescent in Building 3</td>
</tr>
<tr>
<td>Install low-flow toilets in the conference complex</td>
</tr>
<tr>
<td>A. Acceptable payback period</td>
</tr>
<tr>
<td>B. Energy efficiency</td>
</tr>
<tr>
<td>C. Reduced operating cost</td>
</tr>
<tr>
<td>D. Increased employee productivity</td>
</tr>
<tr>
<td>E. Health and safety benefits</td>
</tr>
<tr>
<td>F. Regulatory compliance</td>
</tr>
<tr>
<td>G. Reduced environmental and health risk (spills, vapors, liability etc.)</td>
</tr>
<tr>
<td>H. Reduced business risk (impact of changes in regulation, input costs etc.)</td>
</tr>
<tr>
<td>I. Enhanced environmental awareness</td>
</tr>
<tr>
<td>J. Improved public image</td>
</tr>
<tr>
<td>K. Other companies also implemented the same or similar solution</td>
</tr>
<tr>
<td>L. Corporate commitment to resource use/waste reduction</td>
</tr>
</tbody>
</table>

For each implemented P2 opportunity, what was the top reason/justification for implementation? Please write the letter (A – L) from the above list that was the top one reason/justification the P2 opportunity was implemented.

| Replace high bay lighting with T5 fluorescent in Building 3                      |
| Install low-flow toilets in the conference complex                               |

For example, as Table 4.3 details, for an implemented recommendation of “Replace high bay lighting with T5 fluorescent,” the client was asked to check all the reasons that
Table 4.4. Example Survey Form (Continued).

<table>
<thead>
<tr>
<th>Specific Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4) For each P2 opportunity that has not yet been implemented, what are the reasons?</td>
</tr>
<tr>
<td>Please check all that are appropriate.</td>
</tr>
<tr>
<td>Switch from pentachlorophenol to copper naphthenate for treating wood</td>
</tr>
<tr>
<td>A. Not technically feasible</td>
</tr>
<tr>
<td>B. Lack of capital (financing)</td>
</tr>
<tr>
<td>C. Insufficient financial payback</td>
</tr>
<tr>
<td>D. Other priorities for capital investments</td>
</tr>
<tr>
<td>E. Risk of production disruption/inconvenience/slowdown</td>
</tr>
<tr>
<td>F. Lack of perceived environmental/risk reduction benefits</td>
</tr>
<tr>
<td>G. Limited in-plant expertise/capability</td>
</tr>
<tr>
<td>H. Lack of staff awareness/willingness to change</td>
</tr>
<tr>
<td>I. Customer specifications</td>
</tr>
<tr>
<td>J. Uncertainty/lack of confidence in technology (quality, cost, benefits)</td>
</tr>
<tr>
<td>K. Insufficient information regarding recommendation</td>
</tr>
<tr>
<td>L. Difficulty in coordinating between units within company</td>
</tr>
<tr>
<td>5) For each implemented P2 opportunity, what was the top reason/justification for</td>
</tr>
<tr>
<td>implementation? Please write the letter (A – L) from the above list that was the top</td>
</tr>
<tr>
<td>one reason/justification the P2 opportunity was implemented.</td>
</tr>
<tr>
<td>Switch from pentachlorophenol to copper naphthenate for treating wood</td>
</tr>
</tbody>
</table>

recommendation was implemented from a list of 12 possible reasons. The client was then asked to select the top reason. The same was done for all of the non-implemented recommendations, as detailed in Table 4.4 with the recommendation of “Switch from pentachlorophenol to copper naphthenate for treating wood.”

The purpose of the first general question was to explore the clients’ self-reported engagement in different types of P2 activities, and to compare those responses to previous large-scale surveys performed by Massachusetts Institute of Technology (2011) and United States Department of Labor (2012). The MIT survey respondents included 3,107 manager and executives, representing every major industry and region of the world. The Green Technology and Practices (GTP) survey, conducted by the US Department of Labor, had a statistical sample size of 35,000 establishments and was designed to collect
data on the use of green technologies and practices. The first general question for this survey was the exact same as a previous UNL survey (Kekilova et al., 2014), which also received UNL’s IRB approval. The question was modeled off the MIT and GTP surveys.

The purpose of the specific questions was to better understand what was driving the implementation of specific recommendations as well as what barriers there were to recommendations that weren’t implemented. The 12 possible responses covered the three pillars of sustainability (economic, environmental, and social), with some reasons focused primarily on just one of the pillars of sustainability and some encompassing a combination. The 12 reasons for the implemented recommendations came from a previous UNL survey (Kekilova et al., 2014), which were determined based off a review of several studies (Williams et al., 1993; Sharfman et al., 2000; Dvorak et al., 2008; Youngblood et al., 2008a; Hughey and Chittock, 2011; MIT, 2011; Diamond, 2013). The second specific question asked the client, of all the reasons selected in the previous question, for the top reason. This question was not asked in the previous UNL study but was added to this survey to help understand the top reason a client implements a P2 recommendation.

The final two questions were modeled off the first two specific questions, except for recommendations not implemented. These questions were not part of the previous UNL study, but they were added to this survey to help understand what barriers exist to implementing sustainability improvements. As was the case for the implemented reasons, the client had 12 reasons to select from. The 12 possible responses were not the same as for implemented recommendations, but they did cover the three pillars of sustainability,
with some reasons focused primarily on just one of the pillars and some encompassing a combination. Relatively few studies have been performed looking at the barriers to sustainability as they have on the motivations, but the 12 responses came after a thorough review of several previous studies (Trianni and Cagno, 2012; Rohdin and Thollander, 2006; Doniec et al., 2002; Shi et al., 2008) as well as multiple discussions of the UNL and KSU staffs based on previous experiences. As already stated, the survey received UNL’s IRB approval.

4.2 Overview of Clients Reassessed and Surveyed

KSU selected its reassessments randomly, dividing its pool of clients that received assistance into sectors to make sure each sector was represented and then using a random number generator. UNL contacted all of its previously assisted clients that had not yet been reassessed and then reassessed those that responded and agreed to be interviewed. On average, the reassessments performed in 2014 occurred 4.0 years after the initial assistance (maximum of eight years, minimum of one year).

Along with the clients reassessed in 2014, this data analysis in some instances also includes 25 UNL clients that were reassessed from 2005-2011 and subsequently surveyed as part of a study by Kekilova et al. (2014). Most of the clients that were reassessed from 2005-2011 received their primary original assistance between 2003 and 2010, though two received assistance before then (with the earliest being 1999). Those reassessment and survey results are included in this paper’s analyses when applicable to increase sample size. In some cases, because some survey questions were not the same and because of the multiple years between when the reassessments were conducted, only
reassessments from 2014 are included in some analyses. It is noted when those results are included and when they are not. All of KSU’s 2014 reassessments were from clients that received original assistance between 2006 and 2013. UNL’s 2014 reassessments were from clients that received original assistance between 2008 and 2013.

Figure 4.2 illustrates the past UNL and KSU clients analyzed for this study. This figure lists how many total clients have received assistance, were reassessed (including those that were not part of the analysis for this study), and responded to a survey from the primary time period studied. The outer boxes for both the KSU and UNL program show how many clients have been assisted, from 2005-2013 for UNL (120) and from 2006 to 2013 for KSU (71). The next boxes show how many of those total clients have been reassessed (94 for UNL and 40 for KSU). This box is divided by past reassessments (81 for UNL and 23 for KSU) and those performed in 2014 for this study (13 for UNL and 17 for KSU); some of the clients that were reassessed in 2014 by KSU also were at least partially reassessed previously when they received new assistance, but they are considered 2014 reassessments for this figure. The inner box shows the reassessed clients that have been surveyed (33 for UNL and 15 for KSU), divided for the UNL program by those clients that were previously reassessed and surveyed (25). The previous survey for the UNL program included the same first two questions.
The survey response rate for the clients reassessed in 2014 that were sent a survey was 82% (88% for KSU vs. 73% for UNL); two clients reassessed by UNL requested not to do a survey. The response rate was higher for clients that received full assistance (88%) than partial assistance (75%); two clients that received partial assistance were not sent a survey. The response rate for UNL clients that were reassessed from 2005-2011 and sent a survey in 2012 was 43%; one client, which is included as previously reassessed and as a previous survey respondent in Figure 4.2, was reassessed in 2010 and responded to a new survey sent in 2014. The time between the reassessment visit and survey being sent was several years in many cases for the clients reassessed from 2005-2011, while the clients reassessed in 2014 often were sent a survey a few weeks after the reassessment visit, which may explain the difference in response rates.
Figure 4.3 shows a breakdown of the clients reassessed by program (UNL or KSU), mode of assistance (full or partial), and number of employees at the specific location that received assistance (fewer than 100, 100-250, 251-1,000, or greater than 1,000 employees). This includes surveyed clients from previous UNL reassessments from Kekilova et al. (2014) and clients that were reassessed in 2014. UNL’s clients consisted of more that received partial assistance than KSU. Of the 17 clients reassessed by KSU, 65% received full assistance. Only 39% of the UNL clients received full assistance. Smaller businesses typically received partial assistance, while clients with more employees typically received full assistance. Of the clients that had fewer than 100 employees, 95% received partial assistance. Of the clients that had more than 250 employees, 80% received full assistance.

Figure 4.3. Breakdown of Clients Reassessed by Program, Company Size, and Mode of Assistance.
Of all the clients reassessed for this study, 36% were from the manufacturing sector as determined by the North American Industry Classification System (NAICS) codes. Most reassessed manufacturers (90%) were originally assisted using the full summer mode. The rest of the clients included those in the hospitality, health care, public (school districts, waste water treatment plants, government offices, etc.), agriculture producer, and other (warehouses, offices, etc.) sectors. Sector differences are not discussed in detail in this chapter. How sector impacts pollution prevention motivations is discussed in Chapter 5.

4.3 Engagement Results

One approach to understanding the clients’ perceptions was to explore their self-reported engagement in various pollution prevention and sustainability activities on a 1-to-5 Likert scale, with 1 being not considered and 5 being always applied. This was the first question asked on the survey, a general question that was the exact same for all of the clients. The general question, as well as the rest of the survey, was sent after the in-person reassessment to the contact who met with the UNL or KSU program to discuss the reassessment. It typically was the same contact who worked directly with the intern during the original assessment, often an environmental or facilities coordinator. Table 4.5 lists the average results from the engagement question, divided by mode of assistance (full and partial), along with responses from the MIT (2011) and GTP surveys (2012). The first column is each engagement activity rated by the survey respondents. The average responses from the MIT and GTP surveys are presented in columns 2 and 3, respectively; neither survey provided standard error data. Because not all of the responses
Table 4.5. Average and Standard Error for Level of Engagement by Program and Mode of Assistance.

<table>
<thead>
<tr>
<th>Engagement Activity</th>
<th>Responses to other surveys (sample size in parentheses)</th>
<th>Responses to this study’s surveys (number of clients in parentheses)</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIT (3,107)</td>
<td>GTP (35,000)</td>
<td>Total (48)</td>
</tr>
<tr>
<td>Improving energy efficiency</td>
<td>3.69</td>
<td>57%</td>
<td>3.9 ±0.1</td>
</tr>
<tr>
<td>Reducing or eliminating the creation of waste materials</td>
<td>3.69</td>
<td>55%</td>
<td>3.6 ±0.1</td>
</tr>
<tr>
<td>Reducing the creation or release of pollutants or toxic compounds</td>
<td>n/a</td>
<td>13%</td>
<td>3.6 ±0.2</td>
</tr>
<tr>
<td>Building awareness of pollution prevention in the organization</td>
<td>3.22</td>
<td>n/a</td>
<td>3.4 ±0.1</td>
</tr>
<tr>
<td>Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)</td>
<td>3.10</td>
<td>n/a</td>
<td>3.3 ±0.1</td>
</tr>
<tr>
<td>Building culture of innovation by pursuing sustainability/P2 strategies</td>
<td>3.06</td>
<td>n/a</td>
<td>3.2 ±0.1</td>
</tr>
<tr>
<td>Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)</td>
<td>n/a</td>
<td>19%</td>
<td>3.2 ±0.2</td>
</tr>
<tr>
<td>Reducing greenhouse gas emissions</td>
<td>2.83</td>
<td>13%</td>
<td>3.0 ±0.2</td>
</tr>
<tr>
<td>Generating electricity, heat, or fuel from renewable sources</td>
<td>n/a</td>
<td>2%</td>
<td>1.9 ±0.1</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>-</td>
<td>3.3</td>
</tr>
</tbody>
</table>

*Statistically significant difference at alpha of 0.05

were offered in these surveys, “n/a” indicates a response is not available for that particular survey. Responses for the GTP survey were provided in percentage of total establishments that reported application of the activity, while MIT also used a Likert
scale. Columns 4-8 show the average response for the UNL and KSU surveys, along with standard error (standard deviation of the mean divided by the square root of the number of observations of the sample), by mode of assistance and by program, and the total average response for all surveys.

Although some literature from the statistics field has cautioned against using averages from Likert scale questions for comparisons and there has been debate on how to statistically analyze Likert scale data (Jamieson, 2004; Allen and Seaman, 2007; Norman, 2010), the results are presented in this manner in part because only averages were available from the MIT study. Similarities between the respondents to the MIT survey and this study are visible from Table 4.5. Despite the differences in measurements (responses for the GTP survey were provided in percentage of total establishments that reported application of the activity), the GTP survey results showed similar trends to this survey in some cases, such as low engagement in generating energy from renewable sources and high engagement in energy efficiency and waste reduction. The respondents from this survey provided on average slightly higher results than the MIT survey for the activities that were the same in this survey and the MIT survey. This may be explained by the fact that these surveys were more recent than the MIT surveys, and/or perhaps the clients assessed from the UNL and KSU programs are slightly more environmentally conscientious than the national average. But, with the average response similar to the MIT survey, it would be reasonable to assume these clients as a whole are not atypical of business people in the United States.
In order to compare and statistically analyze the differences between the modes of assistance and between the programs in terms of engagement activities, the survey respondents were divided into those that selected 4 or 5 (frequently applied or always applied) and those that selected 1, 2, or 3 (not considered, under consideration, or sometimes applied). A Chi-square test was used to determine if a statistical relationship existed at an alpha of 0.05.

Comparing the KSU and UNL intern programs, the two programs were similar in terms of engagement relative to the number of clients that said they frequently or always apply various P2 engagement activities. For all activities, KSU’s clients were slightly more engaged than UNL (48% with a response of 4 or 5 for KSU vs. 46% for UNL or 3.3 for KSU vs. 3.2 for UNL on a Likert scale average), but the differences were not statistically significant (Chi-square with one degree of freedom = 0.2708, \( p = 0.603 \)). None of the individual engagement activities between the two programs yielded statistically significant differences at an alpha of 0.05, suggesting the two programs and the clients they work with have been similar in nature.

Comparing the modes of assistance for all clients surveyed, respondents that were provided full assistance had a statistically significant higher level of engagement for all the activities on average than those provided partial assistance (55% vs. 40%; Chi-square with one degree of freedom = 12.05, \( p = 0.0005 \)). The most significant differences were in conserving natural resources (58% vs. 25%; Chi-square with one degree of freedom = 5.49, \( p = 0.0192 \)), reducing greenhouse gas emissions (50% vs. 21%; Chi-square with one degree of freedom = 4.46, \( p = 0.0346 \)), and improving energy efficiency (88% vs. 79%; Chi-square with one degree of freedom = 6.42, \( p = 0.0112 \)).
63%; Chi-square with one degree of freedom = 4.0, \( p = 0.0455 \). There was not an overall difference between full and partial for KSU, though the sample size was only five for KSU clients that received partial assistance. The overall difference between full and partial assistance for UNL was significant (61\% vs. 35\%; Chi-square with one degree of freedom = 19.77, \( p = 0.00001 \)).

The higher responses by clients receiving full assistance may be a function of them being larger and more complex organizations that have a greater emphasis on sustainability (as most full summer clients were larger in number of employees than partial summer clients). Those clients that interacted with an intern on-site for an entire summer also may have become more engaged overall. Although the question was worded such that it was to represent all of the clients’ activities and is independent of the clients’ work with a P2 intern program, the survey occurred after the clients received assistance.

### 4.4 Reassessment Results

Reassessment data was used in this study to quantify the implementation rates and impacts (savings) gained by the clients from implementation of technical assistance P2 recommendations from the interns. Implementation rates and impacts were analyzed on the basis of mode of assistance, P2 assistance program, client sector, and category of P2 recommendation. Parts of this data came from close-ended questions. The example reassessments forms, as discussed previously and shown in Table 4.2 and Figure 4.1, detail much of the information that was collected from the clients during the reassessments.
4.4.1 Implementation Rate

One way to analyze the success of the original assessments is to look at the implementation rate. An analysis of reports from in-person reassessments of 55 past UNL P3 and KSU PPI clients was performed. This includes clients that were reassessed in 2014 by both UNL and KSU for this study, as well as those previously surveyed UNL clients that were reassessed from 2005-2011. Some clients were assisted over multiple years, referred to as multiple summer for the mode of assistance. Most clients received between two and seven total recommendations in a summer, though some received as few as one and some more than 10. In all, from the 55 clients that were reassessed, there were 504 recommendations. Taking into account that some companies were reassessed over multiple summers, including one for as many as six consecutive summers, the 504 recommendations came from 78 client summers for an average of 6.5 recommendations per client per summer. In determining the implementation rate: P2 opportunities that were presented to the client that weren’t recommended at this time, often because of long payback periods, weren’t included; and recommendations that included options, for instance doing one thing or another where it was not possible to do both, counted as one recommendation.

Table 4.6 lists the implementation rate by program and mode of assistance, with the number of clients and the number of recommendations in each category in parentheses below the implementation rate percentage. Column 1 is the program (KSU or UNL) and the combined total. Column 2 is the implementation rate for clients that received partial summer assistance, divided in the second and third rows by the KSU and
UNL programs. Column 3 is single summer assistance and Column 4 is multiple summer assistance, both divided in the second and third rows by the programs. Column 5 is the totals of all the modes of assistance.

Table 4.6. Implementation Rate by Program and Mode of Assistance (Number of Clients/Number of Recommendations in Parentheses).

<table>
<thead>
<tr>
<th>Mode of assistance/Program</th>
<th>Partial summer</th>
<th>Single summer</th>
<th>Multiple summer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>KSU</td>
<td>39% (6/31)</td>
<td>62% (5/13)</td>
<td>64% (6/74)</td>
<td>57% (17/118)</td>
</tr>
<tr>
<td>UNL</td>
<td>42% (23/187)</td>
<td>49% (10/99)</td>
<td>58% (5/100)</td>
<td>48% (38/386)</td>
</tr>
<tr>
<td>Total</td>
<td>41% (29/218)</td>
<td>51% (15/112)</td>
<td>60% (11/174)</td>
<td>50% (55/504)</td>
</tr>
</tbody>
</table>

Overall, it was found that 50% of all recommendations made by interns were implemented for clients reassessed in 2014 and previously surveyed clients, though some recommendations were implemented with modification. This is slightly higher than the implementation rate of 42% reported by Youngblood et al. (2008a) for UNL reassessments from 1997-2004 and the 44% reported by Kekilova et al. (2014) for all UNL reassessments from 2005-2011. Looking only at the new KSU and UNL reassessments performed in 2014, the implementation rate was 54% (57% for KSU and 52% for UNL). The overall implementation rate of 50% falls right in line with the 50% average found by the US Department of Energy for energy-related P2 recommendations made by student-driven Industrial Assessment Centers from 1981 to 2014 (US DOE, 2015) and is consistent with other studies that found implementation rates in the 40 to 60% range student-driven assistance programs (Martin et al., 1999; Guillemin and
Goldberg, 1999; Lindsey, 1999). KSU’s implementation rate was higher than UNL’s (57% vs. 48%), though not statistically significant (Chi-square with one degree of freedom = 2.8327, $p = 0.0924$). As discussed below, the mode of assistance is important and more of UNL’s reassessments were from clients that received partial assistance than KSU’s.

The implementation rate was analyzed by mode of assistance received on the original assessment: multiple, single, or partial summer assistance. As listed in Table 4.6, the greater the contact between the client and the intern program, the higher the implementation rate. A statistically significant relationship was found between the mode of assistance and implementation rate (Chi-square with two degrees of freedom = 14.1, $p = 0.0009$). Combining the single and multiple summer modes of assistance, full assistance resulted in an implementation rate of 57% versus an implementation rate of 41% for partial level of assistance, a statistically significant difference (Chi-square with one degree of freedom = 10.9861, $p = 0.00092$). This is consistent with the findings of Youngblood et al. (2008b) that in-depth complex technical assistance projects result in a higher implementation rate than simpler projects and short-term assistance. Interns that spent a full summer with a client (full assistance) are able to develop a better relationship and are able to provide the client with a more detailed report than those who spend part of a summer there (partial assistance). Interns also are able to better understand the clients’ processes and equipment. Further, clients receiving multiple summer assistance are able to create an even greater relationship with the intern program, which explains why
multiple summer assistance has a higher implementation rate than single summer (60% vs. 51%).

When the implementation data was separated into nine different types of P2 recommendations (energy efficiency, equipment/process modification, improved housekeeping/preventative maintenance, in-process recycling/modify waste stream, material substitution, off-site recycling, purchasing, training/policies, water sensors/flow meters) and analyzed by implementation rate based off mode of assistance, two types of recommendations stood out. Training/policies recommendations were implemented 83% of the time for clients receiving full assistance, while they were implemented only 38% of the time for clients receiving partial assistance for a statistically significant difference between the two modes of assistance (Chi-square with one degree of freedom = 11.9056, \( p = 0.00056 \)). A statistically significant difference (Chi-square with one degree of freedom = 4.5351, \( p = 0.0332 \)) also was found for improved housekeeping/preventative maintenance recommendations for full assistance (89% implementation rate) vs. partial assistance (64%). An intern that is with a client for an entire summer likely has a better understanding of the client’s culture and what would be successful in terms of training or policies than an intern who is there for only a small portion of the summer, which may explain the difference in percentages. Although not as extreme, the same also could be said for recommendations related to improved housekeeping or preventative maintenance.

4.4.2 Impact

Another way of considering a P2 program’s success is the impact of implementation in terms of cost savings, energy and natural resources use reductions, and
reduced waste production. The impact for reassessments performed in 2014 by UNL and KSU was calculated and analyzed and is listed in Table 4.7; this does not include previous UNL reassessments that were performed between 2005 and 2011 because the costs would not be an accurate comparison. The first column of the table lists the mode of assistance with the multiple and single summer clients combined into full because their results were similar. The number of clients for each mode of assistance is listed in the parentheses, with clients that received assistance for multiple summers counting as the number of summers assisted for normalization. For example, one specific client received assistance over six summers and is considered to be six clients for normalization because that client received assistance over six full summers. The second column in the table notes which row includes the total, average per client, and median values. The subsequent columns include data for client-reported annual cost savings, electrical and natural gas usage reduction, solid waste and hazardous waste disposal reduction, and water use

<table>
<thead>
<tr>
<th>Impact/Assistance</th>
<th>Measure</th>
<th>Cost savings $/yr</th>
<th>Electricity kWh/yr</th>
<th>Natural gas therms/yr</th>
<th>Solid waste lbs/yr</th>
<th>Haz. waste lbs/yr</th>
<th>Water gal/yr</th>
<th>GHG MTCO₂ E/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full (30)</td>
<td>Total</td>
<td>$2,727,626</td>
<td>9,183,980</td>
<td>555,273</td>
<td>24,243,850</td>
<td>29,600</td>
<td>34,983,500</td>
<td>12,280</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>$90,921</td>
<td>306,132</td>
<td>18,509</td>
<td>808,128</td>
<td>987</td>
<td>1,116,117</td>
<td>409</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>$46,209</td>
<td>69,914</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>147</td>
</tr>
<tr>
<td>Partial (17)</td>
<td>Total</td>
<td>$108,169</td>
<td>1,086,248</td>
<td>6,800</td>
<td>31,400</td>
<td>12,863</td>
<td>49,892,505</td>
<td>1,130</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>$6,363</td>
<td>63,914</td>
<td>400</td>
<td>1,847</td>
<td>757</td>
<td>2,934,853</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>$2,136</td>
<td>10,307</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Total (47)</td>
<td>Total</td>
<td>$2,835,795</td>
<td>10,270,228</td>
<td>562,073</td>
<td>24,275,250</td>
<td>42,463</td>
<td>84,876,005</td>
<td>13,410</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>$60,336</td>
<td>218,515</td>
<td>11,959</td>
<td>516,495</td>
<td>903</td>
<td>1,805,872</td>
<td>285</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>$20,300</td>
<td>21,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>63</td>
</tr>
</tbody>
</table>

Other notable impacts:
- 1,250,000 lbs/yr primary sludge and topsoil.
- 1,329,000 cubic feet/yr of Argon.
- 1,504,432 cubic feet/yr of welding gas.
- 360 gallons/yr of diesel.
reduction. The last column is the annual greenhouse gas emissions reductions, which were calculated by the UNL and KSU programs. Additional notable reductions are listed in the final row of the table.

A large percentage of the savings in each category in Table 4.7, with the exception of water savings, comes from clients that received full assistance compared to partial assistance. On average, the cost savings impact for clients that received full assistance was found to be nearly $91,000 compared to about $6,400 for clients that received partial assistance. The median cost savings for full summer assistance was $46,209, compared to only $2,136 for partial level of assistance. This is consistent with the findings of Youngblood et al. (2008b) that in-depth complex projects result in larger savings than simpler projects where the client receives short-term assistance. The one exception to full summer assistance being many times higher in impact than partial summer assistance was for water. Included in this analysis were several agricultural irrigators assisted by interns based out of extension offices who assisted the extension agents in providing one-on-one education of producers related to the value of a new technology (soil moisture sensors), which help producers determine when to use the irrigation system. One irrigator was able to realize an annual savings of 29 million gallons of water.

Clients that received assistance over multiple summers were considered multiple clients, based off the number of summers they were assisted, for determining the average and median impact in this analysis; this was done because these clients realized savings each summer they were assisted. The median savings for natural gas, solid waste and
water were all zero, as less than 50% of businesses realized a savings in those three areas. The cost savings in Table 4.7 do not include the value of indirect benefits (e.g., reduced environmental liability, improved worker health and safety) because of the difficulty in providing estimates of these indirect benefits. Although data was collected concerning energy and water reduction benefits and releases prevented, these were rarely a major focus of projects; due to the small sample size, they are not discussed in this study.

Also, Table 4.7 does not include the impacts from a number of opportunities that clients implemented on their own after receiving assistance that were not directly recommended by a student during the original assistance, though the client often indicated the student’s assistance played a role in leading the client to implement an opportunity on its own. For example, one client added an outdoor LED system that has amounted to an annual savings of $333,000 and 3.7 million kWh. Another client switched from a water vacuum pump to a closed oil pump, resulting in an annual savings of $120,000 and 4 million gallons of water.

Another way to analyze impact is through the Pareto analysis, which is shown for the clients reassessed in 2014 by UNL and KSU in Figure 4.4. Pareto analysis is a statistical method to explain the distribution of a set of numbers, such as wealth or impact, where typically the top 20% of ranked items account for 80% or more of the total; it’s often called the 80-20 rule (Freivalds and Niebel, 2009). In Figure 4.4, the impact of the 20% of clients with the largest reported values for each metric were displaced in light gray, as opposed to the impact from the other 80% of clients. Different clients may be in
the top 20% for each metric (e.g., some clients primarily implemented natural gas reductions and others primarily solid waste reductions).

As Figure 4.4 illustrates, cost savings is close to the 80-20 rule (the top one-fifth account for 74% of the total); greenhouse gas emissions and electricity also are close. Natural gas, solid waste and water come from almost exclusively the top 20% of clients. This shows that a few clients often accounted for a large percentage of the savings in a particular metric. A Pareto analysis also was performed for implemented recommendations, which yielded similar results where a large percentage of the savings
coming from a small number of the individual recommendations, but is not shown for brevity.

4.5 Number of Motivations

As part of the survey, clients were asked to select from a list of 12 applicable justifications for both implementation and non-implementation of each recommendation presented to them in the original assessment. After analyzing the number of justifications the client selected for both implementation and non-implementation, it was found that clients that received full assistance gave fewer motivations than those that received partial assistance. Those that received full assistance gave an average of 3.7 motivations for implementation compared to 5.3 for those that received partial assistance, while the difference for non-implemented recommendations was 1.9 reasons for full and 2.6 reasons for partial assistance. An analysis also was performed on the individual recommendations to see if the number of motivations may be a function of the implementation cost of the recommendations, but the differences were minimal and no trends were seen (4.7 for less than $1,000 vs. 5.1 for at least $1,000 for implemented recommendations and 2.6 for less than $1,000 vs. 2.0 for at least $1,000 for non-implemented recommendations).

The difference between number of motivations selected for full and partial assistance suggests that clients that received full assistance may have had a stronger emphasis on the source reduction recommendations, thus selecting fewer reasons. This may be because of the relationship and depth of assistance they had with the interns who made the recommendations and/or because clients that receive full assistance typically
were bigger companies and had a greater focus on sustainability than clients receiving partial assistance. This stronger priority is illustrated in the engagement results, where it was found clients receiving full assistance responded on average higher than those receiving partial assistance in various P2 activities. This also was seen with a higher implementation rate and a greater impact for full assistance over partial assistance.

4.6 Conclusion

The clients reassessed and surveyed by the UNL and KSU sustainability technical assistance intern programs were slightly more active than a national study in engagement in sustainability activities, with those large companies that received assistance for a full summer by one of the two programs being more engaged at a statistically significant level than those that received assistance for only part of a summer. Recommendations were implemented about half the time, with recommendations for clients that received more intense assistance being implemented at a statistically significant higher percentage than the recommendations for clients that received assistance for part of a summer.

On average, clients that received full assistance reported an order of magnitude or more of impact in savings for cost, natural gas, and solid waste than those that received partial assistance. The savings realized from the assistance of a student intern was sizable: on average, students that spent an entire summer with a client helped that business see an annual savings of more than $90,000 and a reduction of more than 400 MTCO$_2$E from energy and water savings. The Pareto analysis showed a large majority of the implemented impact for each metric from a small percentage of clients, especially for solid waste, water, and natural gas. Clients that received full assistance selected fewer
reasons on average for implementing or not implementing a specific recommendation than those clients that received partial assistance.
CHAPTER 5: RESULTS – GENERAL BUSINESS SUSTAINABILITY

5.1 Introduction

A challenge to technical assistance providers is to identify the driving forces beyond the decision a business may make to implement a change to improve their overall environmental sustainability. The data from reassessments and a survey of clients has been analyzed to identify trends related to motivations. The objective of Chapter 5 is to identify the driving forces and barriers to implementing P2 recommendations, considering the importance of client sector as well as the type of recommendation.

5.1.1 Technical Assistance Models

This chapter includes results from both the University of Nebraska-Lincoln (UNL) Partners in Pollution Prevention (P3) program and the Kansas State University (KSU) Pollution Prevention Institute (PPI) intern program. The two programs have student interns assist businesses and other organizations by conducting assessments of waste streams and developing recommendations to minimize waste generation. Over the years, UNL has offered assistance to a larger percentage of small businesses than KSU, though both programs have assisted business ranging from small to large and from varying sectors, including both public and private entities.

The two programs each have less than one full-time equivalent staff supervising the program. The interns primarily are upper-level undergraduate engineering students who receive several days of pollution prevention training before spending much of the summer working with host companies. At the end of the summer, the interns provide the clients with written reports detailing the P2 recommendations.
Both the KSU and UNL programs have offered different assistance modes based on the depth of a project. The two programs have had three modes of assistance, with varying intensity levels: partial summer, single summer, and multiple summer. Partial summer was the least intense, with a student providing assistance to multiple similar clients in one summer. For this mode of assistance, the students typically spent only part of a summer at the business. Single summer and multiple summer mode of assistance both refer to clients that had an intern there for an entire summer. The difference between the two was that single summer assistance was for clients that participated with the UNL or KSU program for just one full summer, while multiple summer assistance refers to clients that collaborated with one of the programs by hosting a student multiple times during the study period. Oftentimes with multiple summer assistance, the projects were related or a continuation of the previous summer. The two programs and modes of assistance are further detailed in Section 4.1.1 (Technical Assistance Modes).

5.1.2 Reassessment Methods

The UNL and KSU programs conducted open-ended reassessment interviews in 2014 of 30 clients previously assisted by students. These reassessments were performed in order to determine the implementation status of previous recommendations, quantify the impact (savings) of implemented recommendations, and gather other valuable information. The reassessment standard operating procedures and example forms are detailed in Section 4.1.2, Section 3.3 and the QAPP (Appendix A).
5.1.3 Survey Methods

After being reassessed, in order to learn more about the clients’ motivations for implementing or not implementing recommendations, the clients were sent a five-question survey. The survey included one general question to assess each client’s level of engagement in various sustainability and P2 activities, and four questions that were specific to each client’s recommendations to identify the client’s motivations for implementing or not implementing each recommendation. The survey’s components, along with an example survey, are further detailed in Section 4.1.3, Section 3.4, and the QAPP (Appendix A).

The survey sent to companies reassessed in 2014 was similar to a previous UNL P3 survey (Kekilova et al. 2014). The first general question relating to level of engagement and the first specific question on reasons for implementation of a recommendation were the same. The final three specific questions, which asked for the top reason to implement a recommendation and the reasons (both all and the top) for not implementing a recommendation, were new for this survey. In a few analyses where it was relevant, results from the previous UNL P3 survey (Kekilova et al. 2014) were included. It is noted in this chapter when those results are included.

Of the 30 clients that were reassessed in 2014, 23 responded to surveys. There were a few cases where the client did not answer all questions of the survey, which explains why the number of recommendations isn’t the same for the top reason and all the reasons later in this chapter when the survey results are discussed.
5.2 Overview of Clients Surveyed

The client base assisted by UNL P3 and KSU PPI is highly varied by sector and company size. The sectors for the clients were categorized using the North American Industry Classification System (NAICS) code. The sectors were generalized into the following groupings: manufacturing, public, health care, hospitality, and other. Clients in the “other” sector were those that did not fit in the rest of the sectors and typically were offices or warehouses. As noted previously, the clients received either full (multiple and single summer) assistance, where the intern spent the entire summer with the client, or partial assistance, where the intern spent only part of the summer with the client. A profile of surveyed clients by sector (manufacturing, public, other, health care, or...
hospitality), mode of assistance (full or partial), and number of employees (fewer than 100, 100-250, 251-1,000, or greater than 1,000) is provided in Figure 5.1. This includes clients that were previously surveyed (Kekilova et al., 2014). The largest number of surveyed past clients came from the manufacturing sector (40%), with 89% of the surveyed manufacturing clients receiving full assistance. Public had the next highest number of surveyed clients at 23% of the total. Smaller businesses typically received partial assistance, while clients with more employees typically received full assistance. Of the surveyed clients that had fewer than 100 employees, 93% received partial assistance. Of the surveyed clients that had more than 250 employees, 78% received full assistance. The majority of the surveyed smaller clients (fewer than 100 employees) came from the public (36%) or other (29%) sector.

5.3 Engagement results

As done in the previous chapter, one approach to understanding the clients’ motivations was to explore their self-reported engagement in various pollution prevention and sustainability activities on a 1-to-5 Likert scale, with 1 being not considered and 5 being always applied. Table 5.1 lists the average results from the engagement question, divided by client sector, along with responses from the MIT (2011) and GTP (2012) surveys. The table includes surveyed clients from both reassessments performed in 2014 and Kekilova et al. (2014). The first column shows each engagement activity rated by the survey respondents. The average responses from the MIT and GTP surveys are presented in columns 2 and 3, respectively; neither survey provided standard error data. Because not all of the responses were offered in these surveys, “n/a” indicates a response is not
available for that particular survey. Columns 4-10 show the average response, along with standard error (standard deviation of the mean divided by the square root of the number of observations of the sample). Columns 4-9 show the average response by sector, and the final column shows the total average response.

As discussed in the previous chapter, similarities between MIT and this survey – regardless of sector – are visible from Table 5.1. Despite the differences in measurements (responses for the GTP survey were provided in percentage of total establishments that reported application of the activity), the GTP survey results showed similar trends to this survey in some cases, such as low engagement in generating energy from renewable sources and high engagement in energy efficiency and waste reduction. Overall differences between this survey and the MIT survey are detailed further in the previous chapter. With the average response similar to the MIT survey, it would be reasonable to assume those clients as a whole are not atypical in the United States. The MIT survey respondents included more than 3,000 managers and executives representing every major industry and region of the world, while the GTP survey had a statistical sample size of 35,000 establishments and was designed to collect data on the use of green technologies and practices. Neither national survey detailed the differences in responses by sector.
Table 5.1 Average and Standard Error for Level of Engagement by Sector (Number of Client Respondents in Parentheses).

<table>
<thead>
<tr>
<th>Engagement Activity</th>
<th>Responses to other surveys</th>
<th>Responses to this study’s surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIT (3,107)</td>
<td>GTP (35,000)</td>
</tr>
<tr>
<td>Improving energy efficiency</td>
<td>3.69</td>
<td>57%</td>
</tr>
<tr>
<td>Reducing or eliminating the creation of waste materials</td>
<td>3.69</td>
<td>55%</td>
</tr>
<tr>
<td>Reducing the creation or release of pollutants or toxic compounds</td>
<td>n/a</td>
<td>13%</td>
</tr>
<tr>
<td>Building awareness of pollution prevention in the organization</td>
<td>3.22</td>
<td>n/a</td>
</tr>
<tr>
<td>Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)</td>
<td>3.1</td>
<td>n/a</td>
</tr>
<tr>
<td>Building culture of innovation by pursuing sustainability/P2 strategies</td>
<td>3.06</td>
<td>n/a</td>
</tr>
<tr>
<td>Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)</td>
<td>n/a</td>
<td>19%</td>
</tr>
<tr>
<td>Reducing greenhouse gas emissions</td>
<td>2.83</td>
<td>13%</td>
</tr>
<tr>
<td>Generating electricity, heat, or fuel from renewable sources</td>
<td>n/a</td>
<td>2%</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Statistically significant difference at alpha of 0.05 compared to rest of the sectors combined
As was performed in Section 4.3, in order to compare and statistically analyze the differences between sectors in terms of engagement activities, the survey respondents were divided into those that selected 4 or 5 (frequently applied or always applied) and those that selected 1, 2, or 3 (not considered, under consideration, or sometimes applied). A Chi-square test was used to determine if a statistical relationship existed.

Comparing the sectors in terms of engagement relative to the numbers of clients that said they frequently or always apply various P2 engagement activities (4 or 5 on the Likert scale), manufacturing was significantly more engaged than the rest of the sectors (60% with a response of 4 or 5 for manufacturing vs. 38% for all others; Chi-square with one degree of freedom = 20.64, \( p = 0.000006 \)). Overall, manufacturing was statistically more engaged than health care (60% vs. 37%, \( p = 0.0028 \)), other (60% vs. 24%, \( p = 0.0000 \)), and public (60% vs. 42%, \( p = 0.0046 \)). The sample sizes of agriculture (78% with a response of 4 or 5) and hospitality (48%) were not high enough to realize a statistical difference. Other (24% with 4 or 5) was statistically less engaged than all of the sectors. With 89% of the surveyed manufacturing clients receiving full assistance, this corresponds with the findings of Chapter 4 that clients receiving full assistance were more engaged than those receiving partial.

The “other” sector included offices and warehouses where the client typically did not own the building and therefore may not reap some of the long-term benefits of pollution prevention activities, which may explain why that sector is lower in engagement than the rest of the sectors. Manufacturing was significantly higher than the rest of the sectors combined in the following engagement activities: reducing or eliminating the creation of waste materials, conserving natural resources, and reducing
greenhouse gas emissions. This may be a function of these activities applying more to clients in the manufacturing sector than the rest of the sectors.

5.4 Reassessment Results

Reassessment data was used for this chapter to quantify the implementation rates and persistence, or reoccurrence, of technical assistance recommendations from the interns. Implementation rates were analyzed on the basis of client sector, category of P2 recommendation, and finances of the recommendation (initial cost and payback period). Parts of this data came from close-ended questions. The example reassessments forms, as discussed in the previous chapter, detail much of the information that was collected from the clients during the reassessments.

5.4.1 Implementation Rate

One way to analyze the success of the original assessments is to look at the implementation rate. An analysis of reports from in-person reassessments of 55 past UNL P3 and KSU PPI clients was performed. This includes clients that were reassessed in 2014 by both P3 and PPI for this study, as well as those previously surveyed P3 clients that were reassessed from 2005-2011. Most clients received between two and seven total recommendations, though some received as few as one and some more than 10. In all, from the 55 clients that were reassessed, there were 504 recommendations.

Sector

The implementation rate was analyzed by sector and mode of assistance (full or partial). There was not a statistically significant difference between the sectors for the same mode of assistance; the implementation was dependent on the mode of assistance, not the sector. For all sectors, the implementation rate for partial assistance was between
7 and 22% lower than that for full assistance. As noted in the previous chapter, the difference between full and partial was significant (41% vs. 57%).

**P2 Categories**

The implementation rate also was analyzed based on types of recommendations (P2 categories). There were nine P2 categories (including an agriculture-specific category called water sensors/flow meters), which were introduced previously. Table 5.2 lists the implementation rate by P2 category and mode of assistance. Column 1 is the P2 category. Columns 2 and 3 are implementation rates by mode of assistance (partial and full, respectively) for each category, and the fourth column is the total implementation rate for each category. In parentheses under the percentages are the numbers of recommendations.

Table 5.2 Implementation Rate by P2 Category and Mode of Assistance (Number of Recommendations in Parentheses).

<table>
<thead>
<tr>
<th>Mode of assistance/ P2 category</th>
<th>Partial</th>
<th>Full</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water sensor irrigation/ flow meter</td>
<td>100% (4)</td>
<td>- (0)</td>
<td>100% (4)</td>
</tr>
<tr>
<td>Improved housekeeping/ preventative maintenance</td>
<td>64% (14)</td>
<td>89% (38)</td>
<td>83% (52)</td>
</tr>
<tr>
<td>Off-site recycling</td>
<td>52% (29)</td>
<td>69% (29)</td>
<td>60% (58)</td>
</tr>
<tr>
<td>Training/policies</td>
<td>38% (39)</td>
<td>80% (30)</td>
<td>57% (69)</td>
</tr>
<tr>
<td>In-process recycling/ modify waste stream</td>
<td>30% (10)</td>
<td>63% (19)</td>
<td>52% (29)</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>37% (49)</td>
<td>48% (71)</td>
<td>43% (120)</td>
</tr>
<tr>
<td>Equipment/process modification</td>
<td>37% (54)</td>
<td>41% (73)</td>
<td>39% (127)</td>
</tr>
<tr>
<td>Material substitution</td>
<td>50% (6)</td>
<td>25% (16)</td>
<td>32% (22)</td>
</tr>
<tr>
<td>Purchasing</td>
<td>23% (13)</td>
<td>40% (10)</td>
<td>30% (23)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41% (218)</strong></td>
<td><strong>57% (286)</strong></td>
<td><strong>50% (504)</strong></td>
</tr>
</tbody>
</table>
Outside of water sensor/flow meter recommendations for agricultural irrigators, which had a sample size of only four, improved housekeeping/preventative maintenance recommendations were implemented at the highest rate (84%), a statistically significant difference from the rest of the categories (Chi-square with one degree of freedom = 24.7883, $p = 0.00001$). These included those that minimize leaks, spills, and overflows, and improve housekeeping. They typically required little to no initial cost and had a short payback period, which helps explain the high implementation rate. Other types of recommendations that had high implementation rates included off-site recycling (60%) and training/policies (57%), though not statistically significant different from all other categories. Off-site recycling recommendations often were those that could be considered low hanging fruit. As stated in Chapter 4, training/policies recommendations were implemented at a statistically significant higher rate for clients that received full assistance than partial (80% vs. 38%), as were improved housekeeping/preventative maintenance recommendations (89% vs. 64%). About half of the recommendations fell into the P2 categories of energy efficiency or equipment/process modification, which had similar rates (43% and 39%, respectively). The implementation rates for P2 categories also were analyzed by client sector and no notable differences or trends were found.

**Implementation Cost/Payback Period**

The implementation rate was analyzed based on the direct implementation cost and the projected simple payback period (e.g., reduced operating cost divided by implementation cost); the reported operating costs tended to only include easily quantifiable factors such as reduced material and utility inputs and reduced waste disposal costs, and did not include more difficult to quantify factors such as worker safety,
reduced liability and regulatory compliance costs. Figure 5.2 illustrates the implementation rate versus projected payback period in years, separating the implementation costs into less than $1,000 and $1,000 or greater and the payback periods into less than one year, from one to two years, between two and four years, and greater than four years. The recommendations were separated at initial costs of $1,000 in order to maintain data sizes (approximately a 60-40 split) and because $1,000 appeared to best represent a relative division point in the data. The figure also shows the number of recommendations for each respective payback period and implementation cost. This includes clients that were reassessed in 2014 by both P3 and PPI for this study, as well as those previously surveyed P3 clients that were reassessed from 2005-2011. Not included in the figure are a number of recommendations that had unknown implementation costs or unknown payback periods, as well as some that had no implementation cost and no cost savings, which explains why there are only 373 recommendations represented.

Figure 5.2. Implementation Rate by Payback Period and Implementation Cost.
Figure 5.2 shows the highest implementation rate occurs with a payback period of less than a year and an implementation cost of less than $1,000 (63%) and the lowest implementation rate at a payback period of greater than four years and an implementation cost of at least $1,000 (22%). This is consistent with past findings (Huppe et al., 2006; Hoof and Lyon, 2013) that small and medium enterprises tend to implement pollution prevention projects with simple payback periods shorter than two years at a higher frequency. It also falls in line with the findings by the US Department of Energy for energy-related P2 recommendations made by student-driven Industrial Assessment Centers that the average projected payback period is shorter for recommendations implemented than not implemented (US DOE, 2015). Within the respective projected payback categories, significant differences are seen in implementation between the costs for less than one year (63% for less than $1,000 vs. 39% for at least $1,000; Chi-square with one degree of freedom = 6.4057, \( p = 0.0114 \)) and greater than four years (50% vs. 22%; Chi-square with one degree of freedom = 6.0185, \( p = 0.0142 \)), but not significant for the other two payback period categories. Outside of the differences between the highest and lowest implementation rates seen at the far left and far right of the figure, respectively, the differences are less extreme (with implementation rate ranging between 39% and 58%) and follow no trend. This suggests there are other factors beyond implementation cost and payback period that are important in considering implementation of recommendations, which is consistent with previous studies (Granek et al. 2006, Youngblood et al. 2008b, MIT 2011) that found risk-based factors, indirect financial considerations and social factors often are important.
5.4.2 Persistence

As part of the interview for reassessments conducted in 2014, clients were asked to define the period of persistence (longevity) of benefits after the recommendations were originally implemented. The client also was asked when the recommendation was implemented, which in most cases was within a year of the client receiving initial technical assistance, and if the recommendation was still occurring. Only 2% of 129 recommendations that initially were implemented were no longer occurring during the reassessment visit, with the benefits realized by the client for less than a year in all cases. More than 95% of the recommendations where the client gave an estimate of how long the recommendation was expected to continue had a persistence of at least five years. In addition, of those recommendations where an implementation date was available, the recommendations on average already had seen a reoccurrence of 2.8 years. In other words, they were implemented on average 2.8 years before the reassessment and had an overall expected reoccurrence of at least five years. This suggests that sustainability improvements almost always continue for multiple years after they are implemented. These results are similar to findings of Kekilova et al. (2014), though with a higher rate of anticipated persistence of benefits. Kekilova et al. found via a survey of clients assisted two to eight years previously that only 48% of implemented off-site recycling recommendations had a persistence of more than a year, while 82% of all other implemented recommendations had a persistence of more than a year. The difference in the persistence rates may be a function of differences between data collection methodologies (in-person versus survey), length of time since the previous survey, and/or differences in the clients (with more partial assistance clients in Kekilova clientele).
5.5 Motivations

The reassessment results, particularly the implementation rate data, illustrated a need to further research the range of motivations for implementation of facility-level sustainability and P2 recommendations. In most cases, the data analysis for this section includes only results from clients that were reassessed and surveyed by P3 and PPI in 2014. In some cases, to increase sample size and when it is applicable, surveyed clients that were reassessed from 2005-2011 are included in the results. When that is the case, it is explicitly noted in this section.

For each implemented and non-implemented recommendation, each survey respondent identified motivations from a predetermined list of 12 options, first selecting all that applied and then identifying the top motivation. Figure 5.3 illustrates the percent of implemented recommendations for which each motivation was selected by respondents. There are three lines on the figure: the solid one for when the client was asked to select the top motivation for implementation; the dotted line for when the client was asked to select all the motivations; and the dashed line for the respondents’ selection of the top justification when acceptable financial payback was not selected as one of the reasons (a subset of the solid line for top motivation). The numbers of recommendations are listed in parentheses for each line. The y-axis corresponds to the percent of recommendations that has a particular motivation selected. Also shown at the bottom of the figure is a line that groups the motivations into the following categories: financial, social, and health/compliance, with “energy efficiency” and “other companies implemented” each standing on its own. The 12 motivations a respondent could select from for implemented
recommendations were grouped into those categories because of similarities within them and in order to be able to analyze what types of driving forces are most important in the decision-making process.

The frequencies that an option was selected as one of several motivations versus the top motivation were similar. The options most commonly selected as one of the motivations were also the ones most commonly selected as the top motivation. The reported motivations for non-implementation are shown in Figure 5.4, and like the data in

Figure 5.3. Motivations Provided by Respondent for Each Implemented Recommendation (Number of Recommendations in Parentheses).
the previous figure for implementation, the reasons most commonly selected as one of the motivations for non-implementation were also the ones most commonly selected as the top motivation. Those motivations are grouped into the following categories: financial, feasibility, personnel, and other. The two figures illustrate that the clients selected more than twice as many reasons for implementation than non-implementation when they were asked to select all the reasons that apply: 4.8 per implemented recommendation versus

![Figure 5.4](image)

Figure 5.4. Motivations Provided by Respondent for Each Non-Implemented Recommendation (Number of Recommendations in Parentheses).
2.2 per non-implementation recommendation on average. This suggests that if an insurmountable barrier is identified, the evaluation of the recommendation often ends right then. In addition, that barrier often is financial in nature.

When the survey respondent was asked to select the top motivation for each implemented recommendation, a financial justification accounted for 37% of the top motivations. For recommendations not implemented, a financial reason accounted for 56% of the top motivations. This suggests that finances may be more of a barrier to implementation than a reason to implement a P2 recommendation. Further, the top financial reasons not to implement a recommendation was “other priorities for capital investments” (26%). This reason also was selected more than any other reason when the client was asked to select all the reasons for non-implementation of a recommendation (56%). “Lack of capital” was the second most selected reason. Combined the two capital reasons accounted for 40% of the top reasons to not implement a recommendation compared to only 11% for “insufficient financial payback,” suggesting capital is more of a barrier than a poor payback. Further, the barrier is not a lack of capital as much as it is other priorities for investments. The relative unimportance of payback here suggests an appreciation of the indirect and intangible benefits.

This is consistent with past finding that financial reasons are major barriers to the implementation of a sustainability improvement (Souto and Rodriguez, 2015; Trianni and Cagno, 2012; Rohdin and Thollander, 2006; Doniec et al., 2002). That capital was the top barrier in this study is similar to the findings of Trianni and Cagno (2012) and Doniec et al. (2002). Most other studies did not differentiate between other priorities for capital and lack of capital or did not include both of them as options. This study suggests that both
are key barriers, but other priorities for capital may be more of a barrier than simply not
having enough capital on hand.

In order to better understand motivations where acceptable payback was not a
reason for implementation, an analysis was done on the implemented recommendations
where acceptable payback was not even selected as one of the reasons for implementation.
This is illustrated in Figure 5.3 with the third line. While the percentages for most of the
top reasons were similar for the implemented recommendations that did not select
acceptable payback as a reason, corporate commitment to resource use/waste reduction as
the top reason jumped from 16% for all implemented recommendations to 39%. This
highlights the importance of corporate commitment when the payback period may not
meet standard corporate expectations, which is consistent with the findings of Williams et
al. (1993) that social issues are important.

While “energy efficiency” and “reduced operating cost” were the most selected
reasons when the survey respondent was asked to pick the top motivation for each
recommendation, as Figure 5.3 shows, corporate commitment to resource use/waste
reduction was selected more than any other justification when the client was asked to
select all the reasons for implementation (84% of all recommendations). “Improved
public image” and “enhanced environmental awareness” also were often selected as a
reason for implementation (54% of the recommendations had at least one selected, and
27% had both selected), though they weren’t often selected as the top reason for
implementation. This further suggests the importance of these social reasons even though
they may not be the top reason why a P2 recommendation is implemented, and that there
are other factors beyond implementation cost and payback period that are important in
considering implementation of recommendations. Williams et al. (1993) also found that social issues are important to companies in the implementation of sustainability improvements.

5.5.1 Implementation Cost/Payback Period

Similar to implementation rate data, the recommendations were divided into categories for implementation cost and payback period and analyzed based on the financial motivations. Table 5.3 shows the percent of recommendations that had a financial reason as the top justification for implementing or not implementing based on payback period and initial cost. The first column is the payback period (less than one year, greater than or equal to one year, nothing, or unknown). “Nothing” for the payback period is where the recommendation had no initial cost and no cost savings. “Unknown” is where the payback period was unknown; typically the recommendation was expected to have some cost savings and some implementation cost, but those values were not able to be calculated or estimated. Columns 2 and 3 are recommendations that had implementation costs of less than $1,000, divided into implemented and not implemented. Columns 3 and 4 are for recommendations with implementation costs of at least $1,000, again divided into implemented and not implemented. The recommendations were separated at initial costs of $1,000 for the same reasons they were when analyzing the implementation rate, in order to maintain data sizes and because $1,000 seemed to best represent a relative division point in the data. The next two columns are for recommendations where the implementation cost was unknown. The last two columns are the totals for each payback period. The percent values within the table are the percent of
Table 5.3. Percent Top Reason is Financial for Implementation and Non-implementation by Payback Period and Implementation Cost (Number of Recommendations in Parentheses).

<table>
<thead>
<tr>
<th>Implementation cost/ Payback</th>
<th>&lt;$999</th>
<th>&gt;$1,000</th>
<th>Unknown</th>
<th>Total</th>
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<tr>
<td></td>
<td>Implemented</td>
<td>Not implemented</td>
<td>Implemented</td>
<td>Not implemented</td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>41% (51)</td>
<td>26% (23)</td>
<td>44% (9)</td>
<td>83% (12)</td>
</tr>
<tr>
<td>≥1 year</td>
<td>33% (6)</td>
<td>40% (5)</td>
<td>45% (21)</td>
<td>71% (34)</td>
</tr>
<tr>
<td>Nothing</td>
<td>17% (6)</td>
<td>0% (2)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unknown</td>
<td>-</td>
<td>0% (1)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>38% (63)</td>
<td>26% (31)</td>
<td>45% (30)</td>
<td>74% (46)</td>
</tr>
</tbody>
</table>

recommendations where the client selected a financial reason as the top reason for either implementing or not implementing the recommendation. In parentheses is the number of recommendations within that category.

For implemented opportunities, there was little variation between the payback period and initial cost categories for percent of recommendations where the top reason for implementation was a financial one. The financial reasons for implementation were actually slightly higher for the least financially appealing recommendations than the most (45% vs. 41%). There was not a statistical significant difference in financial motivations based on payback period and initial cost for implemented opportunities (using Chi-square with an alpha level of 0.05). Overall, as mentioned previously, regardless of payback period and initial cost, a financial reason was given as the top motivation for implementation for 37% of the recommendations. Clearly, other factors often were more important to clients in making decisions about implementation.
However, when looking at the top reason for non-implementation, there was more variation between the two extremes in terms of the frequency financial reasons were given (26% for shorter than one year projected payback and less than $1,000 initial cost vs. 71% for at least one year and at least $1,000). The statistical analysis found a statistically significant relationship between the four payback/cost categories and percent of financial motivations (Chi-square with three degrees of freedom = 15.5, \( p = 0.001 \)). Even the non-implemented recommendations that had a projected simple payback of less than one year but an implementation cost of at least $1,000 were not implemented because of financial reasons (79%), suggesting the main barrier may be based more off the availability of capital for implementing a recommendation than the payback period. This is further seen in the large difference in financial motivations for recommendations not implemented based on initial cost independent of payback period (73% vs. 21%).

While finances certainly are one of the top barriers in the decision-making process (56% of non-implemented recommendations), companies are concerned with more than payback and reduced operating costs; indirect and intangible benefits clearly are important.

The findings in this section and the previous section are consistent with results of a survey conducted in the Toronto region that found cost savings and return on investment are important, but they are not the primary consideration for implementation of sustainability improvements (Grenek et al., 2006), as well as the findings of Lyon et al. (2002) that large firms implement voluntary environmental actions for solid economic reasons, however the mechanism linking environmental and financial performance is
unclear. Williams et al. (1993) and Hughey and Chittock (2011) also found reasons beyond finances important to pollution prevention practices.

5.5.2 Sector

The motivations were analyzed by client sector (manufacturing, public, health care, hospitality, and other) for all of the implemented and non-implemented recommendations. Figure 5.5 illustrates the percent top motivation for implementation and the top motivation for non-implementation of recommendations by sector, with the reasons divided into categories as previously grouped at the bottom of Figure 5.3 and Figure 5.4. The “n” at the top of the “Implemented” and “Non-implemented” portions of the figure represents the number of recommendations in that respective client sector.

Ignoring the “other” sector because of its small sample size, energy efficiency was selected as the top motivation for implementation at a similar rate (15-25%) for all sectors. Clients in the manufacturing and health care sectors were similar in the rate of selecting a top financial motivation; however, they differed on specific financial motivation. Acceptable payback period was more important for clients in the health care sector (35%) than all other sectors (9% combined), a statistically significant difference (Chi-square with one degree of freedom = 9.5428, $p = 0.0020$). Reduced operating cost was more important for clients in the manufacturing sector (35%) than all other sectors (10%), a statistically significant difference (Chi-square with one degree of freedom = 9.292, $p = 0.0023$). Along with acceptable payback, corporate commitment to resource use/waste reduction (30%) was an important reason to implement recommendations in the health care sector. This compares to 11% for all other sectors (Chi-square with one degree of freedom = 4.884, $p = 0.0271$), including only 7% in manufacturing. This may
suggest corporate commitment is not as much of the main driving force to implement P2 recommendations in the pool of manufacturers studied compared to all other sectors, and

Figure 5.5. Top Motivations Provided by Respondent for Each Recommendation by Client Sector (Number of Recommendations Notated by “n” for Each Sector)
corporate commitment is especially important for the health care providers examined in this study.

A financial reason was selected by public sector respondents as the top motivation, for both implementation and non-implementation, less frequently than the rest of the sectors. The difference was approaching statistical significance for implementation (Chi-square with one degree of freedom = 3.5499, \( p = 0.0596 \)) and was statistically significant for non-implementation (Chi-square with one degree of freedom = 5.8964, \( p = 0.0152 \)).

Oftentimes, clients in the public sector are driven as much or more so by approval of boards, the public, and meeting specific criteria than by finances. Social motivations were more frequently provided by the public (44%) and health care (35%) sectors than hospitality (17%) and manufacturing (14%) when implementing recommendations. Health/compliance reasons were more important for manufacturing (19%) and hospitality (17%) than public (7%) and health care (4%), though it should be noted that hospitality is a sample size of only six implemented recommendations. This corresponds to the level of engagement results (Figure 5.1), which found the manufacturing and hospitality sectors had higher average responses for analyzing risks associated with P2 sustainability issues.

**5.5.3 Types of Recommendations**

Another way to analyze the motivations for implementation and non-implementation is to look at the types of recommendations. Figure 5.6 shows the top motivation for implementation and non-implementation based off P2 category, with the reasons divided into the same categories as they were for sectors. The types of P2 recommendations were broken down into five categories, two of which included more than one specific type of recommendation: energy efficiency, equipment/process
modification, recycling (both in-process and off-site recycling), training/policies, and other (improved housekeeping/preventative maintenance, material substitution, training/policies, and other (improved housekeeping/preventative maintenance, material substitution,

Figure 5.6. Top Motivations Provided by Respondent for Each Recommendation by P2 Category (Number of Recommendations Notated by “n” for Each Category)
purchasing). The types of P2 recommendations were divided into those four categories because of the similarities between the types of recommendations and the similarities between the motivations with each individual type of recommendation. For the implemented recommendations, “other” was mainly improved housekeeping/preventative maintenance (10 of the 15 recommendations in that category). Almost four-fifths of the recommendations not implemented fit the category of either energy efficiency (48%) or equipment/process modification (31%), which limited the analysis of non-implemented recommendations on the basis of motivation and type of recommendation.

A statistical analysis found a statistically significant relation between the five types of P2 categories shown in Figure 5.6 and the number of implemented recommendations that had a financial motivation (Chi-square with four degrees of freedom = 14.1312, p = 0.0069). Financial reasons were most frequently provided for the implementation of equipment/process modification recommendations (64%), while training/policies (7%) were least frequently provided. This suggests finances are not the main driving forces for recommendations dealing with training and policies, which typically had low initial costs but also did not realize significant monetary savings. Although the sample size was only six non-implemented recommendations, finances also was not a barrier for training/policies recommendations (17% selected a financial reason as the top motivation for non-implementation). Only energy efficiency and equipment/process modification types of recommendations had financial and energy efficiency reasons account for more than half of top motivations for implementation, suggesting indirect and intangible benefits outside of finances or even energy efficiency are important for the implementation of recommendations that deal with recycling,
training, and improved housekeeping/preventative maintenance. Social reasons were especially important for recycling and training/policies recommendations (provided 57% of the time for each category compared to no higher than 16% for the other categories), a statistical significant difference (Chi-square with one degree of freedom = 24.4477, \( p = 0.000 \)). Of the social reasons, corporate commitment to resource use/waste reduction was especially important: 43% for training/policies and 33% for recycling compared to only 4% for all other categories combined, a statistical significant difference (Chi-square with one degree of freedom = 22.6472, \( p = 0.000 \)).

Health/compliance reasons were most important with recommendations in the “other” category. An analysis of those recommendations where a health/compliance reason was selected as the top motivation for implementation found that several of those recommendations led to the reduction or elimination of toxins. In order to increase the sample size, an analysis was performed on implemented recommendations that reduced or eliminated toxins of UNL surveyed clients that were reassessed from 2005-2011 for Kekilova et al. (2014) in addition to those that were reassessed and surveyed in 2014. These implementations came from varying categories, as at least one implemented recommendation came from each type described earlier. When the survey respondent was asked to check all justifications for implemented recommendations, health/compliance motivations were selected most frequently when toxins were reduced or eliminated: reduced environmental and health risk (68% for toxins vs. 28% for others); health and safety benefits (55% vs. 28%); and regulatory compliance (45% vs. 22%). This highlights the importance of health, safety, and regulatory compliance when toxins are involved.
While energy efficiency and equipment/process modification recommendations had similar percentages for a financial reason being the top motivation not to implement, the specific reasons varied. Of the energy efficiency recommendations not implemented, 40% had other priorities for capital investments selected as the top reason not to implement with only 7% as lack of capital. Of the equipment/process modification recommendations, only 15% had other priorities for capital investments as the top reason with 22% as lack of capital. This suggests that clients may have the capital for energy efficiency recommendations, but that there are other uses for investments the client deems a priority. This is the case even though in both Kansas and Nebraska, low interest loans for energy efficiency projects have been available to the private sector.

For all categories of recommendations, a feasibility reason was occasionally selected as the top justification for non-implementation, though no trends were visible solely based off the categories. A further analysis determined that many of those non-implemented recommendations had an initial cost of less than $1,000 and a payback period of less than one year. Of the 23 non-implemented recommendations with a low initial cost and payback, nearly half selected a feasibility reason as the top motivation to not implement (22% not technically feasible, 22% customer specifications, and 4% insufficient information regarding recommendation). This suggests that there may have been some recommendations the client felt did not make sense with the company’s business model despite the student’s finding that the recommendation had attractive finances.
5.6 Conclusion

Based on the results of the survey of past clients reassessed by the UNL and KSU sustainability technical assistance programs, clients in the manufacturing sector had the highest average level of engagement in pollution prevention/sustainability activities, notably more engaged than other sectors. Improved housekeeping/preventative maintenance recommendations were implemented at a much higher rate than other types of recommendations. Almost all of the implemented recommendations had a persistence (reoccurrence) of at least five years after it was initially implemented. Recommendations with paybacks of less than one year and implementation costs of less than $1,000 were implemented at the highest rate, and recommendations with paybacks of more than four years and costs of more than $1,000 were implemented at the lowest rate, though there were other factors beyond finances that were important in considering implementation of recommendations.

There were more reasons given for implementation than non-implementation of each pollution prevention recommendation when a client was asked to select all justifications that applied. Finances were less of a motivation than a barrier for implementation, and finances were most important for equipment/process modification recommendations and least important for training/policies. Capital was more of a financial barrier for implementation than poor payback. Finances were not as important for public institutions, which typically are not driven by profit but by meeting expectations of boards and the public. Other indirect and intangible benefits were important when considering the implementation of recommendations. Social motives, particularly corporate commitment to resource use/waste reduction, were especially
important for recycling and training/policies recommendations. Corporate commitment also was important for recommendations that an acceptable payback was not a reason for implementation. Health and compliance factors were important for recommendations that involved toxins and VOCs.
CHAPTER 6: CONCLUSIONS

From the analysis of reassessments and surveys of the UNL and KSU sustainability technical assistance intern programs, a better understanding of the programs’ impact and of the driving forces and barriers to implementation was gained. Several key conclusions were made regarding the impact of intern recommendations and business motivations to implementation of sustainability improvements.

The clients reassessed and surveyed by the two programs during the study period were slightly more active than a national study in engagement in sustainability activities, with large companies that received assistance for a full summer being more engaged than those that received assistance for only part of a summer. Clients in the manufacturing sector had the highest average level of engagement in P2 activities.

Recommendations from the two programs were implemented about half the time, with recommendations for clients that received assistance for an entire summer being implemented at a higher percentage than for clients that received assistance for part of a summer. The savings realized from the clients were sizable. On average, clients that received full assistance reported an order of magnitude or more of impact in savings for cost, natural gas, and solid waste than those that received partial assistance. Improved housekeeping/preventative maintenance recommendations were implemented at a higher rate than other types of recommendations, and training/policies recommendations were implemented at a much higher percentage for clients receiving assistance for an entire summer than part of a summer.

Almost all of the implemented recommendations had an expected persistence (reoccurrence) of at least five years after they were initially implemented. The Pareto
analysis showed a large majority of the savings coming from a small percentage of clients. Clients that received full assistance selected fewer reasons on average for implementing or not implementing a recommendation than those clients that received partial assistance.

Recommendations with paybacks of less than one year and implementation costs of less than $1,000 were implemented at the highest rate, and recommendations with paybacks of more than four years and costs of more than $1,000 were implemented at the lowest rate, though there were other factors beyond finances that were important in considering implementation of recommendations.

There were more motives given for implementation than non-implementation of each P2 recommendation when the clients were asked for all reasons that applied. Finances were less of a motivation than a barrier for implementation, and finances were most important for implementation of equipment/process modification recommendations and least important for implementation of training/policies. Capital was more of a financial barrier for implementation than poor payback. Finances were not as important for public institutions, which typically are not driven by profit but by expectations of boards and the public.

Other indirect and intangible benefits were important when considering the implementation of recommendations. Social motives, particularly corporate commitment to resource use/waste reduction, were especially important for recycling and training/policies recommendations. Corporate commitment also was important for recommendations that an acceptable payback was not a reason for implementation. Health and compliance factors were important for recommendations that involved the reduction or elimination of toxins.
REFERENCES


APPENDIX A: QUALITY ASSURANCE PROJECT PLAN (QAPP) FOR EPA

A1: Title and Approval Sheet

Quality Assurance Project Plan (QAPP)
for Source Reduction Assistance

Kansas State University (KSU)
Pollution Prevention Institute (PPI)
In partnership with
University of Nebraska – Lincoln (UNL)

<table>
<thead>
<tr>
<th>Project Officials</th>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project PI and manager</td>
<td>Nancy Larson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Director, KSU PPI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project QA officer</td>
<td>Bruce Snead</td>
<td></td>
<td></td>
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<tr>
<td>K-State</td>
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<tr>
<td>Project subcontractor</td>
<td>Bruce Dvorak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Director, UNL P3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA Project officer</td>
<td>Jeannette Kerr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality assurance manager</td>
<td>Diane Harris</td>
<td></td>
<td></td>
</tr>
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</table>

*Effective date of this plan.
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A3. Distribution List
The following individuals will receive copies of the approved QAPP:

Nancy Larson, Project PI, KSU PPI
David Carter, Project reviewer, KSU PPI
Yvonne Cook, reassessment staff, KSU PPI
Bruce Dvorak, subcontractor, UNL, P3
Vincent Kuppig, subcontractor staff, UNL P3
Jeannette Kerr, EPA Region 7
Christina Schmaltz, EPA Region 7

A4. Project Task/Organization

Jeanette Kerr, EPA Region 7
Provide oversight to KSU PPI and UNL to ensure successful completion of grant projects.
913-551-7245

Diane Harris, EPA Region 7
QA Manager
Review QAPP and provide final approval.
913-551-7258

Nancy Larson, KSU PPI
Project Lead
Responsible for administering grant, reporting, and records management; assist data collection and review in accordance with QAPP.
316-660-0104

Bruce Snead, Project QA Officer K-State
Responsible for reviewing and maintaining QAPP.
785-5324992

Dr. Bruce Dvorak, UNL
Project Director for UNL portion
Responsible for administering contract and reviewing data.
Responsible for reassessment forms, standards and final data analysis.
402-472-3431

David Carter, KSU PPI
Assist in project lead for 6 months, primarily with data review.
785-532-9998

Yvonne Cook, KSU PPI
Reassessment staff
785-210-6414

Vincent Kuppig, UNL
Reassessment staff
402-472-3431
A5. Problem Definition/Background
The Kansas State University Pollution Prevention Institute (KSU) and the University of Nebraska – Lincoln (UNL) Partners in Pollution Prevention (P3) have each hosted pollution prevention (P2) intern programs for multiple years. Many organizations lack internal expertise and resources needed to identify and implement P2 opportunities, some of whom have worked with KSU and UNL as host companies for interns completing assessments. In the past, both KSU and UNL have completed follow-up assessments with intern host companies to determine recommended project implementation rates and outcomes. This program will complete on-site reassessments in both states, and then further study what motivates these past intern companies to implement recommendations and changes that produce measurable environmental outcomes, as well as factors that prevent companies from making the changes.

Actual reassessments and documentation associated with the reassessments will be performed by undergraduate students, graduate students, and hourly staff members under the supervision of the KSU and UNL P3 programs. This quality assurance project plan (QAPP) will be used as a guidance template for the KSU and UNL Partnership to Reassess P2 Implementation and Study Related Motivating Drivers program under the requirements of Source Reduction Assistance. All staff involved with this project will be trained on the contents of this QAPP, and the importance of using and documenting generally acceptable data collection procedures.

A6. Project /Task Description
The project strategy includes the following systematic tasks:
- Update existing reassessment forms for collecting environmental and behavior change data from past intern host companies.
- Obtain IRB approvals for survey tools to be used with project. These approvals are required if data is to be presented in any papers or manuscripts.
- Develop a QAPP for submittal to EPA. Survey tools and a standard operating procedure document are included as Appendix A-C of the QAPP.
- Identify a list of industry contacts as potential participants. Industries that have hosted multiple interns will be prioritized. The remaining reassessments will be selected from a list of industry types, pulling from different sectors to get a good representation.
- Train existing staff and environmental technicians to perform on-site reassessments of past clients. The QAPP will be included in the training.
- Reassess past intern projects (up to 25 total). This will be done with the assistance and oversight of KSU and UNL project leads.
- Review the reassessment results collected during the initial reassessment. Unless otherwise specified, the word review is used in this document as a verb and means to exam formally with the possibility or intent to change if needed. The review will compare the initial intern recommendations and the responses or answers provided by the host industry during the reassessment. The review will also include a close
examination of which of the four-tier data valuation categories (data quality indicator) has been assigned and request clarification as needed. If new data results are collected, the review will include replicating the calculations to confirm the same data outcome. This will be done by KSU and UNL professional staff. Reassessment staff will follow up with clients as needed to obtain complete surveys.

- Send a reassessment summary to each client for review and comment.
- Send out a short, six-question survey concerning motivation for implementing specific P2 suggestions. The survey after the fact will result in specific answers from the client, separate from the narrative gathered by the reassessment staff, as both types of data are useful. The survey will also quantify the length of time the client continued to gain benefit from each P2 suggestion implemented.
- Analyze the data. UNL will use a graduate student to enter the reassessment data and perform an initial data analysis. Under Dr. Dvorak’s guidance, the student will prepare a short report, which will be part of the final report.
- Collaborate to publish the study and data nationally. This will ensure the partnership work, methodology, and data are transferred to both industry and technical assistance providers.

**A7. Quality Objectives and Criteria**

The primary objective is to obtain environmental outcomes from the previous intern clients through a reassessment process. The reassessment staff will evaluate client implementation and re-evaluate environmental outcomes (behaviors and performance data) related to recommendations of the original/previous P2 intern. The goal is to collect the best possible data, despite potential limitations associated with client willingness or ability to provide detailed information.

Data gathered for this project will include environmental performance data (e.g., gallons, kWh, and pounds), financial data (e.g., cost of electricity, labor rates, and equipment costs), and changes in behavior (e.g., additional P2 opportunities implemented and further P2 assistance). The reassessment staff will use a KSU-and UNL-developed standard method for collecting the information.

The second objective will be to investigate client motivations that led to action or a decision not to take action. With input from KSU, the UNL developed a survey tool and method to collect this information.

Both KSU and UNL teams will use the same tools for all work. These tools are contained in the appendix.

Use of common tools and methods will allow this project to meet the precision data quality indicator (DQI). A four-tiered data valuation system will be used to address the accuracy of the DQI. The following are the four levels of data accuracy:
Tier 1: High-quality direct measures
- Utility bills (electricity, natural gas, water)
- Purchasing invoices (for diesel fuel costs and quantities)
- Metered/measured by business (e.g., Waste or material use logs)
- Initial estimate, based on meter/measurement by business
- Initial estimate, based on meter/measurement by intern;
- Equipment data (e.g., motor horsepower and efficiency, pipe sizes) from nameplate

Tier 2: Moderate-quality indirect measures
- Verbal estimates of use by experienced production staff / management
- Previous intern’s tier 2 data

Tier 3: Low-quality indirect measures
- Equipment data from vendor specifications used to make usage estimates
- Estimated data based on published industry standards, external calculation tool, or outside expert opinion.

Tier 4: Non-peer reviewed low-quality indirect measures
- Estimated data based on non-peer reviewed published industry standards, external calculation tool, or outside expert opinion.
- Estimates of use by new or inexperienced production staff / management

Other DQIs, including but not limited to bias, accuracy, and comparability, will be utilized as part of the data review and analysis.

A8. Special Training Certification
If site-specific health and safety training is required for gathering data, the host company is responsible for providing it.

A9. Documents and Records
All staff involved in the project has reviewed the draft QA project plan. When EPA finalizes the plan and approves it, the updated copy will be provided to and reviewed with all project staff. KSU and UNL will provide standardized reassessment forms and a notebook for staff performing reassessments. These will be used to record all data collected during reassessments. In most cases, a short narrative report will be written to summarize each reassessment. Data collected on-site as part of the reassessment, as well as phone and e-mail correspondence will all be maintained as part of the records.

It is not anticipated that equipment will be used as part of this project, but if it is, KSU will maintain all records (including calibration records) for a three-year period past the
close out period. KSU and UNL will document the type of equipment used and associated procedures as part of the file. For example, if the equipment is calibrated, then this will be documented. Calibration documentation will remain with the equipment storage at the respective primary university locations.

Reassessment forms, summary report, motivation survey, and any further notes or site-specific documents will be maintained by reassessment staff and then provided to KSU and UNL staff. When the project is complete, KSU will maintain all documents and records for a period of at least three years from the date of close out. These documents, both hard copy and electronic will be maintained at the KSU Wichita satellite office managed by the project lead, Nancy Larson.

Due to the proprietary nature of some data, the host company may be reluctant or unwilling to release copies of such to the staff. Consequently, KSU and UNL may be unable to maintain these records, but will have the name and contact information of the host company employee with access to these records in their final reports.

B1. Sampling Process Design (Experimental Design)
This project data collection design does not include collecting samples that would need to be analyzed by a certified laboratory.

As previously stated, it is not anticipated that equipment will be used as part of this project, but if it is, KSU will maintain all records (including calibration records) for a three-year period past the close out period. KSU and UNL will document the type of equipment used and associated procedures as part of the file. For example, if the equipment is calibrated, then this will be documented.

KSU reassessment staff will reassess up to 20 different intern projects and UNL will reassess at least five. Partners will collaborate to select a sampling of host companies representing a variety of industry and institutions. Host companies that have hosted interns multiple years will be prioritized.

In most cases, measurements made by a previous KSU or UNL intern as part of a previous project will be used. More precise methods of gathering data – such as utility records and equipment installed and calibrated by the host company – will be encouraged to quantify environmental and economic savings. The highest tier data will be sought first to the extent resources are available. As noted in section A7, a four-tiered data valuation system will be used to address the accuracy DQI.

A tiered system of greenhouse gas (GHG) conversation factors (based on source reduction type) will be used to address the accuracy of the DQI. The highest level (e.g., A) will be used when possible. Results will be reported to the nearest tenth.
A. Data from the US EPA’s 2014 EPA Pollution Prevention Programs GHG Calculator spreadsheet will be used for electricity, other stationary sources (e.g. natural gas, diesel, propane), mobile sources (e.g., diesel, gasoline), and for municipal unheated water when direct energy use data for pumping and treatment is not available. For electricity and municipal water, the state-specific conversation factors will be utilized.

B. US EPA Warm model (http://epa.gov/epawaste/conserve/tools/warm/index.html) for specific cases of source reduction (especially for organic/food waste reductions).

In each case, the following will be listed in the calculation appendix for each reassessment: tool used, version, and key assumptions / input factor.

B2. Sampling Methods
Not applicable.

B3. Sample Handling and Custody
Not applicable.

B4. Analytical Methods
Not applicable.

B5. Quality Control
Not applicable.

B6. Instrument/Equipment Testing, Inspection, and Maintenance
Not applicable.

B7. Instrument/Equipment Calibration and Frequency
Not applicable.

B8. Inspection/Acceptance of Supplies and Consumables
Not applicable.

B9. Non-direct Measurements
By design, this project will follow up with past host companies to determine whether P2 recommendations have been implemented. When projects have been implemented, the reassessment staff will refer to the original intern’s data collection and calculations to
determine if expected results are still applicable to the recommendation. In some situations, staff and interns are merely using data that has already been gathered by the host company or third parties, such as utility companies or private consultants. In all cases, staff will make attempts to verify implemented P2 data and will then categorize it as Tier 1, 2, 3 or 4. The highest tier data will be sought first to the extent resources are available.

B10. Data Management
Data collected as part of this project will be recorded on reassessment forms, within a narrative summary report, and disaggregated by tiers for the final report. KSU and UNL will maintain these field documents and electronic documents in Word and Excel as part of overall data and records management. As noted above in section A9, KSU will be responsible for maintaining data records for at least three years after project close out.

Examples of standard engineering equations and conversions used by KSU and UNL staff are noted below.

- **Energy conservation:** Several of the past intern facilities have implemented lighting efficiency projects that result in energy use reduction. For example, if a facility implements lighting-efficiency projects that reduce energy use by about 380,000 kWh per year, at a cost of .056 per kWh, the facility would realize a cost savings of approximately $21,000, and greenhouse gas reductions of 412.5 MTCO$_2$e a year. The detailed calculations for this example are provided in Appendix A.

- **Water conservation:** A number of businesses, including hospital and lodging facilities, have implemented water conservation projects. For example, low flow toilets may be implemented at a facility resulting in 250,000 gallons a year of water savings, cost savings of $5,000 a year, and greenhouse gas reductions of 0.9 MTCO$_2$e a year. The detailed calculations for this example are provided in Appendix A.

- **Toxics Source Reduction**– Source reduction quantities and cost impacts will be estimated. For example, a business has switched from using pentachlorophenol to copper naphthenate for wood treating, reducing the quantity of sludge requiring incineration and reducing TRI reported emissions. The detailed calculations for an example are provided in Appendix A.

The project staff will document the equations and demonstrate how the data was calculated in the client summary report and in some cases as part of the field notes. In all cases, staff must document their data collection methodology, sample size, and calculations as part of their reports. Reassessment standard operating procedures are in Appendix B.

As with most data gathered by KSU, environmental and economic data collected will be entered into KSU PPI’s database system, and possibly the Region 7 P2 Results
Measurement Application on the Pollution Prevention Regional Information Center website. KSU will coordinate with UNL to ensure data reported to Region 7 is not duplicated.

**C1. Assessments and Response Action**

As noted in the work plan, staff will fill out reassessment forms (examples provided in Appendix A) and prepare a short narrative report with appendices that documents key assumptions, calculations, and literature data sources used. It is expected that KSU and UNL will find that most companies reassessed have implemented at least one or more projects that were originally recommended by the intern.

Most of the on-site reassessments will take place between May – September 2014. Most of the final motivational surveys will be sent and collected between August and October 2014. All reassessments will be conducted by KSU or UNL staff, primarily reassessment staff as noted in section A.3.

Results of each reassessment will be reported to and reviewed by either KSU or UNL staff, then by the host company. KSU and UNL will meet once a month to review project progress and ensure data collection consistency. Problems or concerns that arise when working with host companies or gathering data will be addressed immediately or as part of a meeting. In some cases the EPA technical project advisor may be asked to join a meeting.

**C2. Reports to Management**

KSU and UNL management will be kept informed of the internal project progress as part of the reassessment review process, through internal meetings, and the monthly project team meetings that involve most or all of the KSU and UNL project team (see A.4). Reassessment staff will gathered data and send draft calculations to KSU and UNL as part of a draft summary report. As previously noted, KSU and UNL staff will review summary report and once finalized, the summary report will be sent to host-company. Next, KSU and UNL will send a short client motivation survey concerning motivations for implementing specific suggestions to the host company clients. See Appendix C for the survey. The survey after the fact is to get some very specific answers from the client, separate from the narrative, as both types of data are useful. The survey will also quantify the length of time the client continued to gain benefit from each implemented P2 suggestion. All data will be available for data analysis at least three months before the end of the project in March 2015. This reassessment data will be entered and an initial data analysis performed by both KSU and UNL. Data from the client motivation survey will be analyzed and then combined with past survey data by UNL staff. These will be complied into a short report by UNL, which will become a part of the final report.
KSU will submit the semi-annual progress reports and the final report to EPA Region 7. The final report will be collaboratively prepared by KSU and UNL to publish the study and data nationally, and ensure partnership work, methodology, and data are transferred to both industry and technical assistance providers.

D1. Data Review, Verification and Validation
In preparation for each reassessment, staff reviews the previous intern report and recommendations. Staff then asks the host company specifically whether the past recommendations were implemented or not. If implemented, staff reviews the expected environmental and cost saving results (previously calculated by the original intern) with the host company representative. It is at this point that the host company can indicate if data seems appropriate or not. Next, staff will ask about additional P2 projects the host company has implemented and the related measures. As part of the internal review of the data, KSU/UNL reviewers determine whether data collected can be verified and appropriately categorized using the four-tier data quality and objective system as detailed above in section A7. If it does meet the quality objectives as defined in A7, then the data will be accepted, if not it will be questioned for further clarification or rejected. In cases where the KSU/UNL reviewer has questions, or the client reviewer disagrees with the estimate, the reassessor will be asked to re-calculate the impact measurements. If the data cannot be validated, then the data will be rejected. This process and the related calculation will be documented in the field notes as well as in the summary report. KSU and UNL will collaborate on data decisions to ensure consistency.

D2. Verification and Validation
All data collected from KSU and UNL clients for the purpose of reporting to EPA under this project are collected and verified using the procedures noted below:

1. Reassessor (undergraduate student, graduate student, or hourly worker) collects data on site, with follow-up data collected via phone or e-mail directly from the client.
2. When required, the reassessor will make calculations based on the information provided by the client. In these cases, an appendix (as noted above and an example provided in Appendix A) will be prepared and attached to the reassessment form and also the reassessment summary.
3. Data is documented by the reassessment staff, and then reviewed by KSU or UNL, before it is sent to the client in summary format for review and comment. After the client has had an opportunity to review the data, P2 staff will review data second time before finalizing results and reports. Data will be categorized into tiers 1-4 as previously described. In some cases, data from the KSU/UNL review will be compared to data results from other similar studies and to examples published in the technical literature. Data will be accepted if it is considered
reasonable and can be reproduced by the reassessment staff and the KSU/UNL reviewer. In cases where the KSU/UNL reviewer has questions, or the client reviewer disagrees with the estimate, the reassessor will be asked to re-calculate the impact measurements. If the data cannot be validated, then the data will be rejected. This process and the related calculation will be documented in the field notes as well as in the summary report. KSU and UNL will collaborate on data decisions to ensure consistency.

4. Once data and technical reports have been through a KSU/UNL review and edited, the final product will be reviewed for grammatical edits by the KSU editor.

5. UNL will be responsible for statistically analyzing data, and looking for relationships and notable trends. UNL will then prepare a short report, which will be part of the final report.

D3. Reconciliation with User Requirements

After a staff member has gathered data for a project, he or she will send draft calculations to both the host company contact, and the KSU or UNL specialist. The host company and KSU/UNL will review the data (and data source tier valuation) to determine if it is an appropriate and accurate documentation of the data or environmental metric. As noted above in D2, UNL will be responsible for statistically analyzing data, and looking for relationships and notable trends. UNL will then prepare a short report, which will be part of the final report.
Appendix A.1: Example Reassessment Form and Narrative Report

Example Narrative Report for Reassessment

Note: The below example is only a portion of the report narrative which provides context to the calculation pages and the summary impact forms.

BACKGROUND

The UNL Partners in Pollution Prevention (P3) program staff visited Company ABC in City, Nebraska, on June 1, 2014, to conduct a reassessment of the P2 analysis for the facility performed in 2010 by P3 intern Jack Student.

The reassessment was performed by UNL graduate student John Doe to determine which recommendations from the 2010 waste assessment report were implemented and what the benefits were for the facility. An interview was held with Environmental Coordinator Jim Professional to review the recommendations.

P2 OPPORTUNITIES

Three out of four recommendations from the 2010 report were implemented. The three recommendations that have been implemented are: (1) replace high bay lighting with T5 fluorescent in Building 3; (2) install low-flow toilets in the company’s conference complex; and (3) switch from pentachlorophenol to copper naphthenate for treating wood.

The one recommendation that has not been implemented is: replace T12 office lighting with T8 fluorescent.

In addition, there was one P2 opportunity presented in the original 2010 report that was not recommended because of a high payback period that has not been implemented: install geothermal heat pump in Building 3. There also was an opportunity that was not recommended to be performed until later because of the equipment’s life expectancy that
has not been implemented yet: upgrade wastewater evaporator when current one needs to be replaced in approximately 2016.

The following is a brief description of each recommendation and information on its implementation.

**Recommendations implemented**

1. **Replace high bay lighting with T5 fluorescent in Building 3.** It was recommended that Company ABC improve its high bay lighting in Building 3 by switching from high-pressure sodium lights and metal halide lights to T5 fluorescent. This recommendation was implemented as suggested in 2011. The client agreed with the intern’s initial estimation of an annual reduction of 380,000 kWh in electricity and a cost savings of $21,000 per year. The initial cost, including installation, was approximately $50,000 after Nebraska Public Power District incentives, according to the client based off the company’s purchasing records. This P2 recommendation also results in the reduction of approximately 412.5 MTCO$_2$E in greenhouse gases annually. This P2 recommendation is expected to continue for at least another five years. Calculations can be found in Appendix A.1.1.

2. **Install low-flow toilets in the conference complex.** It was recommended that Company ABC purchase low-flow toilets in the bathrooms in its conference complex. This recommendation has been implemented as suggested, with low-flow toilets (1.3 gallons per flush) having been purchased and installed beginning in 2011 to replace the previous toilets that used 6.4 gallons per flush. Based off assumptions detailed in Appendix B, which the client agreed with, this recommendation has resulted in a savings of approximately 250,000 gallons of water and $350 per year. It had a total initial cost of approximately $5,000, according to the client based off the company’s purchasing records. This P2 recommendation also results in the reduction of approximately 0.9 MTCO$_2$E in greenhouse gases annually. This P2 recommendation is expected to continue for at least five more years. Calculations can be found in Appendix A.1.2.
3. **Switch from pentachlorophenol to copper naphthenate for treating wood.** The intern recommended the company switch to copper naphthenate, which is substantially less toxic and does not require TRI reporting. Copper naphthenate treated wood waste is neither a listed nor a characteristic hazardous waste according to the current EPA regulations under the Resources Conservation and Recovery Act, and it may be disposed of in landfills in accordance with federal, state and local regulations. This recommendation was implemented as suggested in 2012. The implementation cost $25,000 in new equipment and installations, according to the client based off the company’s purchasing records. The annual cost of copper naphthenate was the same as pentachlorophenol, according to the client based off the company’s purchasing records, thus no cost savings were credited for the purchase price. The switch to copper naphthenate reduced the cost of waste disposal (incineration in the pentachlorophenol case). According to the client based off the company’s disposal records, it reduced the pentachlorophenol sludge to be disposed by 4,000 pounds per year with cost savings of $6,500 and reduced the cost of disposing of wood scraps, gloves, boots and aprons by 4,600 pounds per year at a cost of $7,000, for an approximate total hazardous waste savings of 8,600 pounds per year and an approximate total cost savings of $13,500 per year. This recommendation also reduced 5 pounds of pentachlorophenol annually released to water, as reported in the client’s 2010 TRI. This recommendation is expected to continue for at least another five years. Calculations can be found in Appendix A.1.3.

**Recommendations not implemented**

1. **Replace T12 office lighting with T8 fluorescent.** Switching from T12 to T8 lighting in the offices potentially could have saved $8,700 annually and reduced electricity usage by 108,000 kWh per year at an initial cost of $19,000. This opportunity was not investigated because the client indicated office lighting has not been a high priority at Company ABC.
P2 opportunities not recommended

There were two opportunities that were not recommended in the original 2010 report that have not been implemented: (1) **install geothermal heat pump in Building 3** ($30,000 cost savings and 33,000 therms reduction in energy annually with a $630,000 initial cost); (2) **upgrade wastewater evaporator when current one needs to be replaced** ($5,000 cost savings and 600 therms reduction in energy annually with an initial cost of $40,000). The first opportunity listed above was not recommended because of the extremely long payback period and the second was not recommended until the current wastewater evaporator needs to be replaced, which was not expected to be until 2016.
Appendix A.1.1: Calculations for Opportunity 1: High bay lighting in Building 3

All values are from Jack Student’s 2010 assessment report and confirmed by the company representative during the reassessment visit. The reassessing student visually confirmed the reasonableness of the data during a building walk through.

**Previous lighting fixtures**

*Hours of operation (based off client)*

24 hours/day * 365 days/year = 8,760 hours/year

*Metal halide electricity (# of fixtures per wattage use counted by intern)*

95 fixtures * 458 watts/fixture * 8,760 hours/year * 1 kW/1,000 watt + 4 fixtures * 1,060 watts/fixture * 8,760 hours/year * 1 kW/1,000 watt = 420,000 kWh/year

*Pressure sodium electricity (# of fixtures per wattage use counted by intern)*

129 fixtures * 468 watts/fixture * 8,760 hours/year * 1 kW/1,000 watt + 12 fixtures * 1,060 watts/fixture * 8,760 hours/year * 1 kW/1,000 watt = 640,000 kWh/year

*Total annual electricity used*

420,000 + 640,000 = 1,060,000 kWh/year

*Total annual cost (electricity unit cost according to client, based off bills)*

1,060,000 kWh/year * $0.056/kWh = $59,000/year

**New (replacement) lighting fixtures**

*T5 fluorescent electricity (# of fixtures per wattage use counted by intern and confirmed by the company)*

240 fixtures * 324 watts/fixture * 8,760 hours/year * 1 kw/1,000 watt = 680,000 kWh/year

*Total annual cost (electricity unit cost according to client, based off bills)*

680,000 kWh/year * $0.056/kWh = $38,000/year

*Initial cost (according to client, based off purchasing records)*

240 fixtures * $200/fixture (materials) + 240 fixtures * 1 hour/fixture * $60/hour (installation & labor) – $12,500 (NPPD incentives) = $50,000
**Total annual savings**

*Electricity*

1,060,000 – 680,000 = **380,000 kWh/year**

*Cost*

$59,000 – $38,000 = **$21,000/year**

**Greenhouse gas reduction**

Assumptions:
- GHG conversion based on Nebraska conversion factor
- For each 1000 kWh used 1.086 Metric Tons of Carbon Dioxide is reduced (MTCO2E) (based on US EPA eGrid data that is in the 2014 EPA Pollution Prevention Programs GHG Calculator Spreadsheet). Factor used in original assessment.
- All savings are from electric reduction

Calculation:
- 380,000 kWh/yr * 1.086 MTCO₂E/1,000 kWh = **412.5 MTCO₂E/year**

Appendix A.1.2: Calculations for Opportunity 2: Low-flow toilet calculations

Assumptions
— Approximately 250 uses of one flush per day
— Approximately 180 days per year use of this conference complex
— Approximately 10 days per year where only complex staff are in attendance
— Approximately 50 flushes per conference event
— Approximately 60 conference events per year
— Approximately 10 flushes per day during non-conference periods
— Approximately 60 non-conference days

Note: The numbers above were determined based off client estimates.

— Total flushes per year = 250 flushes/day * 180 days/year + 50 flushes/day * 10 staff days/year + 50 flushes/conf. event * 60 conf. events/year + 10 flushes/non-conf. day * 60 summer days/year = 49,000 flushes/year
— Previous toilets used 6.4 gallons/flush
— New toilets use 1.3 gallons/flush
— $1.40/1,000 gallons (according to Nebraska League of Municipalities for the 2014 water rates for city that Company ABC is located in. Company ABC did not share their most recent water bills, but did confirm that these costs are reasonable.)

Calculations
Previous water usage
49,000 flushes/year * 6.4 gallons/flush = 313,600 gallons/year
313,600 gallons/year * $1.40/1,000 gallons = $440/year

Current water usage
49,000 flushes/year * 1.3 gallons/flush = 63,700 gallons/year
63,700 gallons/year * $1.40/1,000 gallons = $90/year

Water savings: 313,600 – 63,700 = 250,000 gallons/year

Cost savings: 250,000 gallons/year * $1.40/1,000 gallons = $350/year

Initial cost
= $5,000 (according to client, based off purchasing records)

Greenhouse gas reduction
Assumptions: GHG conversion based on Nebraska conversion factor (using factor used during original assessment).
Calculation: 250,000 gallons/year * 3.58 MTCO₂E/1,000,000 gallons non-heated water = 0.9 MTCO₂E/year
Sources: 2014 EPA Pollution Prevention Programs GHG Calculator Spreadsheet, based on data from:
(1) Water and Sustainability: US Electrical consumption for water supply and treatment, the next half century, EPRI, Palo Alto, CA, 2000 and
Appendix A.1.3: Calculations for Opportunity 3: Wood treatment calculations

Assumptions
— 4,000 pounds per year of pentachlorophenol sludge disposed previously (according to client based off company’s disposal records)
— $1.63 per pound in disposal costs for pentachlorophenol sludge (according to client based off company’s bills)
— 4,600 pounds per year in disposal of wood scraps, gloves, boots and aprons (according to client based off company’s disposal records)
— $1.52 per pound in disposal costs for wood scraps, gloves, boots and aprons (according to client based off company’s bills)
— $25,000 initial cost in equipment and installation costs (according to client based off purchasing records)

Calculations
Pentachlorophenol sludge disposal costs
4,000 pounds/year * $1.62/pound = $6,500/year

Wood scraps, gloves, boots and aprons disposal costs
4,600 pounds/year * $1.52/pound = $7,000/year

Hazardous waste savings
4,000 pounds/year + 4,600 pounds/year = 8,600 pounds/year

Cost savings
$6,500/year + $7,000/year = $13,500/year
2014 Pollution Prevention Reassessment Form (use one reassessment form for each management report/business reassessed)

Your name, number, email: John Doe, 402-555-5555, jdoe@unl.edu  
Date of Revisit: June 1, 2014

Business: Company ABC  
Contact name, number, email: Jim Professional, 402-555-5255, pro@companyabc.com

This is a reassessment of the 2010 (year) project completed by Jack Student (original intern).

<table>
<thead>
<tr>
<th>P2 Opportunity (Brief Description)</th>
<th>Implemented</th>
<th>Not Implemented</th>
<th>Doing Before Assessment</th>
<th>Comments (refer to narrative report for more information)</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Suggested</td>
<td>With Modification</td>
<td>Investigated</td>
<td>Not Investigated</td>
<td>Don’t Know</td>
</tr>
</tbody>
</table>
| Replace high bay lighting with T5 fluorescent in Building 3 | X | | | | Source: Electricity  
Implemented as suggested in 2011 |
| Install low-flow toilets in the conference complex | X | | | | Source: Water  
Implemented as suggested in 2011 |
| Switch from pentachlorophenol to copper naphthenate for treating wood | X | | | | Source: Hazardous Waste  
Implemented as suggested in 2012 |
| Replace T12 office lighting with T8 fluorescent | | X | | | Source: Electricity  
Client indicated office lighting has not been a high priority |
| Install geothermal pump in Building 3 | | X | | | Source: Natural gas  
Opportunity was not recommended because of lengthy payback period. |
| Upgrade wastewater evaporator when current one needs to be replaced | | X | | | Source: Natural gas  
Opportunity was not recommended at this time – only when current evaporator needs to be replaced in 2016 |

(Note: This and the following pages are your understanding of the client’s perception until the client approves the report)
Note for Comments Column: Be sure to indicate what source was reduced for each opportunity implemented above (solid waste, hazardous material or waste, water use or water pollution, electricity, natural gas, diesel, coal, air emissions). Add any other comments which clarify status or future plans, particularly for those not implemented. Refer to the narrative report for further details on each opportunity.

How many of the P2 opportunities that you checked in NOT Implemented categories did client say he/she was still interested in? 0
How many of the P2 opportunities that you checked in NOT Implemented categories did client ask you to investigate further? 0

As you reassessed the business, did you make any other P2 suggestions? (yes or no) No

If yes, please prepare an appropriate management report and fill out impact forms as a new assessment.

Instructions and Additional Information
Fill out the following sections for each of the P2 opportunities that you checked in the Implemented categories above. Copy and insert as many additional opportunity sections as you need, numbering sequentially to coincide with the accompanying management report wherein you provide a brief discussion of all P2 opportunities. Explain why each is in its category in the above table. Include discussion of metrics with proper units for each opportunity in the table.

Try to obtain metrics for all implemented opportunities – they are very important for program analysis. Include how these metrics were obtained (sources of data) on the following page. If an opportunity was implemented but no savings metrics were obtained, still list the opportunity and give a brief reason why (e.g., client refused to provide information, no impact existed, promoting good practices in others, health/safety benefits, not enough time has passed to quantify, still working on, or other reasons).

For the sources of data, select the source(s) from the list of possible sources that was used to come up with the savings and write it under the particular category. Include a brief description with this.

If calculations were required quantify the savings, attach an appendix with those calculations. Include any assumptions made in these calculations. If the initial intern’s calculations were used, include that appendix from the original assessment report.
**Company Information**

| Company Name, Location & Sector: | Company ABC; City, NE; manufacturing |
| Visitation Date: | June 1, 2014 |
| Company Contact: | Jim Professional |
| Contact Position: | Env. Coordinator |

**Assessor:** John Doe

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**Intern Information (only on 1st page of Reassessment)**

| Intern Name(s) & Date(s) of Internship: | Jack Student, 2010 summer |

**Benefits for Opportunity #1**

**Data listed below is annual unless otherwise noted; Include the type and units for each category as necessary.**

| Description: Replace high bay lighting in Building 3 | Progress: Implemented |
| Quantification Possible: | Yes |
| Month/Year Benefits Started: | 2011 |
| Reoccurrence so far (check time period): | One Time |
| Is Benefit Still Occurring? | Yes |
| If yes, estimate of how long it will continue: | Less than 2 more years |

**Cost Savings**

| Savings ($/yr): | $21,000/yr |
| Initial Cost ($): | $50,000 |

**Energy**

| Electricity Reduced (kWh): | 380,000 kWh/yr |
| Other Energy (Type, Quantity, Units): |

**Hazardous Materials**

| Pounds Reduced: |

**Water Use**

| Gallons Reduced: |

**Water Pollutions**

| Pollutant Reduced (lbs. and type): |

**Hazardous Waste**

| Pounds Reduced: |

**Solid Waste**

| Pounds Reduced: |

**Air Emissions (GHG)**

| Emissions Reduced (type): | 412.5 MTCO₂/yr |

**Releases & Intangible/Indirect Benefits**

| Releases Prevented (avg): |

**Notes:**
## Company Information

<table>
<thead>
<tr>
<th>Company Name, Location &amp; Sector:</th>
<th>Company ABC; City, NE; manufacturing</th>
<th>Assessor: John Doe</th>
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</thead>
<tbody>
<tr>
<td>Visitation Date:</td>
<td>June 1, 2014</td>
<td>Company Contact:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jim Professional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contact Position:</td>
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<td></td>
<td></td>
<td>Env. Coordinator</td>
</tr>
</tbody>
</table>

## Benefits for Opportunity #2

Data listed below is annual unless otherwise noted; Include the type and units for each category as necessary.

<table>
<thead>
<tr>
<th>Description:</th>
<th>Progress: Implemented</th>
<th>✓ if Progress Changed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install low-flow toilets in the conference complex</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantification Possible:</th>
<th>✓ Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If no, why not?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month/Year Benefits Started:</th>
<th>Reoccurrence so far (check time period):</th>
<th>One Time</th>
<th>3 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is Benefit Still Occurring?</th>
<th>✓ Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If no, when ended?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If yes, estimate of how long it will continue: 
Less than 2 more years | 2-5 more years | X 5-15 more years

### Cost Savings

<table>
<thead>
<tr>
<th>Description</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings ($/yr):</td>
<td>$350/yr</td>
</tr>
<tr>
<td>Initial Cost ($):</td>
<td>$5,000</td>
</tr>
</tbody>
</table>

### Energy

- Electricity Reduced (kWh): 
- Other Energy (Type, Quantity, Units):

### Hazardous Materials

<table>
<thead>
<tr>
<th>Description</th>
<th>Water Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds Reduced:</td>
<td>Gallons Reduced: 250,000</td>
</tr>
</tbody>
</table>

### Water Pollutions

<table>
<thead>
<tr>
<th>Description</th>
<th>Air Emissions (GHG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds Reduced:</td>
<td>Emissions Reduced (type): 0.9 MTCO2e/yr</td>
</tr>
</tbody>
</table>

### Releases & Intangible/Indirect Benefits

- Releases Prevented (avg): 
- Material Prevented from Release: 
- How much will be prevented from release (lbs.)? 
- Where would release have gone?

### Sources of Data for Opportunity #2

For each of the savings/benefits for the above opportunity description, select the source(s) of data that was used to come up with the values. Select from the following list and include a brief description with it. NOTE: If calculations are made to quantify the impact, include them in an appendix to the reassessment report. Include a copy of the intern’s calculations/appendix if used.

1a. Bills 
1c. Initial estimate – based on meter/measurement by business 
2a. Initial estimate – based on indirect methods (wattage, # dumpsters, etc.): 
3a. Use of external calculation tool/published industry standard (list tools); (appears to be peer reviewed) 
4a. Estimate by inexperienced client staff 
1b. Metered/measured by business 
1d. Initial estimate – based on meter/measurement by intern 
2b. Verbal estimate by experienced client staff 
3b. Outside expert opinion for input (list expert or ref. source) 
4b. Use of external calculation tool/published industry standard (list tools; unclear if peer reviewed)

### Cost Savings

- 3b unit cost based off Nebraska League of Municipalities and based off water use savings to right; 2b confirmed by client

### Hazardous Materials:

- Water Use:
- 2b number of flushes per day; 2a amount of water per flush

### Hazardous Waste:

### Water Pollutions:

### Solid Waste:

- Air Emissions: 4b EPA calculator based off water use savings from above

### Releases:

### Notes:
### Company Information

<table>
<thead>
<tr>
<th>Company Name, Location &amp; Sector:</th>
<th>Company ABC; City, NE; manufacturing</th>
<th>Assessor: John Doe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visitation Date:</td>
<td>June 1, 2014</td>
<td>Company Contact: Jim Professional</td>
</tr>
<tr>
<td>Contact Position:</td>
<td>Environ. Coordinator</td>
<td></td>
</tr>
</tbody>
</table>

### Benefits for Opportunity #3

Data listed below is annual unless otherwise noted; Include the addition of type and units for each category as necessary.

<table>
<thead>
<tr>
<th>Description:</th>
<th>Switch from pentachlorophenol for treating wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progress:</td>
<td>Implemented</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantification Possible:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If no, why not?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month/Year Benefits Started:</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reoccurrence so far (check time period):</td>
<td>___ One Time or ___ 2 Years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is Benefit Still Occurring?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If no, when ended?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If yes, estimate of how long it will continue: ___ Less than 2 more years ___ 2-5 more years ___ X 5-15 more years

### Cost Savings

<table>
<thead>
<tr>
<th>Savings ($/yr):</th>
<th>$13,500/yr</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Energy</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Initial Cost ($):</th>
<th>$25,000</th>
</tr>
</thead>
</table>

### Hazardous Materials

| Pounds Reduced: | |
|-----------------||

### Water Use

| Gallons Reduced: | |
|-----------------||

### Water Pollutions

| Pollutant Reduced (lbs. and type): | |
|-----------------------------------||

### Hazardous Waste

<table>
<thead>
<tr>
<th>Solid Waste</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pounds Reduced:</th>
<th>8,600/yr</th>
</tr>
</thead>
</table>

### Air Emissions (GHG)

| Emissions Reduced (type): | |
|---------------------------||

### Releases & Intangible/Indirect Benefits

<table>
<thead>
<tr>
<th>Releases Prevented (avg):</th>
<th>1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Material Prevented from Release:</th>
<th>Pentachlorophenol</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>How much will be prevented from release (lbs.)?</th>
<th>5 lbs/yr</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Where would release have gone?</th>
<th>Water</th>
</tr>
</thead>
</table>

### Sources of Data for Opportunity #3

For each of the savings/benefits for the above opportunity description, select the source(s) of data that was used to come up with the values. Select from the following list and include a brief description with it. NOTE: If calculations are made to quantify the impact, include them in an appendix to the reassessment report. Include a copy of the intern’s calculations/appendix if used.

1. Bills
2. Initial estimate – based on indirect methods (wattage, # dumpsters, etc.):
3. Use of external calculation tool/published industry standard (list tools); (appears to be peer reviewed)
4. Estimate by inexperienced client staff
5. Metered/measured by business
6. Initial estimate – based on meter/measurement by business
7. Initial estimate – based on meter/measurement by intern
8. Verbal estimate by experienced client staff
9. Outside expert opinion for input (list expert or ref. source)
10. Use of external calculation tool/published industry standard (list tools; unclear if peer reviewed)

### Notes:

- Company’s TRI

### Cost Savings: 1a Disposal costs ($/pound) based off bills according to the client and based off hazardous waste savings below

### Energy:

### Hazardous Materials:

### Water Use:

### Hazardous Waste: 1a Disposal records

### Water Pollutions:

### Solid Waste:

### Air Emissions:

### Releases: 1 Company’s TRI
Additional Questions:

Other P2 opportunities the client implemented since first assessment:
None.

Did your business contact report that the previous P2 intern assessment had an impact on the business? (yes or no) No
If yes, what impact? (Increased awareness began looking for P2 opportunities when making business decisions, improved employee involvement, improved employee morale, etc.). BE SPECIFIC.

If the client could speak with the intern who first assessed this business, what suggestions would they give him/her to improve the rate of implementation of opportunities or acceptance of P2 by the business?
None.

Have there been changes to management since the original assessment? (yes or no) No
If yes, how so?

Has the client hired additional personnel to assist with the intern’s recommendations or further P2 assistance since the original assessment? Or have employees had their job duties expanded/modified? (yes or no) No
If yes, how so?

How has the client’s workforce changed since the original assessment? More employees? Fewer employees? Were any of the changes because of the original assessment?
No significant changes.

Has the client made other changes in terms of tracking data, training, hiring, etc. as a result of the original assessment? (yes or no) No
If yes, how so?

Who did the initial intern meet with/interact with? (Title of contact; if multiple people, please explain)
Jim Professional, environmental coordinator

Is the original contact still there? (yes or no) Yes
If yes, did you meet with the original contact? (yes or no) If no (to either question), who did you meet with? (Title of contact)

Did the client report implementing/establishing a P2/sustainability/environmental policy within the last three years? (yes or no) No
If yes, how so? Explain. (Health & Safety team?)

Did the client report establishing some form of an environmental management system (EMS, 15001, other certifications, etc. within the last three years? (yes or no) No
If yes, how so? Explain.

Does the client have any additional comments about initial assessment or the reassessment, interest in having a P2 intern in the future, etc:
No comments

Does the client have interest in having a P2 intern in the future? (yes or no) No
If yes, how so?

Is the client willing to respond to a three-part mail or e-mail survey that will be sent within the next month? (yes or no) Yes
Would the client prefer the survey e-mailed or mailed? Who should it be addressed to? Would a follow up phone call be preferred?
Mail is fine
Appendix A.2: Reassessment Instructions (Standard Operating Procedure)

Reassessments: Method of helping the programs learn about successes from past implementation of P2 suggestions, and how to improve the assistance provided to clients. Also valuable for helping students learn about assessment process and encouraging businesses to renew efforts to implement suggestions.

1. Arrange for reassessment visit and discuss what a reassessment is with client (via phone or in person). Confirm that the client has a copy of the original technical assistance report. If the client has lost or does not remember the report, be sure to arrange to get the client a copy.

2. Review the original technical assistance report submitted to the client.
   - List the original recommendations/suggestions made to the client on the reassessment form. Prepare a list of questions based on what is needed to complete the reassessment form.
   - Review the original report’s “impact” form. Identify waste reduction and cost savings estimates, and understand how the original intern made each of these estimates.
   - Note the reduction /savings for each recommendation in the original report.
   - Consider how to help the client make estimates of potential savings.
   - Review the hierarchy of data sources that will be used when collecting data. Aim to obtain data from the highest quality source possible.

 Tier 1: High-quality direct measures
   - Utility bills (electricity, natural gas, water)
   - Purchasing invoices (for diesel fuel costs and quantities)
   - Metered/measured by business (e.g., Waste or material use logs)
   - Initial estimate, based on meter/measurement by business
   - Initial estimate, based on meter/measurement by intern;
   - Equipment data (e.g., motor horsepower and efficiency, pipe sizes) from nameplate

 Tier 2: Moderate-quality indirect measures
   - Verbal estimates of use by experienced production staff / management
   - Previous intern’s tier 2 data
Tier 3: Low-quality indirect measures
- Equipment data from vendor specifications used to make usage estimates
- Estimated data based on published industry standards, external calculation tool, or outside expert opinion.

Tier 4: Non-Peer Reviewed Low-quality indirect measures
- Estimated data based on non-peer reviewed published industry standards, external calculation tool, or outside expert opinion.
- Estimates of use by new or inexperienced production staff / management
  - Note the media (solid waste, water, hazardous materials/waste, energy, etc.) involved in each original recommendation.
    - Include in your list questions that will help you complete the last two pages of the reassessment form (e.g., other P2 opportunities the client implemented since first assessment, “P2 policy”, “P2 team” and “EMS”, did the previous P2 intern assessment have an impact on the business, etc.).

3. Complete the “client profile form” for internal program information related to the original intern and information related to the original key contact at the partner company

4. Visit client and discuss the status of each original P2 suggestion. Visits typically last anywhere from 20 minutes to several hours. The client may include a site tour or you may ask for one.

Go through each P2 opportunity on the reassessment form and ask the client if the opportunity was implemented. You may need to refer to the original report to help the client. If an opportunity was implemented, determine if it was implemented as suggested or with modification. If the opportunity was not implemented, find out if it was investigated or not. In some instances, especially if the original contact is no longer at the business, the client may not know. Check the appropriate box on the reassessment form for the respective P2 opportunity. There is also a box to check if the client was performing the opportunity before the original assessment. On the comments section, indicate the source (solid waste, hazardous waste, water use or water pollution, electricity, natural gas, diesel, coal, air emissions). Also include a brief comment that would complement the more detailed narrative report. The comments are both to help the Program Staff know the key media reduced and to provide information to help the Program Staff confirm which recommendation from the initial report is discussed.
The second page of the form is general questions related to the number of P2 opportunities. This information is general information to help the KSU PPI and UNL P3 programs know if there are additional P2 assistance opportunities with this client related to these topics.

Then obtain the client’s description (and perception) of the actual outcome of each opportunity that was implemented and record the savings on the “Benefits” portion of the “P2 Reassessment Benefits and Sources of Data Form” and record the sources on the “Sources of Data” portion. Note that the benefits are annual unless otherwise noted. For each implemented opportunity, answer the questions on the “Benefits” portion. Determine when the benefits started, the reoccurrence of the benefits, if the benefits are still occurring, and how long the benefits will continue. If the client is unsure how long the benefit will continue, investigate the anticipated equipment life.

In obtaining savings, stress that you want the reduction/savings outcomes to be as accurate as possible. If a suggestion WAS implemented, determine reductions/savings by following the hierarchy of data sources mentioned above:

- Ask clients to consult purchasing orders, utility bills, and waste disposal manifests or other existing measurements/records to accurately quantify savings. If a measurement made by the client, note key information on the measurement equipment and method. These are the ideal methods for obtaining reductions/savings.
- If the client does not have bills or ways to measure/meter the savings (the top two methods in the hierarchy of sources), see if the reductions/savings can be determined based off the initial report – based on meter/measurement by the business, meter/measurement by intern, or indirect methods.
- If the purchasing or disposal records are not available and the original intern report can’t be used as a starting point, ask the client to estimate the outcomes based on any other methods routinely used by the client. These will be data sources from tiers 1 and 2.
- If the client is unable to estimate the savings, use an external calculation tool (e.g., EPA calculator, Department of Energy tip sheet, etc.) or expert opinion for input (e.g., data from surveys sent to producers in the Nebraska Ag Water Management Network on water savings from water moisture sensors, spokesperson from NDEQ/KDHE, etc.).
- In some cases, you may have multiple sources of data savings. Be sure to record the sources of the data so you can properly fill out the reassessment forms, as shown in the example reassessment form in the Appendix. For each data source, list the source and the tier number following the example.
- Note that if savings are not directly given to you, or if any calculations are required to determine additional savings, you will need an appendix.

If a suggestion was NOT implemented, learn why by asking follow-up questions.
Ask the client questions from the last two pages of the reassessment form (e.g., additional P2 implementation, P2 policy, P2 team, EMS, etc.).

Note that until the client approves the report, this is your understanding of the client’s perception.

5. If you have questions about specific data or estimates provided by the client, you may want to share the reassessment report data/appendices with the client to make sure the savings/data are appropriate. Note that the final impact projections will be shared with the client again in step 8. Include with this appendices showing calculations/assumptions/sources for determining the savings. Share the savings with the client for all data (e.g., cost savings, energy, solid waste, water use, etc.). If the client disagrees with any of the values, explain how you obtained the values by referring to the appendix calculations/assumptions/sources. If necessary, make adjustments to the data so the client finds the values acceptable.

6. Prepare a narrative feedback report for the client (and the UNL P3/KSU PPI program). In this report, start with a background paragraph. Then for each original P2 recommendation, state what the recommendation was and the metrics expected from implementation, what was learned about the implementation status and any direct benefits realized, and then discuss any additional indirect benefits realized. At the end of the report, explain what else you learned from the reassessment, in terms of other overall indirect benefits of the assistance, and how to improve future assistance to enhance the likelihood of P2 implementation. Include a calculation appendix with calculations, assumptions and sources of data when necessary. Do this for any savings that were not directly given to you and required some form of calculation or assumption.

As part of the discussion of additional or indirect benefits, consider factors like liability reduction or employee exposure reduction from the implementation of a suggestion.

See the Appendix for example calculations/assumptions/sources.

7. Complete the reassessment forms using the information you have gathered. Typically you do not share the “reassessment form” with the client. The UNL P3/KSU PPI staff will review your reassessment report and form, and may ask you to respond to specific questions. In some cases you may need to contact the client to gather additional information to complete the reassessment. Make any modifications based on review and submit it to staff for review again.

8. Share the quantified results with the client, asking that they respond to you by a specific deadline (often two weeks later) if they have any comments.
9. Submit your report and completed reassessment forms to your key contact within the P2 program.
Appendix A.3: Example Survey

University of Nebraska-Lincoln Partners in Pollution Prevention (P3) Survey: Reasons and Motivations for Implementation


SUMMARY
A P2 assessment of Company ABC was conducted in 2010 by P3 intern Jack Student. According to a reassessment conducted in 2104 by graduate student John Doe, three out of four recommended opportunities were implemented. In addition, there were two opportunities that were not recommended that have not been implemented. A brief description of the implemented opportunities and their direct benefits is summarized in Table 1 below. A brief description of the opportunities not implemented is summarized in Table 2 below.

| Table 1. Summary of Implemented P2 Opportunities. |
|---|---|---|
| **##** | **P2 Opportunity** | **Direct Benefits** |
| 1 | Replace high bay lighting with T5 fluorescent in Building 3 | Cost savings of $21,000/yr Reduction of 380,000 kWh/yr |
| 2 | Install low-flow toilets in the conference complex | Cost savings $350/yr Reduction of 250,000 gallons of water |
| 3 | Switch from pentachlorophenol to copper napthenate for treating wood | Cost savings of $13,500 Reduction of 8,600 lbs/yr hazardous waste |

| Table 2. Summary of P2 Opportunities Not Implemented. |
|---|---|---|
| **##** | **P2 Opportunity** | **Projected Direct Benefits (if available)** |
| 1 | Replace T12 office lighting with T8 fluorescent | Cost savings of $8,700/yr Reduction of 108,000 kWh/yr |
| 2 | Install geothermal pump in Building 3 | Cost savings of $30,000/yr Reduction of 33,000 therms/yr |
| 3 | Upgrade wastewater evaporator when current one needs replacing | Cost savings of $5,000/yr Reduction of 600 therms/yr |
GENERAL QUESTION

Definition of Pollution Prevention for this survey - “Pollution prevention (P2) is reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less-toxic substances, implementing energy efficiency and resource conservation, and re-using materials rather than putting them into the waste stream.”

Question 1: To what extent is your organization engaged in each of the following activities? Rate on a scale of 1 to 5, with the following assumptions: 1 – not considered; 2 - under consideration; 3 - sometimes applied; 4 – frequently applied; 5 – always applied.

___ Building awareness of pollution prevention in the organization
___ Building culture of innovation by pursuing sustainability/P2 strategies
___ Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)
___ Reducing greenhouse gas emissions
___ Generating electricity, heat, or fuel from renewable sources
___ Improving energy efficiency
___ Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)
___ Reducing or eliminating the creation of waste materials
___ Reducing the creation or release of pollutants or toxic compounds
SPECIFIC QUESTIONS

Question 2: For each implemented P2 opportunity, what reasons were important to your organization in implementing the opportunity? Please check all that are appropriate in Table 3 below.

Table 3. Implemented P2 Opportunities from 2010 Assistance Projects.

<table>
<thead>
<tr>
<th>Reason/justification</th>
<th>Implemented P2 opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Replace high bay lighting with T5 fluorescent in Building 3</td>
</tr>
<tr>
<td>A. Acceptable payback period</td>
<td></td>
</tr>
<tr>
<td>B. Energy efficiency</td>
<td></td>
</tr>
<tr>
<td>C. Reduced operating cost</td>
<td></td>
</tr>
<tr>
<td>D. Increased employee productivity</td>
<td></td>
</tr>
<tr>
<td>E. Health and safety benefits</td>
<td></td>
</tr>
<tr>
<td>F. Regulatory compliance</td>
<td></td>
</tr>
<tr>
<td>G. Reduced environmental and health risk (spills, vapors, liability etc.)</td>
<td></td>
</tr>
<tr>
<td>H. Reduced business risk (impact of changes in regulation, input costs etc.)</td>
<td></td>
</tr>
<tr>
<td>I. Enhanced environmental awareness</td>
<td></td>
</tr>
<tr>
<td>J. Improved public image</td>
<td></td>
</tr>
<tr>
<td>K. Other companies also implemented the same or similar solution</td>
<td></td>
</tr>
<tr>
<td>L. Corporate commitment to resource use/waste reduction</td>
<td></td>
</tr>
</tbody>
</table>

Question 3: For each implemented P2 opportunity, what was the top reason/justification for implementation? Please write the letter (A – L) from the above list that was the top one reason/justification the P2 opportunity was implemented.

_____ 1. Replace high bay lighting with T5 fluorescent in Building 3
_____ 2. Install low-flow toilets in the conference complex
_____ 3. Switch from pentachlorophenol to copper napthenate for treating wood
**Question 4:** For each P2 opportunity that has not yet been implemented, what are the reasons? Please check all that are appropriate in Table 4 below.

Table 4. P2 Opportunities Not Implemented from 2010 Assistance Project.

<table>
<thead>
<tr>
<th>Reason/justification</th>
<th>Not implemented P2 opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Replace T12 office lighting with T8 fluorescent</td>
</tr>
<tr>
<td></td>
<td>2. Install geothermal heat pump in Building 3</td>
</tr>
<tr>
<td></td>
<td>3. Upgrade wastewater evaporator when current one needs replacing</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Not technically feasible</td>
<td></td>
</tr>
<tr>
<td>B. Lack of capital (financing)</td>
<td></td>
</tr>
<tr>
<td>C. Insufficient financial payback</td>
<td></td>
</tr>
<tr>
<td>D. Other priorities for capital investments</td>
<td></td>
</tr>
<tr>
<td>E. Risk of production disruption/inconvenience/slowdown</td>
<td></td>
</tr>
<tr>
<td>F. Lack of perceived environmental/risk reduction benefits</td>
<td></td>
</tr>
<tr>
<td>G. Limited in-plant expertise/capability</td>
<td></td>
</tr>
<tr>
<td>H. Lack of staff awareness/willingness to change</td>
<td></td>
</tr>
<tr>
<td>I. Customer specifications</td>
<td></td>
</tr>
<tr>
<td>J. Uncertainty/lack of confidence in technology (quality, cost, benefits)</td>
<td></td>
</tr>
<tr>
<td>K. Insufficient information regarding recommendation</td>
<td></td>
</tr>
<tr>
<td>L. Difficulty in coordinating between units within company</td>
<td></td>
</tr>
</tbody>
</table>

**Question 5:** For each P2 opportunity that was not implemented, what was the top reason for not implementing it? Please write the letter (A – L) from the above list that was the top one reason the P2 opportunity was not implemented.

  ____ 1. Replace T12 office lighting with T8 fluorescent
  ____ 2. Install geothermal pump
  ____ 3. Upgrade wastewater evaporator when current one needs replacing
APPENDIX B: IRB INFORMED CONSENT FORM FOR REASSESSMENTS

PARTNERS IN POLLUTION PREVENTION PROGRAM
A partnership between US EPA, NDEQ, UNL, and Nebraska Business/Industry

INFORMED CONSENT FORM – REASSESSMENTS

Identification of Project:
Partners in Pollution Prevention (P3) Program - Reassessments.

Purpose of the Research:
Starting 1997, the UNL P3 program has used student interns to provide education and technical assistance during the summer to business clients throughout the State of Nebraska. The purpose of this study is to learn clients’ implementation of the recommendations from the original assistance reports and to gather specific metrics (direct cost savings, reduced waste generation, and reduced water and energy use) related to these recommendations. This will help the P3 intern program better understand the implementation rate and justifications for implementation of pollution prevention recommendations. Main benefit will be improvement of technical assistance program aimed to these clients.

Procedures:
Past P3 clients will be contacted and permission obtained for the Secondary Investigator to visit and perform a reassessment on site. Reassessment interviews with client representative typically last between 30 minutes and 2 hours, depending upon the complexity of the original assistance. The total number of companies to be reassessed is about 10. After the reassessment, the Secondary Investigator will provide reassessment report and additional technical assistance suggestions to clients that show an interest in further evaluation of unimplemented P2 suggestions from the original report. The individual participating in reassessment should be someone in an ownership, production management, or environmental management position and be appropriate to participate in the reassessment on behalf of the client.

Risks and/or Discomforts:
There are no known risks or discomforts associated with this research. In the event of problems resulting from participation in the study, you may contact Dr. Bruce Dvorak, P3 Program Director, for assistance or referral at 402-472-3431 or bdvorak1@unl.edu.

Benefits and Compensation:
Participants will have the opportunity to contribute to improving the program for future students and/or business clients.

Confidentiality:
Data in records (word documents and excel spreadsheets) will be by company and not by specific individual.
The data from the reassessment will be maintained confidentially by the Department of Civil Engineering. The information obtained in this study may be published in a graduate student thesis, scientific journals or presented at scientific meetings, but the data will be reported as aggregated data (without individually identifiable information). The name of the participating entities (e.g., company or agency) will not be identified in the results of research or other possible reports.

Opportunity to Ask Questions:
You may ask any questions concerning this research and have those questions answered before agreeing to participate in or at any time during the study. The principal investigator for this research study is Dr. Bruce I. Dvorak, PhD, PE and he may be reached at 402-472-3431, or by email at bdvorak1@unl.edu. Vincent Kuppig is the Secondary Investigator for this study and he may be reached by email at
If you have questions concerning your rights as a research subject that have not been answered by the investigator, or to report any concerns about the study, you may contact the University of Nebraska-Lincoln Institutional Review Board at 402-472-6965.

Freedom to Withdraw:
You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigators or the University of Nebraska. Your decision will not result in any loss or benefits to which you are otherwise entitled.

Consent, Right to Receive a Copy:
You are voluntarily making a decision whether or not to participate in this research study. Your response to the survey is your indication that you agree to participate, having read and understood the informed consent information presented above. You do not need to sign or return this form, it is yours to keep.
APPENDIX C: IRB INFORMED CONSENT FORM FOR SURVEYS

Partners in Pollution Prevention Program
A partnership between US EPA, NDEQ, UNL, and Nebraska Business/Industry

INFORMED CONSENT FORM – SURVEY

Identification of Project:
Partners in Pollution Prevention (P3) Program – Strategic Planning: study of the motivations for implementation of P2 opportunities and its outcomes.

Purpose of the Research:
Starting in 1997, the UNL P3 program has used student interns to provide education and technical assistance during the summer to a diverse business client population, primarily small- to medium-sized businesses throughout the State of Nebraska. The purpose of this study is to understand the reasons and motivations for the implementation and non-implementation of specific pollution prevention suggestions. This will help the P3 intern program and other similar intern programs become better at understanding business motivations for implementing pollution prevention suggestions. Main benefits will be improvement of student training and technical assistance for businesses.

Procedures:
The survey questions will be distributed among the past participants of the UNL P3 Program and the Kansas State Pollution Prevention Institute. The total number of companies is around 25. Participants have to answer the questions and mail them back in an enclosed envelope. It will take participants approximately 5-10 minutes to complete the survey. The individual completing the survey should be someone in an ownership, production management, or environmental management position and be appropriate in making the decision to participate in the survey on behalf of the client.

Risks and/or Discomforts:
There are no known risks or discomforts associated with this research. In the event of problems resulting from participation in the study, you may contact Dr. Bruce Dvorak, P3 Program Director, for assistance or referral at 402-472-3431 or bdvorak1@unl.edu.

Benefits and Compensation:
Participants will have the opportunity to contribute to improving the program for future students and/or business clients.

Confidentiality:
Data in records (word documents and excel spreadsheets) will be by company and not by specific individual.
The data from the survey will be maintained confidentially by the Department of Civil Engineering. The information obtained in this study may be published in a graduate student thesis, scientific journals or presented at scientific meetings, but the data will be reported as aggregated data (without individually identifiable information). The name of the participating entities (e.g., company or agency) will not be identified in the results of research or other possible reports.

Opportunity to Ask Questions:
You may ask any questions concerning this research and have those questions answered before agreeing to participate in or at any time during the study. The principal investigator for this research study is Dr. Bruce I. Dvorak, PhD, PE and he may be reached at 402-472-3431, or by email at bdvorak1@unl.edu. Vincent
Kuppig is the secondary investigator for this study and he may be reached by email at vkuppig@huskers.unl.edu. If you have questions concerning your rights as a research subject that have not been answered by the investigator, or to report any concerns about the study, you may contact the University of Nebraska-Lincoln Institutional Review Board at 402-472-6965.

**Freedom to Withdraw:**
You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigators or the University of Nebraska. Your decision will not result in any loss or benefits to which you are otherwise entitled.

**Consent, Right to Receive a Copy:**
You are voluntarily making a decision whether or not to participate in this research study. Your response to the survey is your indication that you agree to participate, having read and understood the informed consent information presented above. You do not need to sign or return this form, it is yours to keep.
APPENDIX D: IRB APPROVAL LETTER

January 13, 2014

Bruce Dvorak
Department of Civil Engineering
N114 SLNK, UNL, 68588-6105

Vincent Kuppig
Department of Civil Engineering

IRB Number: 20130114052EX
Project ID: 14052
Project Title: Pollution Prevention Program: Reassessments of Past Clients

Dear Bruce:

This letter is to officially notify you of the certification of exemption of your project. Your proposal is in compliance with this institution's Federal Wide Assurance 00002258 and the DHHS Regulations for the Protection of Human Subjects (45 CFR 46) and has been classified as exempt, category 2.

You are authorized to implement this study as of the Date of Final Approval: 01/13/2014.

We wish to remind you that the principal investigator is responsible for reporting to this Board any of the following events within 48 hours of the event:
* Any serious event (including on-site and off-site adverse events, injuries, side effects, deaths, or other problems) which in the opinion of the local investigator was unanticipated, involved risk to subjects or others, and was possibly related to the research procedures;
* Any serious accidental or unintentional change to the IRB-approved protocol that involves risk or has the potential to recur;
* Any publication in the literature, safety monitoring report, interim result or other finding that indicates an unexpected change to the risk/benefit ratio of the research;
* Any breach in confidentiality or compromise in data privacy related to the subject or others; or
* Any complaint of a subject that indicates an unanticipated risk or that cannot be resolved by the research staff.

This project should be conducted in full accordance with all applicable sections of the IRB Guidelines and you should notify the IRB immediately of any proposed changes that may affect the exempt status of your research project. You should report any unanticipated problems involving risks to the participants or others to the Board.

If you have any questions, please contact the IRB office at 472-6965.

Sincerely,

Becky R. Freeman, CIP
for the IRB
Categories of Pollution Prevention Opportunities:

1) Practices and Procedures
   a) Purchasing
      • purchase only the amount of raw materials needed for a production run or a set period of time
      • develop review procedures for all materials purchased
      • replace hazardous materials if possible
   b) Inventory Control
      Waste is often created by using excess or outdate material
      • buy only what you know you will use
      • rotate inventory so older material is used first
      • store material to prevent spills and leaks
      • set up an inventory tracking system
      • label all containers with contents and date
      • don't accept free samples unless you know you will use them
      A potential management resource to alleviate inventory control problems is *Just-in-Time* (JIT) manufacturing:
      • stockless production
      • customer/supplier networking
      • pull system
      • JIT transportation
   c) Improved Housekeeping/ Preventative maintenance
      The use of improved operating practices can reduce spills, overflows, leaks and other inefficiencies. These practices will often increase profits with little or not capital outlay:
      • inspect and maintain equipment routinely
      • replace seals and gaskets on a regular basis
      • repair leaks immediately
      • use tight-fitting lids to prevent evaporation
      • wipe up spills whenever possible rather than hosing them down
      • use spigots and pumps instead of pouring
      • label all containers with contents and date
      • have a spill prevention program
      • use drip pans
   d) Training
      • Explain the environmental, health and safety consequences of spills or poor management practices.
      • provide employee incentives (bonuses, awards, other recognition)
      • train employees on proper waste handling, equipment use, etc.
e) Waste Segregation

- In most cases, it is easier to reuse/treat/dispose a waste that contains only one contaminant than a waste containing many different contaminants.
- When hazardous wastes are mixed with non-hazardous wastes, the resulting waste is hazardous waste.

2) Equipment Modifications

Old or inefficient processes and equipment often account for excess use of toxic substances and unnecessary generation of (hazardous) waste.

- change equipment operating conditions, such as flow rates, temperatures, pressures, etc.
- use more efficient equipment
- modify photocopiersons so they use a refillable toner cartridge
- replace incandescent lighting with energy-efficient compact fluorescent lighting

3) Material Substitution

Hazardous materials used either in the formation of a product or in a production process may be replaced with less hazardous or non-hazardous materials.

Examples:

- Chlorinated solvents => non-hazardous solvents
- Oil-based paints ===> water-based paints

4) Product Reformulation

Product reformulation is a more difficult waste reduction technique, yet reformulation can be very effective.

Examples of product reformulation include:

- using double sided photocopies instead of single sided copies.
- reusing envelopes (e.g., intra-company mail).
- reducing the aluminum thickness in a soda can.
- elimination of pigments that contain heavy metals from ink, dyes and paint formulations
- development of new paint, ink and adhesive formulations based on water rather than organic solvents.

5) Process Modification

Changing the processes or operations used to create the same end product while minimizing waste or increasing efficiency.

Examples:

- use different equipment (using a different technology)
- incineration oven instead of (hazardous) solvent to test bitumen content in asphalt
- shape metal parts by dry grinding and milling instead of using a grinding and milling using a cutting fluid.
- keep food warm by better insulating it instead of using a heating lamp
- performing the COD test using non-hazardous Manganese instead hazardous Dichromate (equipment used also changes).
6) **In-Process Recycling**

Use and reuse of waste materials to reduce the amount of waste generated.

**Examples:**
- recycling a waste back into the production process as a raw material
- purchasing distillation or recovery units (for fluids and solvents)
- reduce salt consumption of industrial (ion exchange) water softeners by capture and reusing last $1/3$rd of brine that passes through resin during recharge process. This brine contains relatively little hardness, but contains high sodium concentrations.
- joining a waste exchange

7) **Energy Efficiency (E2)**

- reduce thermostat setting
- turn lights off
- change lighting type
- use fume hood only when needed
- insulate ovens / pipes
- insulate buildings
- add time to energy using devices
- use energy star appliances
- eliminate compressed air leaks (or inappropriate uses of compressed air)
- replace old motors / compressors
### Table F.1. Implementation Rate by Sector and Level of Assistance (Number of Recommendations and Number of Clients in Parentheses)

<table>
<thead>
<tr>
<th>Sector/Level of assistance</th>
<th>Partial</th>
<th>Full</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>100% (9/3)</td>
<td>- (0/0)</td>
<td>100% (9/3)</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>50% (16/2)</td>
<td>57% (195/18)</td>
<td>56% (211/20)</td>
</tr>
<tr>
<td>Public</td>
<td>39% (100/10)</td>
<td>61% (33/3)</td>
<td>44% (133/13)</td>
</tr>
<tr>
<td>Health Care</td>
<td>33% (30/3)</td>
<td>55% (38/4)</td>
<td>46% (68/7)</td>
</tr>
<tr>
<td>Other</td>
<td>40% (43/7)</td>
<td>50% (20/1)</td>
<td>43% (63/8)</td>
</tr>
<tr>
<td>Hospitality</td>
<td>35% (20/3)</td>
<td>- (0/0)</td>
<td>35% (20/3)</td>
</tr>
<tr>
<td>Total</td>
<td>41% (218/29)</td>
<td>57% (286/26)</td>
<td>50% (504/55)</td>
</tr>
</tbody>
</table>
Table F.2. Implementation Rate by Sector, Mode of Assistance, and P2 Category.

<table>
<thead>
<tr>
<th>Sector/Mode of assistance/P2 category</th>
<th>Manufacturing</th>
<th>Public</th>
<th>Health Care</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Partial</td>
<td>Full</td>
<td>Total</td>
</tr>
<tr>
<td>E2 (# recomm.)</td>
<td>100%</td>
<td>47%</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td>Equipment/ process mod. (# recomm.)</td>
<td>50%</td>
<td>47%</td>
<td>47%</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>49</td>
<td>55</td>
</tr>
<tr>
<td>Imp. house. (# recomm.)</td>
<td>50%</td>
<td>86%</td>
<td>86%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>34</td>
<td>36</td>
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<tr>
<td>In-process recycling (# recomm.)</td>
<td>50%</td>
<td>69%</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Material sub (# recomm.)</td>
<td>0%</td>
<td>27%</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Off-site recycling (# recomm.)</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Purchasing (# recomm.)</td>
<td>0%</td>
<td>29%</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Training (# recomm.)</td>
<td>50%</td>
<td>81%</td>
<td>78%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Watermark (# recomm.)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total (# recomm.)</td>
<td>50%</td>
<td>57%</td>
<td>56%</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>195</td>
<td>211</td>
</tr>
</tbody>
</table>
Table F.3. Implementation Rate by Sector, Mode of Assistance, and P2 Category (Continued).

<table>
<thead>
<tr>
<th>Sector/Mode of assistance/ P2 category</th>
<th>Other</th>
<th>Hospitality</th>
<th>Agriculture</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Partial</td>
<td>Full</td>
<td>Total</td>
<td>Partial</td>
</tr>
<tr>
<td>E2 (# recomm.)</td>
<td>33%</td>
<td>100%</td>
<td>43%</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Equipment/ process mod. (# recomm.)</td>
<td>38%</td>
<td>29%</td>
<td>33%</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>7</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Imp. house. (# recomm.)</td>
<td>25%</td>
<td>100%</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>6</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>In-process recycling (# recomm.)</td>
<td>100%</td>
<td>33%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Material sub (# recomm.)</td>
<td>50%</td>
<td>0%</td>
<td>25%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Off-site recycling (# recomm.)</td>
<td>54%</td>
<td>-</td>
<td>54%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Purchasing (# recomm.)</td>
<td>0%</td>
<td>100%</td>
<td>25%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Training (# recomm.)</td>
<td>33%</td>
<td>75%</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Watermark (# recomm.)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Total (# recomm.)</td>
<td>40%</td>
<td>50%</td>
<td>43%</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>20</td>
<td>63</td>
<td>20</td>
</tr>
</tbody>
</table>
Table F.4. Percent of Clients Selecting “4” or “5” for Level of Engagement by Mode of Assistance and Program (Number of Client Respondents in Parentheses).

<table>
<thead>
<tr>
<th>Engagement Activity</th>
<th>Responses to other surveys</th>
<th>Responses to this study’s surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIT (3,107)</td>
<td>GTP (35,000)</td>
</tr>
<tr>
<td>Reducing or eliminating the creation of waste materials</td>
<td>3.69</td>
<td>57%</td>
</tr>
<tr>
<td>Improving energy efficiency</td>
<td>3.69</td>
<td>55%</td>
</tr>
<tr>
<td>Reducing the creation or release of pollutants or toxic compounds</td>
<td>n/a</td>
<td>13%</td>
</tr>
<tr>
<td>Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)</td>
<td>3.22</td>
<td>n/a</td>
</tr>
<tr>
<td>Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)</td>
<td>3.10</td>
<td>n/a</td>
</tr>
<tr>
<td>Building awareness of pollution prevention in the organization</td>
<td>3.06</td>
<td>n/a</td>
</tr>
<tr>
<td>Reducing greenhouse gas emissions</td>
<td>n/a</td>
<td>19%</td>
</tr>
<tr>
<td>Building culture of innovation by pursuing sustainability/P2 strategies</td>
<td>2.83</td>
<td>13%</td>
</tr>
<tr>
<td>Generating electricity, heat, or fuel from renewable sources</td>
<td>n/a</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table F.5. Percent of Clients Selecting “4” or “5” for Level of Engagement by Sector (Number of Client Respondents in Parentheses).

<table>
<thead>
<tr>
<th>Engagement Activity</th>
<th>Responses to other surveys</th>
<th>Responses to this study’s surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIT (3,107) GTP (35,000)</td>
<td>Health care (6) Hospitality (3) Manufacturing (19) Other (8) Public (10) Total (48)</td>
</tr>
<tr>
<td>Reducing or eliminating the creation of waste materials</td>
<td>3.69 55%</td>
<td>100% 17% 67% 89% 50% 45% 63%</td>
</tr>
<tr>
<td>Improving energy efficiency</td>
<td>3.69 57%</td>
<td>100% 83% 100% 84% 25% 82% 75%</td>
</tr>
<tr>
<td>Reducing the creation or release of pollutants or toxic compounds</td>
<td>n/a 13%</td>
<td>100% 50% 67% 74% 38% 55% 60%</td>
</tr>
<tr>
<td>Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)</td>
<td>n/a 19%</td>
<td>100% 50% 0% 63% 13% 27% 42%</td>
</tr>
<tr>
<td>Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)</td>
<td>3.1 n/a</td>
<td>100% 33% 67% 68% 38% 45% 54%</td>
</tr>
<tr>
<td>Building awareness of pollution prevention in the organization</td>
<td>3.22 n/a</td>
<td>0% 33% 67% 58% 13% 64% 48%</td>
</tr>
<tr>
<td>Reducing greenhouse gas emissions</td>
<td>2.83 13%</td>
<td>100% 33% 33% 53% 13% 18% 35%</td>
</tr>
<tr>
<td>Building culture of innovation by pursuing sustainability/P2 strategies</td>
<td>3.06 n/a</td>
<td>100% 33% 33% 42% 25% 27% 35%</td>
</tr>
<tr>
<td>Generating electricity, heat, or fuel from renewable sources</td>
<td>n/a 2%</td>
<td>0% 0% 0% 11% 0% 18% 8%</td>
</tr>
<tr>
<td>Total</td>
<td>- -</td>
<td>78% 37% 48% 60% 24% 42% 47%</td>
</tr>
</tbody>
</table>
Table F.6. Top Implemented Motivation by Sector (Percent of Opportunities with Motivation Selected as Top Reason).

<table>
<thead>
<tr>
<th>Sector (# of opportunities implemented)</th>
<th>Acceptable payback</th>
<th>Reduced operating cost</th>
<th>Increased employee productivity</th>
<th>Reduced business risk</th>
<th>Reduced env. &amp; health risk</th>
<th>Health and safety benefits</th>
<th>Regulatory compliance</th>
<th>Enhanced env. Awareness</th>
<th>Improved public image</th>
<th>Corporate commitment</th>
<th>Energy efficiency</th>
<th>Other companies implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care (23)</td>
<td>35%</td>
<td>9%</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
<td>30%</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td>Hospitality (6)</td>
<td>0%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>17%</td>
<td>17%</td>
<td>0%</td>
<td>0%</td>
<td>17%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Manufacturing (43)</td>
<td>7%</td>
<td>35%</td>
<td>0%</td>
<td>2%</td>
<td>9%</td>
<td>9%</td>
<td>0%</td>
<td>7%</td>
<td>0%</td>
<td>7%</td>
<td>23%</td>
<td>0%</td>
</tr>
<tr>
<td>Other (3)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>33%</td>
<td>0%</td>
<td>33%</td>
<td>33%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Public (27)</td>
<td>15%</td>
<td>4%</td>
<td>0%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>0%</td>
<td>26%</td>
<td>0%</td>
<td>19%</td>
<td>26%</td>
<td>0%</td>
</tr>
<tr>
<td>Total (102)</td>
<td>15%</td>
<td>21%</td>
<td>0%</td>
<td>2%</td>
<td>6%</td>
<td>5%</td>
<td>1%</td>
<td>12%</td>
<td>1%</td>
<td>16%</td>
<td>23%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table F.7. All Implemented Motivations (Percent of Opportunities with Motivation Selected as a Reason).

<table>
<thead>
<tr>
<th># of implemented opportunities</th>
<th>Acceptable payback</th>
<th>Reduced operating cost</th>
<th>Increased employee productivity</th>
<th>Reduced business risk</th>
<th>Reduced env. &amp; health risk</th>
<th>Health and safety benefits</th>
<th>Regulatory compliance</th>
<th>Enhanced env. Awareness</th>
<th>Improved public image</th>
<th>Corporate commitment</th>
<th>Energy efficiency</th>
<th>Other companies implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>102</td>
<td>73%</td>
<td>63%</td>
<td>16%</td>
<td>22%</td>
<td>25%</td>
<td>25%</td>
<td>15%</td>
<td>45%</td>
<td>36%</td>
<td>84%</td>
<td>60%</td>
<td>19%</td>
</tr>
</tbody>
</table>
### Table F.8. Top Non-Implemented Motivation by Sector (Percent of Opportunities with Motivation Selected as Top Reason).

<table>
<thead>
<tr>
<th>Sector (# of opportunities not implemented)</th>
<th>Insufficient financial payback</th>
<th>Lack of capital (financing)</th>
<th>Other priorities for capital investments</th>
<th>Risk of production disruption/inconvenience/slowdown</th>
<th>Lack of perceived env/risk reduction benefits</th>
<th>Lack of staff awareness/willingness to change</th>
<th>Difficulty in coord. between units within company</th>
<th>Limited in-plant expertise/capability</th>
<th>Customer specifications</th>
<th>Not technically feasible</th>
<th>Uncertainty/lack of confidence in technology</th>
<th>Insufficient information regarding recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care (15)</td>
<td>0%</td>
<td>47%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>23%</td>
<td>0%</td>
<td>13%</td>
</tr>
<tr>
<td>Hospitality (13)</td>
<td>0%</td>
<td>8%</td>
<td>38%</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
<td>23%</td>
<td>0%</td>
<td>23%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Manufacturing (35)</td>
<td>20%</td>
<td>11%</td>
<td>31%</td>
<td>6%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>6%</td>
<td>11%</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>Other (1)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Public (23)</td>
<td>13%</td>
<td>0%</td>
<td>17%</td>
<td>4%</td>
<td>22%</td>
<td>13%</td>
<td>0%</td>
<td>9%</td>
<td>4%</td>
<td>13%</td>
<td>4%</td>
<td>0%</td>
</tr>
<tr>
<td>Total (87)</td>
<td>11%</td>
<td>14%</td>
<td>26%</td>
<td>5%</td>
<td>8%</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
<td>8%</td>
<td>10%</td>
<td>3%</td>
<td>5%</td>
</tr>
</tbody>
</table>

### Table F.9. All Non-Implemented Motivations (Percent of Opportunities with Motivation Selected as a Reason).

<table>
<thead>
<tr>
<th># of opportunities not implemented</th>
<th>Insufficient financial payback</th>
<th>Lack of capital (financing)</th>
<th>Other priorities for capital investments</th>
<th>Risk of production disruption/inconvenience/slowdown</th>
<th>Lack of perceived env/risk reduction benefits</th>
<th>Lack of staff awareness/willingness to change</th>
<th>Difficulty in coord. between units within company</th>
<th>Limited in-plant expertise/capability</th>
<th>Customer specifications</th>
<th>Not technically feasible</th>
<th>Uncertainty/lack of confidence in technology</th>
<th>Insufficient information regarding recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>29%</td>
<td>32%</td>
<td>56%</td>
<td>9%</td>
<td>22%</td>
<td>8%</td>
<td>4%</td>
<td>7%</td>
<td>8%</td>
<td>17%</td>
<td>19%</td>
<td>9%</td>
</tr>
</tbody>
</table>


APPENDIX G: SAMPLE SAS STATISTICAL ANALYSIS

G.1 Coding for implementation rate by mode of assistance analysis

data assistance;
input implementation$ mode$ count;
datalines;
Yes Partial 90
Yes Single 57
Yes Multiple 105
No Partial 128
No Single 55
No Multiple 69
;
run;
proc freq
data = assistance;
tables implementation * mode
/ chisq;
weight count;

G.2 Output for implementation rate by mode of assistance analysis

<table>
<thead>
<tr>
<th>Mode of Assistance</th>
<th>Frequency</th>
<th>Table of implementation by mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Multiple</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13.69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39.66</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>105</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60.34</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>174</td>
</tr>
<tr>
<td></td>
<td></td>
<td>34.52</td>
</tr>
</tbody>
</table>
Statistics for Table of implementation by mode

<table>
<thead>
<tr>
<th>Statistic</th>
<th>DF</th>
<th>Value</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>2</td>
<td>14.1078</td>
<td>0.0009</td>
</tr>
<tr>
<td>Likelihood Ratio Chi-Square</td>
<td>2</td>
<td>14.1959</td>
<td>0.0008</td>
</tr>
<tr>
<td>Mantel-Haenszel Chi-Square</td>
<td>1</td>
<td>4.1445</td>
<td>0.0418</td>
</tr>
<tr>
<td>Phi Coefficient</td>
<td></td>
<td>0.1673</td>
<td></td>
</tr>
<tr>
<td>Contingency Coefficient</td>
<td></td>
<td>0.1650</td>
<td></td>
</tr>
<tr>
<td>Cramer's V</td>
<td></td>
<td>0.1673</td>
<td></td>
</tr>
</tbody>
</table>

Sample Size = 504

G.3 Coding for implementation rate by payback (greater than 4 years) and initial cost

data paybackvcost;
  input implementation$ category$ count;
datelines;
  Yes 999four 12
  Yes 1000four 12
  No 999four 12
  No 1000four 42
;
run;

proc freq
  data = paybackvcost;
  tables implementation * category / chisq;
  weight count;
G.4 Output for implementation rate by payback (greater than 4 years) and initial cost

<table>
<thead>
<tr>
<th>Payback vs Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Squared Test: Payback vs Cost</td>
</tr>
</tbody>
</table>

The FREQ Procedure

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Table of implementation by category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>implementation</td>
</tr>
<tr>
<td></td>
<td>1000four</td>
</tr>
<tr>
<td>Row Pct</td>
<td>No</td>
</tr>
<tr>
<td>Col Pct</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>53.85</td>
</tr>
<tr>
<td></td>
<td>77.78</td>
</tr>
<tr>
<td></td>
<td>77.78</td>
</tr>
<tr>
<td>Yes</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>15.38</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
</tr>
<tr>
<td></td>
<td>22.22</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>69.23</td>
</tr>
</tbody>
</table>

Statistics for Table of implementation by category

<table>
<thead>
<tr>
<th>Statistic</th>
<th>DF</th>
<th>Value</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>1</td>
<td>6.0185</td>
<td>0.0142</td>
</tr>
<tr>
<td>Likelihood Ratio Chi-Square</td>
<td>1</td>
<td>5.8104</td>
<td>0.0159</td>
</tr>
<tr>
<td>Continuity Adj. Chi-Square</td>
<td>1</td>
<td>4.7851</td>
<td>0.0287</td>
</tr>
<tr>
<td>Mantel-Haenszel Chi-Square</td>
<td>1</td>
<td>5.9414</td>
<td>0.0148</td>
</tr>
<tr>
<td>Phi Coefficient</td>
<td></td>
<td>0.2778</td>
<td></td>
</tr>
<tr>
<td>Contingency Coefficient</td>
<td></td>
<td>0.2676</td>
<td></td>
</tr>
<tr>
<td>Cramer's V</td>
<td></td>
<td>0.2778</td>
<td></td>
</tr>
</tbody>
</table>

Sample Size = 78
APPENDIX H: INDIVIDUAL OPPORTUNITY DATABASE WITH SURVEY RESPONSES

Note: Company names are not included in the spreadsheet below; previous reassessments by UNL (2005-2011) do not include specific savings.

<table>
<thead>
<tr>
<th>Recommendation #</th>
<th>Year of assessment</th>
<th>Year of reassessment</th>
<th>Company #</th>
<th>Level of assistance</th>
<th>Company sector</th>
<th>Program (UNL/KSU)</th>
<th>P2 suggestion</th>
<th>P2 category</th>
<th>Implemented</th>
<th>Not implemented</th>
<th>Doing before</th>
<th>Originally Recommended</th>
<th>Originally Not recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2010</td>
<td>2014</td>
<td>1</td>
<td>Multi</td>
<td>Manufacturing</td>
<td>UNL</td>
<td>Replace high bay lighting with T5 fluorescent in Building 3</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2010</td>
<td>2014</td>
<td>1</td>
<td>Multi</td>
<td>Manufacturing</td>
<td>UNL</td>
<td>Replace workspace lighting with T5 fluorescent in Building 3</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2010</td>
<td>2014</td>
<td>1</td>
<td>Multi</td>
<td>Manufacturing</td>
<td>UNL</td>
<td>Install select occupancy sensors</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2010</td>
<td>2014</td>
<td>1</td>
<td>Multi</td>
<td>Manufacturing</td>
<td>UNL</td>
<td>De-lamp vending machines</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2010</td>
<td>2014</td>
<td>1</td>
<td>Multi</td>
<td>Manufacturing</td>
<td>UNL</td>
<td>Replace T12 office lighting with T8 fluorescent</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2010</td>
<td>2014</td>
<td>1</td>
<td>Multi</td>
<td>Manufacturing</td>
<td>UNL</td>
<td>Install vending and snack misers</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2009</td>
<td>2014</td>
<td>1</td>
<td>Multi</td>
<td>Manufacturing</td>
<td>UNL</td>
<td>Install wastewater evaporator</td>
<td>Equipment/process modification</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2010</td>
<td>2014</td>
<td>2</td>
<td>Partial</td>
<td>Public</td>
<td>UNL</td>
<td>Join OPPD's lighting incentive program and redo facility lighting</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2010</td>
<td>2014</td>
<td>2</td>
<td>Partial</td>
<td>Public</td>
<td>UNL</td>
<td>Drill gaps in clarifier's teeth or replace weir</td>
<td>Equipment/process modification</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2010</td>
<td>2014</td>
<td>2</td>
<td>Partial</td>
<td>Public</td>
<td>UNL</td>
<td>Run sludge recycling through one pump</td>
<td>Equipment/process modification</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2010</td>
<td>2014</td>
<td>2</td>
<td>Partial</td>
<td>Public</td>
<td>UNL</td>
<td>Control aeration with DO meter and manually control oxidation rotor speed accordingly</td>
<td>Training/policies</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2010</td>
<td>2014</td>
<td>2</td>
<td>Partial</td>
<td>Public</td>
<td>UNL</td>
<td>Control blowers based on depth in digester</td>
<td>Training/policies</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>2010</td>
<td>2014</td>
<td>2</td>
<td>Partial</td>
<td>Public</td>
<td>UNL</td>
<td>Install VFD's</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>2012</td>
<td>2014</td>
<td>3</td>
<td>Partial</td>
<td>Public</td>
<td>UNL</td>
<td>Install VFDs in blower room</td>
<td>Energy efficiency</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommendation #</td>
<td>Specific status/ category</td>
<td>No longer occurring?</td>
<td>Reoccurrence so far (yrs)</td>
<td>Expected reoccurrence category (yrs)</td>
<td>Initial cost ($)</td>
<td>Actual cost savings ($/yr)</td>
<td>Projected/potential cost savings ($/yr)</td>
<td>Actual payback period (yr)</td>
<td>Projected payback period (yr)</td>
<td>Toxins category</td>
<td>Solid waste (lbs/yr)</td>
<td>Haz. waste (lbs/yr)</td>
<td>Haz. materials, lbs/yr</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------------------------</td>
<td>--------------------------------------</td>
<td>-----------------</td>
<td>---------------------------</td>
<td>----------------------------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
<td>----------------</td>
<td>------------------</td>
<td>------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1</td>
<td>As suggested</td>
<td>3</td>
<td>5-15 more</td>
<td>$50,000.00</td>
<td>$21,000.00</td>
<td>$21,000.00</td>
<td>2.38</td>
<td>2.38</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>As suggested</td>
<td>3</td>
<td>5-15 more</td>
<td>$925.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>6.61</td>
<td>6.61</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>As suggested</td>
<td>3</td>
<td>5-15 more</td>
<td>$5,200.00</td>
<td>$2,200.00</td>
<td>$2,200.00</td>
<td>2.36</td>
<td>2.36</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>As suggested</td>
<td>4</td>
<td>5-15 more</td>
<td>$0.00</td>
<td>$150.00</td>
<td>$150.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Not investigated</td>
<td>5-15 more</td>
<td>$8,600.00</td>
<td>$8,700.00</td>
<td></td>
<td>#DIV/0!</td>
<td>0.99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Not investigated</td>
<td>5-15 more</td>
<td>$2,600.00</td>
<td>$1,900.00</td>
<td></td>
<td>#DIV/0!</td>
<td>1.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>As suggested</td>
<td>0</td>
<td>5-15 more</td>
<td>$37,000.00</td>
<td>$21,000.00</td>
<td>$21,000.00</td>
<td>1.76</td>
<td>1.76</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Investigated</td>
<td>5-15 more</td>
<td>$279.00</td>
<td>$176.00</td>
<td></td>
<td>#DIV/0!</td>
<td>1.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>With modification</td>
<td>2</td>
<td>5-15 more</td>
<td>$1,000.00</td>
<td>$0.00</td>
<td>#DIV/0!</td>
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<td>Use less or local fertilizer</td>
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Survey #2: All reasons for implementing opportunity

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Survey #3: Top reason for implementing opportunity

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- **Survey #4:** All reasons for not implementing
- **Survey #5:** Top reason for not implementing
- **Initial cost category:** $<999$ to $<1$ year
- **Projected payback category:** $<999$ to $>4$ years

**Note:** The table represents a snapshot of reasons for non-implementation and associated costs and paybacks for various recommendations, with specific details ranging from initial cost and projected payback to specific reasons such as lack of capital, insufficient financial payback, and other priorities.
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<th>Company sector</th>
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Survey #2: All reasons for implementing opportunity

Survey #3: Top reason for implementing opportunity

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| 95 | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 96 | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
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Legend:
- A2: Acceptable payback
- B2: Energy efficiency
- C2: Reduced operating cost
- D2: Increased employee productivity
- E2: Health and safety benefits
- F2: Regulatory compliance
- G2: Reduced env. and health risk
- H2: Reduced business risk
- I2: Enhanced env. awareness
- J2: Improved public image
- K2: Other companies also implemented
- L2: Corporate commitment
- A3: Acceptable payback
- B3: Energy efficiency
- C3: Reduced operating cost
- D3: Increased employee productivity
- E3: Health and safety benefits
- F3: Regulatory compliance
- G3: Reduced env. and health risk
- H3: Reduced business risk
- I3: Enhanced env. awareness
- J3: Improved public image
- K3: Other companies also implemented
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**Survey #2: All reasons for implementing opportunity**

- A2: Acceptable payback
- B2: Energy efficiency
- C2: Reduced operating cost
- D2: Increased employee productivity
- E2: Regulatory compliance
- F2: Health and safety benefits
- G2: Reduced env. and health risk
- H2: Reduced business risk
- I2: Enhanced env. awareness
- J2: Improved public image
- K2: Other companies also implemented
- L2: Corporate commitment

**Survey #3: Top reason for implementing opportunity**

- A3: Acceptable payback
- B3: Energy efficiency
- C3: Reduced operating cost
- D3: Increased employee productivity
- E3: Regulatory compliance
- F3: Health and safety benefits
- G3: Reduced env. and health risk
- H3: Reduced business risk
- I3: Enhanced env. awareness
- J3: Improved public image
- K3: Other companies also implemented
- L3: Corporate commitment
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Survey #2: All reasons for implementing opportunity

Survey #3: Top reason for implementing opportunity

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Survey #2: All reasons for implementing opportunity

Survey #3: Top reason for implementing opportunity

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APPENDIX I: CLIENT DATABASE

Note: Company names are not included in the spreadsheets below; previous reassessments by UNL (2005-2011) do not include specific savings.

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