BIOSOLIDS IN BC'S SOUTHERN INTERIOR: A CASE STUDY ON PUBLIC PERCEPTIONS

By

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ABSTRACT

The land application of biosolids continues to be subject to questions and concerns. There exists a difference between public perceptions of biosolids and the promotion of the safety and sustainability of current waste management practices that convert sewage sludge to biosolids. Within the Southern Interior of British Columbia, there is opposition amongst a segment of the population regarding the land application of biosolids. Through a mail-out survey, the communities of Kamloops, Merritt and Princeton were assessed to gain a better understanding of public perceptions of biosolids risks and factors which influence public attitudes towards biosolids management. Two thousand surveys were distributed proportionately between the communities. Response rates for Kamloops and Merritt were 22 and 24 percent respectively. Surprisingly no responses were received from Princeton. Kamloops and Merritt generally identified differing risk perceptions around the management of biosolids, where Kamloops was found to be more accepting in their overall perceptions. This is a likely result of Merritt residents' recent experience with application sites and proximity to biosolids projects, and the associated local media attention. Results from Kamloops highlighted there is general support to find a productive use of biosolids, but a lack of the overall trust necessary for a biosolids project to receive stable community support. Further to this, respondents were asked about their willingness to pay for alternative biosolids management practices. These results can be used as a surrogate for willingness to pay to divert biosolids from land application, thus indirectly estimating the perceived external cost of applying biosolids to land. The results indicate that in Kamloops there may be no perceived external costs but in the neighboring city of Merritt there are.

Key words: community engagement, public opinion survey, biosolids management, contingent valuation

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GLOSSARY OF TERMS

Anchoring: In behavioral economics, anchoring is an effect where initial exposure to a number serves as a reference point, influencing subsequent judgments about value (Samson, Loewenstein, and Sutherland 2014).

Biosolids: The Organic Matter Recycling Regulation defines biosolids as stabilized municipal sewage sludge resulting from a municipal waste water treatment process or septage treatment process which has been sufficiently treated to reduce pathogen densities and vector attraction to allow the sludge to be beneficially recycled in accordance with the requirements of applicable regulation. (BC MOE 2002a). These nutrient-rich organic materials, once treated, can be applied as fertilizer to improve and maintain productive soils and stimulate plant growth (CCME 2012; McCarthy and Loyo-Rosales 2015).

Canadian Council of Ministers of the Environment (CCME): CCME is the intergovernmental forum for collective action on environmental issues of national and international concern. The Council is composed of the environment ministers from the federal, provincial and territorial governments of Canada. The goal if the CCME is to achieve positive environmental results on Canada-wide issues (CCME 2014).

Contingent Valuation: A method commonly used by economists for valuations of non-market goods. Contingent valuation enables the researcher to directly observe the relationship between an economic decision and particular non-market goods (Carson 2000).

Dichotomous choice: Elicitation method for contingent valuation surveys, where respondents are asked, "would you pay $B" for a specified proposal. There is only one bid options, which can be accepted or rejected (Boyle 2003).

Environmental goods: Generally non-market goods, includes clean air, clean water, biodiversity, etc (Tietenberg and Lewis 2009).

External cost: A cost that occurs when a transaction imposes a cost on an unrelated third party. If there are external costs in consuming a good, the social cost will be greater than the private cost (Tietenberg and Lewis 2009).

Framing: Wording presented in a way that highlights the positive or negative aspects of the same decision, resulting in changes in their relative attractiveness (Samson, Loewenstein, and Sutherland 2014).

Gray literature: Material that is made public but not subject to the traditional academic peer-review processes (i.e. newspaper articles or working papers).

Heckman Correction: A common econometrics **s**tatistical method that offers a two-step statistical approach to correct for selection bias (Greene 2012).

Land application: The application to land, after biosolids treatment or composting, of Class A biosolids, Class B biosolids or Class B compost (BC MOE 2002a).

Legitimacy: Perception that the company/project offers benefit to the perceiver [as related to social licence to operate] (Boutilier and Thomson 2011).

Likert scale: A technique for the measurement of attitudes, utilizing a scale that presents an equal number of positive and negative responses (Likert 1932).

Logistic regression: A widely used statistical model that uses the natural logarithm of an odds ratio to determine the distribution of a dichotomous outcome (Greene 2012).

Loss aversion: The concept that the pain of losing is psychologically about twice as powerful as the pleasure of gaining. This can explain differences in risk-seeking versus aversion (Samson, Loewenstein, and Sutherland 2014).

Non-Market Goods: Goods and services that are not traded in markets. Their economic value (i.e. how much people would be willing to pay for them) is not revealed in market prices (Tietenberg and Lewis 2009).

Nonresponse bias: Bias that results when respondents differ in meaningful ways from nonrespondents (i.e. the survey respondents disproportionately possess certain traits which affect the outcome) (Dillman 1991).

Ordered logistic regression: An extension of the logistic model for ordinal dependent variables (Greene 2012).

Organic Matter Recycling Regulation (OMRR): Regulation under BC's *Environmental Management Act* and *Health Act*. The OMRR governs the construction and operation of compost facilities, and the production, distribution, storage, sale and use of biosolids and compost in BC (BC MOE 2002b).

Payment card: Elicitation method for contingent valuation surveys, where respondents are asked to select the highest amount they are willing to pay for a specified proposal from a number of possible bids (Carson 2000).

Probit Model: A statistical regression model based on probability theory to determine the distribution of a dichotomous outcome (Greene 2012).

Protest response: Responses registered by respondents who may actually place a higher- or lower-than-average value on the proposal in question but refuse to pay on the basis of political or ethical reasons (Halstead, Luloff, and Stevens 1992).

Satterthwaite-Welch t-test: Statistical tool used to test the hypothesis that two populations have equal means. An adaptation of the t-test that is more reliable when the two samples have unequal variances and unequal sample sizes.

Selection bias: Bias that results by the selection of individuals, groups or data for analysis in such a way that proper randomization is not achieved (Heckman 1976).

Social capital: The links, shared values and understandings in society that enable individuals and groups to trust each other and to work together (Keely 2007).

Social License to Operate (SLO): The ongoing acceptability of a company and its local operations as perceived by the community (Boutilier and Thomson 2011).

Stakeholder: Those who could be affected by the actions of a proponent or who could have an effect on the proponent (Boutilier and Thomson 2011).

Tobit model: A censored regression model that estimates linear relationships between variables when there is either left- or right-censoring in the dependent variable (Greene 2012).

Trust: Willingness to be vulnerable to risk or loss through actions of another (Boutilier and Thomson 2011).

Voluntary Response bias: Bias that occurs when survey respondents are self-selected volunteers. The resulting sample tends to over-represent individuals who have strong opinions (Kanuk and Berenson 1975).

Willingness to pay: The maximum amount of money a person is willing to pay to acquire a good or service that they consider desirable. The goal is to convert well-being into monetary costs to assess them against the costs of current or planned management practises (Tietenberg and Lewis 2009).

Yea saying: In contingent valuation, when a respondent says yes to an amount even though the respondents willingness to pay is less than the amount asked about (Carson 2000).

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Chapter 1 INTRODUCTION

Introduction and Relevance

As human population continues to rise and population concentration in urban areas continues to increase, there is a growing need to move to sustainable waste management practices, such as the treatment and reuse of municipal waste. Biosolids are produced from the nutrient-rich solids that are a by-product of wastewater treatment. These solids have been separated from the liquids during the wastewater treatment process and then treated to kill potentially harmful bacteria.

In Canada, The Canadian Council of Ministers of the Environment (CCME) encourage the beneficial use of municipal biosolids, while maintaining protection of the environment and human health. Beneficial management includes practices such as composting, agricultural land application and combustion for energy. However, in some municipalities, biosolids are disposed of in landfills or incinerated without energy capture rather than being used in a beneficial manner (CCME 2012). As well, some municipalities release wastewater or associated byproducts into the ocean (McCarthy and Loyo-Rosales 2015). In Canada biosolids are often used as a soil amendment for improving soils and plant growth (CCME 2012; McCarthy and Loyo-Rosales 2015).

Using biosolids as a soil amendment offers advantages such as improving the quality of degraded soils through enabling increased plant productivity and improved soil carbon storage capacity (Robinson et al. 2012) as well as reducing the amount of material otherwise destined for landfilling or incineration and the greenhouse gas generation associated with these practices. Among the public there is a negative perception about biosolids used as a soil amendment (Beecher et al. 2004; Robinson et al. 2012; McCarthy and Loyo-Rosales 2015). These negative views seem to arise from concerns of potential contaminants in biosolids which include inorganic contaminants (e.g., metals and trace elements), organic contaminants (e.g., polychlorinated biphenyls, dioxins, pharmaceuticals, and surfactants) and pathogens (e.g., bacteria, viruses, and parasites), as well as complaints regarding the odor (National Research Council 2002). In order to establish socially acceptable sustainable waste

management practices, it is necessary to assess public knowledge and attitudes regarding biosolids reuse.

Biosolids

In the early 1990's, the Water Environment Federation (WEF), held a contest to develop a term that differentiated treated and tested sewage sludge from raw un-treated sludge. The term "biosolids" was the result of this contest and now is widely used around the world (NEBRA 2008).

The CCME, which approved the Canada-wide Approach for the Management of Wastewater Biosolids in 2012, defines municipal biosolids as organic-based products which are produced from the treatment of municipal sludge. Municipal biosolids are further defined as "municipal sludge which has been treated to meet jurisdictional standards, guidelines or requirements including the reduction of pathogens and vector attraction."

The Organic Matter Recycling Regulation of British Columbia (2002), which regulates biosolids in BC, defines biosolids as "stabilized municipal sewage sludge resulting from a municipal waste water treatment process or septage treatment process which has been sufficiently treated to reduce pathogen densities and vector attraction to allow the sludge to be beneficially recycled in accordance with the requirements of this regulation."

There are treatment processes, strict standards, and quality controls in place aimed to ensure the safety of biosolids application (National Research Council 2002). Biosolids can be produced through a variety of methods, including anaerobic or aerobic digestion, alkaline stabilization, dewatering and composting. Once treated, biosolids have reduced volatile organic compounds, odour, and pathogens (BC 2002; CCME 2012).

Regulatory Framework

Canadian Council of Ministers of the Environment

As defined on the Canadian Council of Ministers of the Environment (CCME) website, the CCME is an inter-governmental forum for collective action on environmental issues of national and international concern. In 2009 the CCME endorsed "The Canada-wide Strategy for the Management of Municipal Wastewater Effluent." This strategy sets out a framework to manage discharges from Canada-wide wastewater facilities, providing a path to achieve a

Canada-wide approach for the land application of biosolids. The strategy merely provides a framework for biosolids management, and thus bears no legal status. Provincial and Territorial governments are responsible for the adoption and enforcement of regulations for biosolids management (CCME 2012).

After two rounds of public consultation, the Ministers approved the Canada-wide Approach for the Management of Wastewater Biosolids in 2012. The standards set out by the strategy were informed by a scientific literature review, a review of Canadian legislative frameworks, and baseline data on biosolids in Canada, and are intended to increase protection for human health and the environment across Canada. This information is intended to provide a firm knowledge base to inform science-based decisions relating to wastewater management and allow for the implementation of uniform approaches to beneficial uses of biosolids in Canada. (CCME 2012).

Regulation of Biosolids in British Columbia

In British Columbia (B.C.), biosolids are regulated under the Organic Matter Recycling Regulation (OMRR), developed in 2002 under the authority of the Environmental Management Act and the Health Act. The regulation is designed to be protective of human health and the environment, and as indicated above, defines biosolids as stabilized municipal sewage sludge resulting from a municipal waste water treatment process or septage treatment process which has been sufficiently treated to reduce pathogen densities and vector attraction to allow the sludge to be beneficially recycled (BC MOE 2002).

The OMRR outlines a series of requirements municipal wastewater products must meet in order to be considered biosolids, which can be found in schedules 1 through 6 of the regulation. Biosolids can be classified under the OMRR as either Class A or Class B biosolids, depending on the quality criteria met (Table 1-2). The regulation limits final land use, site access, application methodology and monitoring requirements depending on the class. The regulation places the responsibility of evaluating sites for land application and minimizing the opportunity for adverse impacts on human health and the environment on a qualified professional.

Table 1-1 Composition criteria for class A and class B biosolids in British Columbia as defined by the Organic Matter Recycling Regulation (BC 2002)

OMRR Criteria	Class A Biosolids	Class B Biosolids
Process Criteria (Schedules 1, 2 and 3)		
Pathogen Reduction	√	√
Vector Attraction Reduction	√	√
Fecal Coliform (MPN g^{-1} dw)	< 1,000	< 2,000,000
Quality Criteria (Schedule 4; μg g^{-1}, dw)[a]		
Arsenic	75	75
Cadmium	20	20
Chromium	-	1,060
Cobalt	150	150
Copper	-	2,200
Lead	500	500
Mercury	5	15
Molybdenum	20	20
Nickel	180	180
Selenium	14	14
Zinc	1,850	1,850
Foreign Matter	≤ 1%[b]	≤ 1%[b]
Sampling and Analyses and Record Keeping (Schedules 5 and 6)		
Sampling and Analysis	Required	Required
Record Keeping	Required	Required

[a] Class A Limits for trace elements specified in *Trade Memorandum T-4-93 (September 1997), Standards for Metals in Fertilizers and Supplements*.

[b] Further requirement of no sharp foreign matter that can cause injury.

Due to growing concerns over the land application of biosolids, the Provincial government of BC announced on June 17, 2015 that a technical working group would conduct a scientific review of biosolids. The scientific review included two key components: (1) a review of scientific and academic literature on biosolids land applications and (2) a soil sampling project. On April 4, 2016 the Province announced it would undertake a review of the Organic Matter Recycling Regulation to ensure it remains protective of human health and the environment. Subsequent amendments to the OMRR, based on engagement and information received from the review, were anticipated to be made in 2017 (BC MOE 2016). At the time of this thesis, although the amendment is still pending, the province did release their intentions paper in October 2018. The intentions paper outlines the proposed changes to the OMRR and seeks for comments and feedback from all interested parties on the proposed changes. Prior to the 2018 intentions paper, as series of intention papers for consultation were

published in 2006, 2011 and 2016 with a summary of public comment subsequently published.

Public Perception

The amount of sewage sludge generated annually continues to rise, increasing the nation's dependence on effective wastewater treatment and management. Despite this reliance, the overall public awareness of what biosolids are and how they may be used remains low (Beecher et al. 2004; Robinson et al. 2012; Youngquist et al. 2015; McCarthy and Loyo-Rosales 2015). There are treatment processes, strict standards, and quality controls in place to ensure the safety of biosolids application, however a negative perception exists amongst the public regarding the use of biosolids (National Research Council 2002; Beecher et al. 2004; McCarthy and Loyo-Rosales 2015). These negative views include concerns of potential contaminants in biosolids which broadly include inorganic contaminants (e.g., metals and trace elements), organic contaminants (e.g., polychlorinated biphenyls, dioxins, pharmaceuticals, and surfactants) and pathogens (e.g., bacteria, viruses, and parasites), as well as complaints regarding the odor (National Research Council 2002; Beecher et al. 2004; Robinson et al. 2012; Youngquist et al. 2015)

Risk management decisions can be highly subject to community opposition based on the public perceptions of an associated risk. One of the central themes of risk management is "How safe is safe enough?" There is an extensive body of literature on risk perception research, where key themes highlight the fundamental role distrust plays in conflicts that emerge over risk management decisions (Fischhoff, Slovic, and Lichtenstein 1978; Slovic 1993). Trust, as Slovic (1993) suggests, is easier to destroy than to create. These idiosyncrasies of human psychology are reflected in the following:

1. Negative (trust-destroying) events are more visible than positive (trust-building) events;
2. Negative (trust-destroying) events are more impactful than positive (trust-building) events;
3. Sources of bad news (trust-destroying) tend to be seen as more credible than sources of good news (trust-building); and
4. Distrust, once initiated, tends to reinforce and perpetuate distrust.

Our reliance on sense of sight, taste, and smell to detect unsafe circumstances has been referred to as "initiative toxicology." The sciences of toxicology and risk assessment were largely created to better assess potential dangers, recognizing our senses are not always an adequate measure. There are however, large differences between the risk perceptions of the general public and toxicologists, in addition to differences that exist between toxicologists working in difference sectors. Overall, technical experts tend to perceive far lower risk and exhibit more favourable attitudes towards chemicals than the general lay public (Slovic 1993; Neil, Malmfors, and Slovic 1994; Slovic et al. 1995).

In general, assessing public perceptions of risk demonstrated that higher risks were perceived to be more acceptable for activities that were seen as beneficial and/or where the risks were entered into voluntarily (Slovic 1993). When considering public risk perceptions, despite the fact that the general public may lack certain information about the hazard, their concerns reflect legitimate concerns which need to be acknowledged (Slovic 1987). Ongoing successful risk management requires the understanding of complex psychological, social, cultural, and political forces (Slovic 1993).

In order to better understand public risk perceptions towards land applied biosolids, Beecher et al. (2004), in collaboration with the Water Environment Research Foundation (WERF), published the report "Public Perception of Biosolids Recycling: Developing Public Participation and Earning Trust," which includes the results of their 2002 Biosolids Public Knowledge and Perception Survey as well as an extensive literature review on public perceptions of biosolids recycling in both Canada and the United States. The report outlines the most significant technical issues about biosolids recycling, listed in order of significance as:

- Trace metals and chemicals ("pollutants");
- Pathogens (human-disease-causing organisms);
- Odours and other air quality concerns;
- Oversight and enforcements;
- Surface water and groundwater quality;
- Soil and food quality;
- Transportation and trucking;

- Economic viability;
- Changes in demographics and changing expectations; and
- Emerging issues and uncertainty.

Biosolids continue to be subject to questions and concerns. Concerns are raised about anything that might be disposed of down the drain that may potentially impact biosolids quality. Biosolids managers have expressed particular frustration around the concept of "perception is reality." Social science research has indicated there exists a considerable gap in risk perception between the technical "experts" and the lay public, highlighting that people who regard themselves as "expert" tend to perceive a lower risk about that topic, whereas non-experts will perceive a higher risk. Risk is further enhanced by factors such as dread, potential for catastrophe, and uncertainty (Beecher et al. 2004; Beecher et al. 2005).

The 2002 Biosolids Public Knowledge and Perception Survey was designed to test a series of hypotheses about the influence of lifestyle choices, life experiences, and demographic characteristics on the public's level of comfort with biosolids recycling. The survey was administered nationwide and consisted of over 1000 phone interviews with American homeowners and home renters. Respondents indicated that 42% of them had heard of biosolids, but only 14% were close in their definition of biosolids and of those definitions only 3% could accurately define them. This supports the view that the general knowledge about the term is weak. Once those individuals who were unclear on the definition of biosolids were told the correct definition by the interviewer, there was little difference between individuals who could already clearly define biosolids and those who couldn't when ask how likely they would be to use biosolids on their own property.

Widespread support for sewage treatment plants (93%) was observed across a broad range of factors including age, gender, religion, personal habits, agricultural experience, and knowledge of the sewage treatment process. Despite 63% of respondents reacting positively to the definition "the solid matter removed from sewage that has been treated and tested so it can be recycled as a fertilizer," 57% of people responded that they would not apply biosolids to their own yard. Factors reducing level of concern with biosolids use included contact by a biosolids manager in advance of use and knowing that the biosolids applied near their home have been independently reviewed and certified each year. Alternatively, biosolids that

originated from a large city or contained industrial waste, greatly increased public concern. About one third of the population indicated their level of concern would be reduced by scientists saying there was negligible risk. Equally, about one third of the population indicated their level of concern would increase based on scientific testimony. This suggests some public uncertainty regarding the scientific community. Despite the apparent ambivalence to scientific testimony, the survey identified that certain categories of people such as academics and government officials tend to be more trusted when speaking to a biosolids management program. This is because communication from perceived "middlemen" or contractors can be perceived to be profit-motivated, resulting in public distrust.

When presented with a series of statements both in support of and against the use of biosolids, the strongest argument in support of biosolids recycling is that it returns nutrients to the soil, and the strongest argument against biosolids recycling is the argument that "not enough is known" followed by "poor government oversight." Odour and health impacts were only considered to be the strongest argument against biosolids recycling by 6% and 13% respectively. Beecher et al. (2004, 2005) identified that one of the most important findings of the 2002 survey was that the public mind is a relatively blank slate regarding the knowledge of biosolids and suggested that the public's perception of biosolids may be significantly influenced by their first introduction to the topic.

Building off of this, Eggers et al. (2011) produced the report "A strategic Risk Communications Process for Outreach and Dialogue on Biosolids Land Application" in collaboration with WERF, which included community stakeholder case studies intended to support the development of communications tools for biosolids professionals. The case studies included a sample of 48 individuals in four communities (Tulsa, Oklahoma; Lunenberg, Tidewater and Fauquier County, Virginia (VA)), in addition to six interviews conducted with officials from the VA Department of Health.

In Tulsa, Biosolids operations began back in 1986, where a high level of support from the farming and ranching communities was reported to exist. Tidewater County had an established biosolids program and experienced minimal local opposition to biosolids land application. Despite Fauquier County also having a long history of biosolids application,

there existed some local opposition to land application projects within the community. Lunenberg County was reported to be relatively new to biosolids land application programs (<5 yrs).

Stakeholders were divided into near neighbours, landowners and the VA Department of Health officials. Near neighbours were defined as individuals who reside in or own property within one mile of current or potential biosolids land application projects (includes Tulsa and VA). Landowners were defined as individuals who offer their property for biosolids land application (Tulsa only). The VA Department of Health officials were defined as individuals who work for the department and would view safety as a top priority and potentially be a source of information on biosolids safety (VA only).

It was found that those who were more familiar with biosolids land application were more in favour of the practice – this included Tulsa landowners and VA Department of Health officials. Those who were against or undecided with regards to biosolids land application expressed a lack of confidence in the decision-makers and regulations, and the "newness" of biosolids. Participants cited that the most important considerations in decisions regarding biosolids land application sites were the quality and oversight of regulations, the safety of biosolids, and the impact on neighbours and the community.

Landowners were found to weigh the benefits of biosolids over the risks and costs (i.e., land owners reported odour to be "short-lived" and "worth it"). Similarly, neighbours and VA Department of Health officials who reported to be in favor of biosolids demonstrated a similar trend. Alternatively, neighbours who were against or undecided with regards to biosolids land application weighted their assessments more against dreaded consequences, potential risks to children, and involuntary exposure. These case studies continued to support the critical role of trust, perceived benefits and perceived sense of control and fairness on an individual's judgments, consistent with existing risk perception studies (Eggers et al. 2011).

More recent risk perception studies focused on specific aspects of biosolids recycling have been completed by Robinson et al. (2012), Lowman et al. (2013), Mason-Renton et al. (2016), and Youngquist et al. (2015). Robinson et al. (2012) conducted a study in south-eastern USA assessing attitudes and risk perceptions of two communities that utilize the land application of biosolids as part of their waste management strategies. Amelia County, VA

has been outspoken against biosolids recycling, whereas Knoxville, TN expressed few concerns over the practice. A phone survey was conducted with 311 randomly selected residents within the two regions. The two communities identified similar risk perceptions around the management of biosolids, highlighting dissatisfaction with the level of stakeholder involvement in decision-making processes concerning biosolids. Overall perception included views that the health and safety risk does not outweigh the benefits of biosolids recycling, where female respondents perceived significantly greater health and safety risks than males. Amelia County respondents also expressed that they felt that biosolids were inadequately treated for land application and that the odours resulting from biosolids application were a health risk.

Lowman et al. (2013) conducted in-depth interviews with neighbours of land application sites across North Carolina, South Carolina, and Virginia, and noted similar themes of inadequate community involvement in decision-making processes regarding biosolids management and the perception of biosolids application having a negative impact on their health. Over half of the respondents expressed concern for the environment, highlighting incidents of biosolids spills, lack of signage at land application sites, and contaminated runoff into surface waters. The interviews further delve into mental and social wellbeing and environmental justice components. Over half the respondents expressed frustration over the lack of engagement regarding the biosolids application site in their neighbourhood, lack of regulatory oversight and enforcement, lack of response from public officials over reported concerns and health impacts. Respondents reported feelings of misery, fear, anxiety, insecurity and helplessness. In additional to this, 17 of the 34 respondents indicated that the biosolids application sites are owned by individuals or entities who do not live in the community, leading to the feeling that these rural communities are being used unfairly as a dumping ground for city waste. The similarities across participant response for these states highlighted both environmental and health concerns further emphasizing the importance of meaningful community involvement (Lowman et al. 2013).

Alternatively, Mason-Renton et al. (2016) examined how a proposed biosolids processing facility in rural Ontario resulted in several residents expressing strong concerns over health impacts and impacts to the therapeutic nature of their landscapes, and hostile community conflict. This study investigated residents' perceptions in a state of uncertainty as opposed to

perceptions of an established facility. The concept of therapeutic landscapes includes the idea that an individual's sense of place and attachments contribute to overall wellbeing and good health, highlighting impacts to residents' feelings of safety and security within their community. The research included 23 residents within the township of Southgate, Ontario, who participated in in-depth interviews on the proposed biosolids processing facility. Key concerns expressed included the vulnerability of children to potential environmental contaminants, loss of the ability to enjoy sitting outdoors and to relax in their natural surroundings due to the smell from the facility, and negative impacts on overall wellbeing due to fears of potential risks (Mason-renton and Luginaah 2016).

Highlighting the challenges of community involvement, Youngquist et al. (2015) completed a case study in a collaborative effort with Washington State University exploring community engagement strategies around waste management in the town of La Conner in Skagit County, Washington. La Conner has a population around 900 people, with the surrounding area reaching approximately 118,000 people. This includes the Swinomish Indian Tribal Community, directly across the channel from La Conner, home to approximately 800 First Nations. An increase in acceptance of outside septage to the wastewater treatment plant (WWTP) lead to increased odour complains within the community, in addition to growing concerns over compost management and storage at the WWTP. Data collection took place over 32 months by engaging in participant observation in addition to a mail-out survey to 374 Skagit County households.

Project researchers made themselves available through participation in town council meetings. Despite this effort, curiosity and/or concern for the research project was very limited. This lack of engagement from community suggests that waste is either somethings that most people do not see as a pressing issue, or that they do not want to think about it. However, it was found that increased visibility of waste management issues within the La Conner community led to more interest in and knowledge about the topic. Survey response rates for La Conner respondents was 52% compared with 32% for Skagit County respondents as a whole. The survey proved to be a valuable tool not only for learning more about opinions and attitudes, but also served as a way to increase respondents' knowledge and interest in waste management.

Further to the "perception is reality" frustration discussed by Beecher et al. (2004, 2005), Youngquist et al. (2015) suggest that members of the public want to test and challenge experts, and that technical experts may lack the social and communicative skills necessary to effectively address their concerns. This would require experts to understand that members of the public may frame risk more broadly and that opposition may not be solely due to ignorance. They suggest there is a need for a robust process that provides an opportunity for residents to participate in conversations and problem solving about subjects that impacts their homes and families. As suggested, such a process requires local government and institutional support, strong leadership, facilitation skills, and community members with both the desire and the resources to participate (Youngquist et al. 2015).

In general, the body of research suggest that there is a general distrust around the safety of biosolids recycling stimulated by unknowns and "what if's," this is in combination with the growing views of a profit-motive believed to be associated with biosolids management programs (Beecher et al. 2004) and lack of faith in regulatory oversight (Beecher et al. 2005; Mason-renton and Luginaah 2016).

Local Opposition

Biosolids management is a recent topic of interest within the Thompson-Nicola interior region of BC. To address public concerns, there is a need to better understand the public's perception around the use of biosolids as a fertilizer and how the people would like to see biosolids managed, as well as a need to recognize how to most effectively address pressing topics regarding biosolids management.

Gray literature is material that is made public but not subject to the traditional academic peer-review processes (i.e. newspaper articles); this material is considered a valuable resource for understanding the public perceptions and concerns for controversial matters (Beecher et al. 2004). Considering grey literature is of particular significance when evaluating the recent opposition against biosolids present within the Thompson-Nicola interior region of BC. A timeline of significant events with regards to the opposition in the Thompson-Nicola Interior Region can be found below in Figure 1.

Concerns with the land application of biosolids within the Thompson-Nicola interior region of BC appear to go back to 2008 where concerns expressed are similar to the ones currently being communicated. There has been a strong, steady opposition by some groups (e.g.,

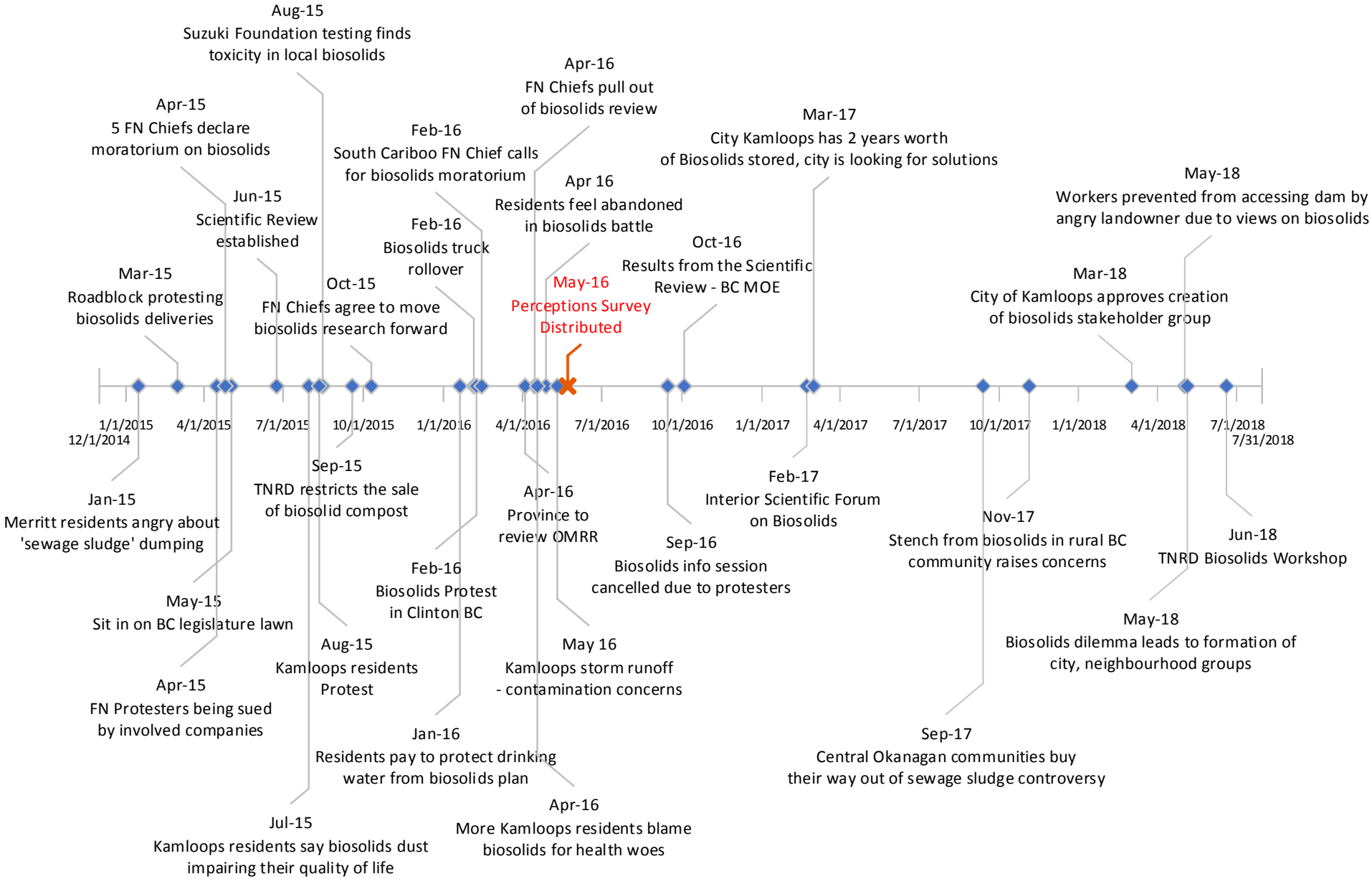

Figure 1-1 Summary of key events and headlines communicated in local media relating to biosolids within the TNRD.

Friends of the Nicola Valley) to the land application of biosolids in this area since late 2014. In Sunshine Valley Estates just east of Merritt, BC biosolids from the central Okanagan were destined for land application on a site just above the housing development and close to their drinking water intake. As outlined in the local newspaper, the Merritt Herald, residents expressed concern over harm to their air quality, contamination of their drinking water source, and decreased property value (Potestio 2014 Dec 11). In December 2014, the First Nations Chiefs of the Nicola Valley submitted a letter to the Ministry of Environment demanding that all current biosolids applications cease and no new projects proceed until the Crown and ministry regulators establish

Organic Matter Recycling Regulation to ensure it remains protective of human health and the environment April 4th, 2016. Subsequent amendments to the OMRR, based on engagement and information received from the review, were anticipated to be made in 2017 (BC MOE 2016). At the time of this thesis, although the amendment is still pending, province did release their intentions paper October 2018. The intentions paper outlines the proposed changes to the OMRR and seeks comments and feedback from all interested parties on the proposed changes. During this period, community members have had rallies and protests to block biosolids from coming into the Nicola Valley, as well as banding together to buy land from proposed biosolids projects to prevent land application sites near their homes and drinking water source (Strachan 2015).

Thesis Research Objectives

This research project aims to better understand public risk perceptions, factors which influence willingness to accept biosolids recycling, and level of knowledge regarding wastewater management and the land application of biosolids. Further to this, we will estimate the perceived external cost of the land application of biosolids, within select communities within the interior of BC.

This research will serve as a tool to understand public attitudes and address key concerns regarding the use of biosolids as a fertilizer, including how residents of the Thompson-Nicola and Princeton regions would like to see biosolids managed. This research aims to offer policy

makers, regulators, and biosolids management tools to support the implementation of publicly successful biosolids management programs.

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Chapter 2 PUBLIC RISK PERCEPTION OF BIOSOLIDS AND FACTORS INFLUENCING PUBLIC ATTITUDES

Introduction and Relevance

The amount of sewage sludge generated annually continues to rise, increasing the nation's dependence on effective wastewater treatment and management. Despite this reliance, the overall public awareness of what biosolids are and how they may be used remains low (Beecher et al. 2004; Robinson et al. 2012; Youngquist et al. 2015; McCarthy and Loyo-Rosales 2015). There are treatment processes, strict standards, and quality controls in place intended to ensure the safety of biosolids application, however a negative perception exists amongst the public regarding the use of biosolids (National Research Council 2002; Beecher et al. 2004; McCarthy and Loyo-Rosales 2015). These negative views include concerns of potential contaminants in biosolids such as inorganic contaminants (e.g., metals and trace elements), organic contaminants (e.g., polychlorinated biphenyls, dioxins, pharmaceuticals, and surfactants) and pathogens (e.g., bacteria, viruses, and parasites), as well as complaints regarding the odor (National Research Council 2002; Beecher et al. 2004; Robinson et al. 2012; Youngquist et al. 2015)

In Canada, the Canadian Council of Ministers of the Environment (CCME) encourage the beneficial use of municipal biosolids, while maintaining protection of the environment and human health. Beneficial management includes practices such as composting, agricultural land application and combustion for energy. However, in some municipalities, biosolids are disposed of in landfills or incinerated without energy capture rather than being used in a beneficial manner (CCME 2012). In BC, and across Canada, biosolids are often used as a soil amendment for improving soils and plant growth (CCME 2012; McCarthy and Loyo-Rosales 2015). Using biosolids as a soil amendment offers advantages such as improving the quality of degraded soils through enabling increased plant productivity and improved soil carbon storage capacity (Robinson et al. 2012; Hong 2013) as well as reducing the amount of material otherwise destined for landfilling or incineration and the greenhouse gas generation associated with these practices. As of recent, biosolids management is a significant topic

within the Thompson-Nicola interior region of BC. To address public concerns, there is a need to better understand the public's perception of biosolids as well as how people would prefer to see biosolids managed.

Gray literature is material that is made public but not subject to the traditional academic peer-review processes (i.e. newspaper articles); this material is considered a valuable resource for understanding the public perceptions and concerns for controversial matters (Beecher et al. 2004). Considering grey literature is of particular significance when evaluating the recent opposition against biosolids present within the Thompson-Nicola interior region of BC. Concerns with biosolids management practices within the Thompson-Nicola interior region of BC appear to go back to 2008 where concerns expressed are similar to the ones currently being communicated today. There has been a strong, steady opposition by some groups in this area since late 2014. In Sunshine Valley Estates just east of Merritt, BC biosolids from the central Okanagan were destined for land application on a site just above the housing development and close to their drinking water intake. As outlined in the local newspaper, the Merritt Herald, residents expressed concern over harm to their air quality, contamination of their drinking water source, and decreased property value (Potestio 2014 Dec 11). After expressed local opposition, on December 2014 the First Nations Chiefs of the Nicola Valley submitted a letter to the Ministry of Environment demanding that all current biosolids applications cease and no new projects proceed until the Crown and ministry regulators establish a meaningful dialogue. As a result, a moratorium was placed on the use of biosolids in the Thompson-Nicola Regional District on April 23rd, 2015 (Potestio 2015 Apr 28).

On June 17th, 2015, the provincial government of B.C. announced that a technical working group would conduct a scientific review of biosolids to address the growing concerns over the land application of biosolids. However, the five band chiefs of the Nicola Valley First Nations walked away from the government-sponsored scientific review in April 2016 after feelings that First Nations participation in the study was limited to "observer" status (The Herald 2016). Further to this, on April 4th, 2016 the Province announced it would undertake a review of the Organic Matter Recycling Regulation (OMRR), which set outs the requirements related to the production, distribution, storage, sale and use or land application of biosolids. This is intended to ensure the regulation remains protective of human health and

the environment. Subsequent amendments to the OMRR, based on engagement and information received from the review, were anticipated to be made in 2017 (BC MOE 2016). At the time of this paper, although the amendment is still pending, province did release their intentions paper October 2018. The intentions paper outlines the proposed changes to the OMRR and seeks for comments and feedback from all interested parties on the proposed changes. Prior to the 2018 intentions paper, as series of intention papers for consultation were published in 2006, 2011 and 2016 with a summary of public comment subsequently published. During this period, community members have had rallies and protests to block biosolids from coming into the Nicola Valley, as well as banding together to buy land from proposed biosolids projects to prevent land application sites near their homes and drinking water source (Strachan 2015).

The practise of the land application of biosolids continues to be subject to questions and concerns. Concerns are raised about anything that might be disposed of down the drain that may potentially impact biosolids quality. The concept of "perception is reality" is a challenge that biosolids managers are faced with overcoming. There are however, processes for engaging concerned or impacted communities and other stakeholders to understand and review options regarding potentially controversial natural resource projects. One of these approaches is the "beyond compliance" approach of seeking proactive community support from stakeholders through meaningful early engagement. The proactive approach considers concerns that may otherwise lead to project delays or prohibitions, as well as alignment with local community interests (Moffat and Zhang 2014). As an explanation to why a proponent may go beyond compliance, Lunch-Wood and Williamson (2018) propose five factors that that potentially drive social interest: (1) Environmental impacts of product and process, (2) Customer power, (3) Customer interest, (4) Corporate/brand visibility and (5) Community pressure. They suggest at least two of these factors must be salient to drive a beyond compliance approach (Lynch-wood and Williamson 2018). This paper assesses community risk-perceptions of biosolids management in Kamloops and Merritt against the overarching concepts of Social License to Operate (SLO) as a framework to understand how to most effectively address the gap between the public perception of biosolids and the promotion of the safety and sustainability of current waste management practices. Although we use the

overarching concepts of SLO, we refer to this as "obtaining community support." This is to better reflect that obtaining and maintaining community support is an evolving process, which requires ongoing meaningful engagement. This research should aid policy makers, regulators, and biosolids management in developing and implementing publicly successful biosolids management programs providing a stakeholder-centric approach around potentially controversial natural resource projects.

Methods

Sample Selection and Survey Delivery

A mail-out survey was distributed to Kamloops, Merritt, and Princeton, BC, to determine the factors that influence public attitudes and risk perception towards the use of biosolids. Although, online surveys may be advantageous given that they pose savings in both time and cost, they present challenges due to limiting access, difficulties in assuring anonymity and confidentiality, potential technical problems, and reportedly low response rates (Sax, Gilmartin, and Bryant 2003; Dillman, Smyth, and Christian 2014). A mail-out surveys was chosen as the best approach for survey delivery based on a number of factors, including the importance of maintaining anonymity of respondents given the controversial nature of the topic, sample selection that will be representative of the broad community (i.e. not limited to having internet access), reducing voluntary response bias (as presented by an open-source URL), and elimination of the potential bias presented by an interviewer in phone surveys (both through survey delivery and lack of anonymity). It is worth noting that mail-out surveys have demonstrated challenges in obtaining adequate response rates for certain groups, particularly of interest the younger population who may not use the mail system readily (Dillman, Smyth, and Christian 2014).

MailWorks, a third-party mailing service, was employed for random sample selection and survey distribution. Canadian consumer lists, available at https://infogroup.infocanada.ca/, were utilized for Kamloops, Merritt, and Princeton to select random samples within each community. MailWorks rented the lists, ensuring the most up-to-date lists available were rented increasing the representativeness of the sample. The survey 'Biosolids: Community Engagement and Risk Perception' administered by TRU was delivered by MailWorks© on May 20, 2016 to 2000 randomly selected households in three municipalities: Kamloops,

Merritt and Princeton. A proportional distribution for survey mail outs was used based on the Statistics Canada 2011 census data for population, resulting in Kamloops receiving 1761, Merritt 173 and Princeton 66 surveys.

Nonresponse bias

The greater the response rate, the more accurately the survey data will estimate the views of the population sampled. However, we can only consider findings representative of the population if the views of those who responded to the survey do not differ significantly from those who did not respond. Nonresponse bias means that the individuals chosen within the sample population are unwilling or unable to participate in the survey and results produced from respondents potentially differ from that of the nonrespondents (Kanuk and Berenson 1975; Sanchez 1992; Sax, Gilmartin, and Bryant 2003; Dillman et al. 2009). Many strategies, as described by Dillman (1991), Dillman et al. (2014), Kanuk and Berenson (1975), and Sanchez (1992) were employed to reduce nonresponse survey error.

To reduce nonresponse bias, the surveys and cover letters distributed were mailed out in envelopes containing a postage-paid return envelope stamped with postage and return address. The cover letter included a description of the study's social usefulness, highlighting that biosolids are of high public interest locally, aiming to further increase response. A reminder postcard was mailed 14 days after the initial distribution of the survey. The cover letter and post card also contained direct contact information (phone number and email address) of the researcher as shown in Appendices I and II.

Survey Design

The survey was designed in a manner consistent to survey methodology as deigned by professionals in the field (Dillman 1991; Sanchez 1992; Dillman, Smyth, and Christian 2014). This research was followed up with face to face interviews to allow for more in-depth discussion of the interview questions and the key concerns presented in a separate study. The survey design included an introductory statement about the study and a brief explanation about biosolids. The explanation was kept brief in order to best establish the baseline knowledge of the respondent. The survey was composed of four key sections:

- Section one included sociodemographic information;
- Section two was about general knowledge, attitudes and actions on environmental issues including climate change, waste management, water pollution, and soil degradation;
- Section three included a series of attitude statements to assess attitude and risk perception towards biosolids management. The attitude statements will capture individual perceptions about biosolids and allow us to determine how heavily influenced emotions are by familiarity with biosolids risks and management;
- Section four posed a willingness to pay section to measure the benefits of alternative uses of biosolids in dollar value at the individual level, which can then be aggregated to the community level;
- A fifth blank section was included for respondent comments and feedback.

Anonymity

It is generally assumed that offering respondents anonymity encourages a high level of voluntary response; however where response is mandatory, assuring anonymity provides the respondent comfort in answering candidly, and minimizing the number of invalid responses. This assumes that there are questions which, if answered candidly, would place respondents in a position of fear (Kanuk and Berenson 1975; Sax, Gilmartin, and Bryant 2003). Since biosolids have been such a controversial topic locally, through pilots of the draft survey, the point has been made that there are certain people, based on their jobs or social commitments, who may not feel they can be honest if their name is attached to the survey.

Other means of increasing response rates, for example providing incentives, were considered; however, the use of incentives (i.e., being entered for a draw for a gift card) as well as personalizing the cover letter both pose the challenge of maintaining respondent anonymity.

Survey Language

The survey was constructed to include language that:

- Does not lead the respondents to a specific response;
- Does not provide too much information up front, which could potentially bias the respondents attitudes; and

- Incudes language suitable for the general public.

The final draft survey was piloted to a selected group of individuals aimed to cover a range of those in favour of and against the recycling of biosolids, as well as both experts and non-experts. The final survey was re-designed based on feedback from the pilot.

Human Ethics Approval

Permission from the TRU Human Ethics Committee was required prior to making contact with potential survey respondents. Survey distribution and data handling was managed in a fashion approved by TRU's Research Ethics Board. Approval was received March 2016, File #: 101107.

Data Analysis

For the purpose of this chapter, we will be focussing on Sections one, two and three. Section one captured general sociodemographic information, inclusive of gender, age, income, education level, if children live at home and description of residence (urban/rural). Given the importance of demographics to this research, this section was placed in the beginning to promote completeness of responses (Teclaw, Price, and Osatuke 2012). The second section was designed to assess respondents' level of concern with prominent social issues, self-ranked level of familiarity with biosolids and factors that influence level of comfort with biosolids management practices. Additionally, this section was designed to capture trustworthy sources of information, as perceived by the public, as well as evaluate respondents most preferred options for learning more. Section three included a series of attitude statements designed to assess attitude and risk perception towards biosolids management. These attitude statements were framed in alternating positive and negative statements and ranked on a 5 point Likert scale: 1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree. Section three responses were analyzed against the sociodemographic information collected in section one, in addition to respondents' self-identified familiarity with biosolids and level of concern for select social issues. This enabled us to assess how heavily emotions are by influenced familiarity with biosolids risks and

Table 2-1 Independent variable for logistic regression of influencing factors of thoughts and feelings on biosolids.

Variable	Name	Description
Gender	Gender	Gender of the Respondent (1 = Male, 0 = Female)
Age (base case: Age 18-50)	Age5064	Respondents who are of the age of 50-64 years old (1 = Yes, 0 = No)
	Age65+	Respondents who are of the age of 65 years or older (1 = Yes, 0 = No)
Children	Child	Respondents who have children currently living at home (1= Yes, 0 = No)
Education (base case: highest level of education some college or trade school graduate)	EduPTC	Respondents whose highest level of education is some college or trade school (1 = Yes, 0 = No)
	EduGTC	Respondents whose highest level of education is college or trade school graduate (1 = Yes, 0 = No)
	EduUni	Respondents whose highest level of education is university graduate (bachelors degree) (1 = Yes, 0 = No)
Environmentalist	Enviro	Respondents opinion of how applicable the term "Environmentalist" applies to them (1 = Strongly Disagree, 5 = Strongly Disagree)
Location (base case: residents live in Kamloops)	Community	Respondents whose residence was located in Merritt (1 = Yes, 0 = No)
Rural Residence (base case: Urban/Suburban)	RuralNF	Respondents who live in non-farm rural area (1 = Yes, 0 = No)
	RuralAg	Respondents who live in rural agriculture area (1 = Yes, 0 = No)
Home sewage system (base case: septic tank or other/don't know)	MuniSewer	Respondents who's home is connected to a municipal sewer system (1=Yes, 0=No)
Community Biosolids Management	BioMngt	Respondents who know how Biosolids are managed in their community (1 = Yes, 0 = No)
Income (base case: respondents for whom annual household income was less than $50,000)	Inc50100	Respondents for whom annual household income was in the range $50,000 to $100,000 (1 = Yes, 0 = No)
	Inc100+	Respondents for whom annual household income was $100,001 or more (1 = Yes, 0 = No)
Aboriginal	Aboriginal	Respondents who identify as Aboriginal (1 = Yes, 0 = No)
Waste Management	WasteMngt	Respondents level of concern regarding Waste Management (1 = Not Concerned, 5 = Very Concerned)
Biosolids Familiarity	BioEd	Respondents opinion of how familiar they were with the term "Biosolids" prior to receiving the survey (1 = Not Familiar, 5 = Extremely Familiar)

management. Section four was designed as a separate assessment for alternative uses of biosolids management discussed in Chapter 3.

Descriptive statistics were generated for all questions. All statistical analysis of the survey data was performed using IHS MarKit EViews (version 10). In order to assess how emotions are influenced by familiarity with biosolids risks and management, ordered logistic regressions were run for the cumulative dataset. Table 2-1 provides details on these explanatory variables. It was found however, that whether respondents were from Kamloops or Merritt was a significant variable in 75% of the results. Consequentially, the two datasets were considered as separate and individual ordered logistic regressions were run for each community. The raw results and initial analysis can be found in Appendices III-V. Where limited responses were obtained for a specific independent variable, categories were combined to preserve degrees of freedom.

Simple t-tests were run to test for neutrality, where mean responses of the attitude statements were assessed against a neutral response of 3. Further to that, Satterthwaite-Welch t-test's were performed to assess the mean responses between Kamloops and Merritt for all twelve attitude statements to determine if the communities demonstrated significantly different attitudes.

As a method to understand the most predominant thoughts surrounding biosolids, a visual depiction of responses to the questions "What comes to mind when you think of biosolids?" was created using the online tool, Wordle^{TM}. This tool generates word clouds where greater prominence is given to words that appear more frequently in the text provided. All text from responses to the question was included, only edited for spelling corrections. The word cloud was formatted to exclude common English words (i.e. "the" or "and").

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Results and Discussion

Kamloops and Merritt were selected for this survey based on the recent salience of the topic of biosolids within the Thompson Nicola Regional District. Community groups originating in the Merritt area had voiced numerous concerns regarding the land application of biosolids in their area; this opposition led to protests and roadblocks, and ultimately a regional moratorium enacted by local First Nations Chiefs. Kamloops, although having experienced some opposition within the community, had experienced relatively few concerns from the broad community at the time of this survey. Alternatively, Princeton had historically been involved in successful land application projects throughout the 1990's and early 2000's, but have not been otherwise involved in land application projects since. According to the 2016 Canadian census the population of Kamloops, Merritt and Prince were 90,280, 5,321 and 2,828 respectively.

Table 2-2 Community response rates based on 423 surveys.

Community	Number Mailed	Number Returned	Community Response Rate
Kamloops	1761	382	22%
Merritt	173	41	24%
Princeton	66	0	0%

A total of 423 surveys were returned (including 2 blank) for a 22% return rate. Some surveys were only partially completed but still contained usable data for some questions, this information was included in the results. A total of 421 surveys were used in the final analysis. Response rates for Kamloops and Merritt were 22 and 24 percent respectively; no survey responses were received from Princeton (Table 2-2). The lack of survey response from Princeton suggests that this may not be a significant topic within the community, Princeton is not further discussed in this paper.

When assessing the survey response data against the 2016 Census data for Kamloops and Merritt (Age, Income, Education, and Gender), it was found that was generally a good representation of income and education but for both communities there was disproportionately high response rate for ages 50+ (Figure 2-1) as well as a disproportionately high response from males in Kamloops. In general, Kamloops and Merritt identified differing risk perceptions around the management of biosolids where Kamloops respondents demonstrated more neutral-accepting perceptions relative to Merritt respondents.

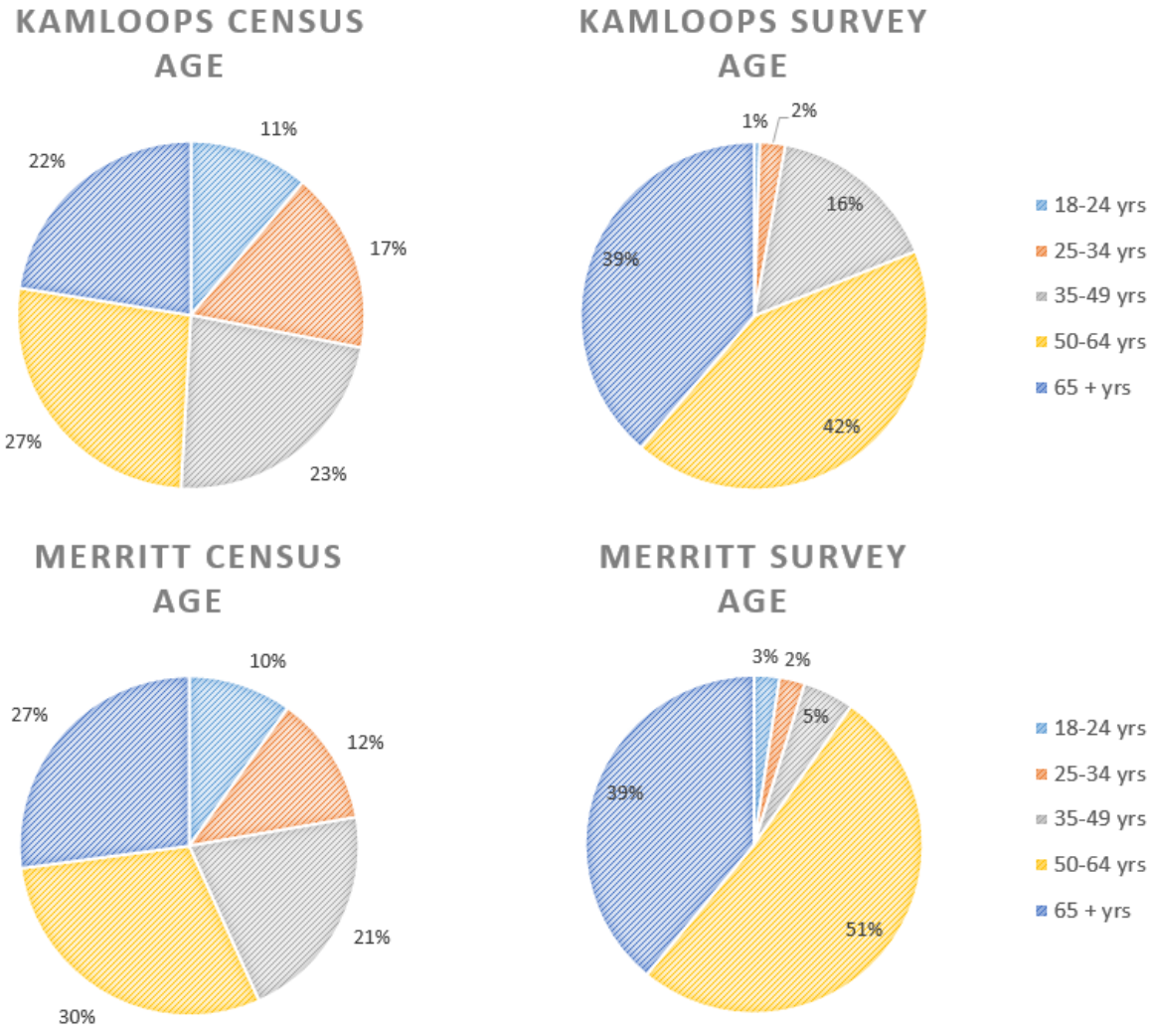

Figure 2-1 Age Distribution: Census Data versus Survey Data.

General Knowledge, Attitudes and Actions

When asked "What comes to mind when you think of biosolids?" respondents demonstrated general familiarity with the term (Figure 2-2). This aligns with the individual community responses reporting average familiarity to be within the range of "Somewhat Familiar" to "Moderately Familiar," as demonstrate below in Table 2-3.

Figure 2-2. Visual depiction of responses to "What comes to mind when you think of biosolids?"

Table 2-3. Before receiving this survey, how familiar were you with the term biosolids?

	Kamloops	Merritt
How do you feel about Waste Management? (1 = Not Concerned; 5 = Very Concerned)		
Not Concerned	4.7 %	0.0 %
Slightly Concerned	11.9 %	5.0 %
Somewhat Concerned	41.1 %	27.5 %
Moderately Concerned	27.2 %	30.0 %
Very Concerned	15.1 %	37.5 %
average	3.5	4.0
Before receiving this survey, how familiar were you with the term "biosolids"? (1 = Not Familiar; 5 = Very Familiar)		
Not Familiar	8.8 %	2.5 %
Slightly Familiar	16.0 %	10.0 %
Somewhat Familiar	27.4 %	17.5 %
Moderately Familiar	39.1 %	60.0 %
Extremely Familiar	8.8 %	10.0 %
average	3.2	3.7

For the ordered logistic regression analysis carried out to assess the twelve attitude statements, two questions asked in the general questions section were considered along with the sociodemographic variables as independent variables. The first one assessed the respondents' level of concern regarding waste management. This question was included because concern for waste management goes beyond the management of wastewater residuals, as such this can be considered an independent factor.

Second, respondents were asked to identify their level of familiarity with the term biosolids prior to receiving the survey. These results are presented in Table 2-3. Both communities reported being somewhat to moderately concerned with waste management and somewhat to moderately familiar with Biosolids. However in general, Merritt respondents reported stronger responses to both questions.

T-tests were performed to determine the difference between the two survey populations. Merritt respondents were determined to be significantly more concerned with waste management than Kamloops respondents ($p=0.0058$). Merritt respondents also reported to be significantly more familiar with the term biosolids ($p=0.0201$). This is a likely result of Merritt residents' recent experience with application sites and proximity to biosolids projects, and the associated local media attention.

Thoughts and Feelings

In order to assess how emotions are influenced by a respondents' familiarity with biosolids risks and management, the responses to the attitude statements were analyzed against the sociodemographic information, respondents self-ranked familiarity with biosolids and level of concern regarding waste management.

Table 2-4 identifies the series of attitude statements, in the order which they were presented in the survey. The sentiment of the statement is also listed, in addition to the assigned community support factor. These factors ultimately represent the key inputs necessary to receive social support on potentially controversial natural resource projects. Sentiment was based on tone of the statement being positively or negatively framed and was used to determine how explanatory variables may respond to this framing. Community support factors were based on the following definitions as defined by Boutilier and Thompson in their conceptual model of social license to operate (Boutilier and Thomson 2011):

- Legitimacy: Perception that the company/project offers benefit to the perceiver.
- Trust: Willingness to be vulnerable to risk or loss through actions of another.

Attitudes regarding the land application of biosolids were assessed for each community using a 5-point Likert scale, average responses are also reported in Table 2-4. The Likert scale

presents an equal number of positive and negative responses (Likert 1932), a mean response >3 indicates agreement with the statement and a mean response <3 indicates a disagreements with the statement. Neutral responses (mean = 3) suggests indifference, lack of comfort with personal level of knowledge, or a perceived lack of information on the topic.

Legitimacy

Kamloops respondents perceived greater value in the land application of biosolids relative to Merritt respondents. Kamloops respondents were more likely to agree with the positively framed questions and disagree with the negatively framed question. This is the reverse for responses from Merritt residents. Kamloops respondents generally agreed with the statement, "Biosolids are a valuable resource that should be used as a fertilizer," this is in contrast to Merritt respondents who reported a general disagreement with the statement. These responses were paralleled for the statements, "Using biosolids as a fertilizer is better than incineration or landfilling" and "Using biosolids as a fertilizer in our community will bring economic benefits." Conversely, Kamloops respondents were less likely to agree with this statement "The risks to public health of using biosolids as a fertilizer outweigh the benefits," where Merritt respondents more likely to agree with the statement. Of the twelve attitude statements, Kamloops most strongly agreed with the statement, "Using biosolids as a fertilizer is better than incineration or landfilling," suggesting the community supports productive uses of biosolids.

Legitimacy - Positive Statements

Results from the logistic regression for the Kamloops dataset indicate that the level of familiarity with the term biosolids significantly influences the responses to question S3Q1: "Biosolids are a valuable resource that should be used as a fertilizer", where those who were more familiar with the term biosolids were more likely to agree that biosolids are a valuable resource ($p=0.0005$). Interestingly, although Merritt respondents reported being more familiar with the term biosolids, familiarity was not a significant variable for the Merritt dataset. The one marginally significant variable reported for S3Q1 for Merritt respondents was level of concern with waste management. It was found that those who were more concerned with waste management were less likely to agree with the statement ($p=0.0826$).

Table 2-4. Overview of thoughts and feelings questions variables and assigned sentiment and social capital indicator.

Variable	Description	Sentiment	Community Support Factor	Deviation from Neutral– Kamloops Response	Deviation from Neutral– Merritt Response	t-Test Comparison of Means - Kamloops and Merritt responses (p-value)
S3Q1	1. Biosolids are a valuable resource that should be used as a fertilizer	Positive	Legitimacy	0.62 (0.0000)	-0.51 (0.0276)	0.0000
S3Q2	2. Not enough is known about biosolids	Negative	Trust	0.81 (0.0000)	0.85 (0.0000)	0.8138
S3Q3	3. Using biosolids as a fertilizer is better than incineration or landfilling	Positive	Legitimacy	0.83 (0.0000)	-0.32 (0.1760)	0.0000
S3Q4	4. The use of biosolids as a fertilizer makes me concerned about my surrounding environment	Negative	Trust	0.25 (0.0000)	0.95 (0.0000)	0.0005
S3Q5	5. Biosolids receive adequate treatment at the wastewater treatment plant to protect public health	Positive	Trust	0.25 (0.0000)	-0.49 (0.0292)	0.0017
S3Q6	6. My family would be at a higher health risk if my neighbours applied biosolids to their land	Negative	Trust	-0.15 (0.0101)	0.56 (0.0056)	0.0008
S3Q7	7. My family would be at a higher health risk if my neighbours applied animal manure to their land	Negative	Trust	-0.66 (0.0000)	-0.75 (0.0000)	0.5909
S3Q8	8. I trust government regulatory agencies to monitor the safe use of biosolids	Positive	Trust	-0.12 (0.0556)	-0.41 (0.0000)	0.0395
S3Q9	9. The odor emitted by biosolids is harmful to my health when breathed	Negative	Trust	-0.05 (0.3569)	0.46 (0.0183)	0.0117
S3Q10	10. The risks to public health of using biosolids as a fertilizer outweigh the benefits	Negative	Legitimacy	-0.38 (0.0000)	0.56 (0.0088)	0.0001
S3Q11	11. Using biosolids as a fertilizer in our community will bring economic benefits	Positive	Legitimacy	0.14 (0.0046)	-0.63 (0.0004)	0.0000
S3Q12	12. Even if used properly, biosolids can still lead to land or water contamination	Negative	Trust	0.19 (0.0013)	0.49 (0.0234)	0.1718

Note: Community responses were ranked on a Likert scale of 1-5 (1 = Strongly Disagree, 5 = Strongly Disagree) and are reported as mean response deviation from neutral (neutral response =3). P-value of test for neutrality (mu=3.0) are given in parenthesis.

For the Kamloops respondents, additional significant variables reported within the 95% confidence interval included those who identified as living on rural agricultural land (p=0.025) and those whose wastewater is managed by a municipal sewer system (p=0.0362) to be more likely to agree with the statement. This may suggest the general public is more trusting than perhaps those who are on septic systems and thus have the potential to be more impacted by land application projects. This assumes that those of the "general population" are towards the urban/suburban center and that those on septic system are in rural areas, where land application projects are more likely to take place.

Female Merritt respondents were significantly less likely to agree with the statement, "Using biosolids as a fertilizer is better than incineration or landfilling" than males (p= 0.0308). This is consistent with the findings of Robison et al, where women were found to perceive higher health and safety risks regarding biosolids projects (Robinson et al. 2012). Those who were concerned with waste management (p= 0.0267) or have a completed a college diploma or trades school (p=0.0360) were also less likely to agree with the statement. Alternatively, for Kamloops respondents neither gender nor familiarity were significant factors. Those who were university graduates (p=0.0154) or earned an annual household income over $100,000 (p=0.0183) were more likely to agree with the statement.

Legitimacy - Negative Statements

For Kamloops respondents, income was found to be the most significant variable (p=0.0544) regarding the statement "The risks to public health of using biosolids as a fertilizer outweigh the benefits." Those who earned an annual household income that ranged from $50,000-$100,000, were less likely to agree with this statement. Age (p=0.0547), gender (p=0.0544) and education (p=0.0711) were also found to be marginally significant variables, where Kamloops respondents who are 65+ years old, female, or whose highest level of education is the completion of some college or trades school, were more likely to agree with the statement. An additional marginally significant variable highlighted that the more familiar Kamloops respondents were with the term biosolids, the more likely they were to disagree with this statement (p=0.0722). This is important when considering the role familiarity may play. Similarly, for Merritt respondents gender (p=0.0108), level of education (0.0285) and level of concern about waste management (p=0.0082) were found to be significant. Those who are from Merritt and are female, have completed college or trade school or are

concerned about waste management were more likely to agree with this statement. The significance of gender continues to support the notion that women perceive higher health and safety risks for biosolids projects.

Trust

Kamloops respondents displayed a higher level of trust regarding the land application of biosolids when compared to Merritt respondents. Kamloops respondents were generally more likely to agree with the positively framed questions and disagree with the negatively framed question than Merritt respondents. T-tests were performed to determine the difference between the attitudes of the two survey populations, interestingly three of the twelve statements were not found to be statistically different, all of which were negatively framed. Both communities reported to equally disagree with the statement, "My family would be at a higher health risk if my neighbours applied animal manure to their land" ($p=0.5909$). When assessing these responses against responses to the statement, "My family would be at a higher health risk if my neighbours applied biosolids to their land," Merritt respondents' agreement with this statement indicates that residents perceive a higher health risk when exposed to biosolids when compared to manure. This was not paralleled by Kamloops respondents, where although responses were generally in stronger disagreement to the statement regarding manure, weak disagreement with the biosolids exposure statement supports that the community may not identify a distinction between the health and safety risks from biosolids and manure exposure. Surprisingly, responses to the statements, "Not enough is known about biosolids" and "Even if used properly, biosolids can still lead to land or water contamination" were not considered to statistically differ between communities, reporting p-values of 0.8138 and 0.1718 respectively. "Not enough is known about biosolids" was also found to be the statement both Kamloops and Merritt reported the second strongest response to, with means of 3.81 and 3.85 respectively. This suggests that respondents may have an overall lack of comfort with their personal level of knowledge or that there is a perceived lack of information on the topic.

Merritt respondents most strongly responded to the statement, "The use of biosolids as a fertilizer makes me concerned about my surrounding environment," and although Merritt respondents were significantly more likely to agree, Kamloops respondents also generally

agreed with this statement. Similarly, both communities disagreed with the statement, "I trust government regulatory agencies to monitor the safe use of biosolids," however Merritt respondents had a significantly stronger response than Kamloops respondents (p= 0.0192). Although Kamloops was found to be generally more trusting regarding biosolids perceptions, agreement from both communities with the statements "Not enough is known about biosolids" and "Even if used properly, biosolids can still lead to land or water contamination" and disagreement with "I trust government regulatory agencies to monitor the safe use of biosolids" demonstrate a general lack of trust in the current regulatory structure and scientific knowledgebase overall.

Trust - Positive Statements

For Kamloops respondents, there was only one significant variable identified for the statement, "Biosolids receive adequate treatment at the wastewater treatment plant to protect public health." It was found that those who identified as living on rural agricultural land were significantly more likely to agree with the statement (p=0.0029). In contrast to this, Merritt respondents who were female (p=0.0241), had completed college, trade school (p=0.0081) or a university degree (p=0.0386), or were concerned about waste management (p=0.0074) were less likely to agree the statement.

Interestingly, responses to "I trust government regulatory agencies to monitor the safe use of biosolids" reported conflicting results between the communities despite the aligned distrust in government oversight. Kamloops respondents who identified as living on rural agricultural land (p=0.0269) or who had completed a university degree or higher (p=0.0023) were significantly more likely to agree with the statement, this is in stark contrast with Merritt respondents where education was also found to be a significant variable, however those who completed a university degree or higher were more likely to disagree (p=0.0407) with the statement. Respondents who were concerned about waste management were also significantly more likely to disagree for both Kamloops (p=0.0536) and Merritt (p=0.0041). Kamloops responses from those who identified as living on rural agricultural land remain consistent, supporting the assumption that people with agricultural experience are more likely

Table 2-5 Section 3 Kamloops-Only Order Logit – Legitimacy: Positively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q1	0.094	0.171	0.508	0.166	-0.372	**-0.594***	0.427	**0.278***	**1.053***	**2.514****	**1.131****	0.016	-0.507	0.124	0.086	-0.139	**0.397*****
	(0.237)	(0.308)	(0.369)	(0.265)	(0.356)	(0.322)	(0.314)	(0.166)	(0.610)	(1.121)	(0.540)	(0.241)	(0.320)	(0.366)	(0.865)	(0.102)	(0.115)
S3Q3	-0.083	0.038	0.264	-0.038	0.392	-0.218	**0.775****	0.167	0.506	1.032	0.509	0.003	-0.123	**0.867****	-0.393	0.014	0.059
	(0.239)	(0.320)	(0.378)	(0.273)	(0.368)	(0.327)	(0.320)	(0.167)	(0.594)	(1.009)	(0.523)	(0.246)	(0.316)	(0.367)	(0.858)	(0.104)	(0.116)
S3Q11	-0.289	0.491	0.543	0.311	0.330	-0.059	-0.111	0.124	0.640	1.504	0.168	-0.220	0.114	0.589	-0.444	0.058	-0.048
	(0.239)	(0.314)	(0.381)	(0.272)	(0.371)	(0.325)	(0.312)	(0.165)	(0.584)	(1.065)	(0.534)	(0.240)	(0.319)	(0.366)	(0.789)	(0.102)	(0.113)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10.*
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

Table 2-6 Section 3 Kamloops-Only Order Logit – Legitimacy: Negatively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q10	**-0.449***	0.365	**0.707***	0.226	**0.624***	0.338	-0.478	-0.227	-0.292	-1.032	-0.474	0.029	**0.631****	0.188	0.335	0.136	**-0.204****
	(0.233)	(0.302)	(0.368)	(0.255)	(0.346)	(0.311)	(0.305)	(0.163)	(0.564)	(1.014)	(0.515)	(0.239)	(0.319)	(0.360)	(0.752)	(0.100)	(0.113)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10.*
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

Table 2-7 Section 3 Kamloops-Only Order Logit – Trust: Positively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q5	-0.381	0.010	0.321	-0.137	0.549	-0.084	0.333	-0.075	0.131	**3.037*** **	0.563	0.154	-0.360	-0.012	-0.130	-0.106	0.053
	(0.238)	(0.306)	(0.371)	(0.263)	(0.362)	(0.326)	(0.307)	(0.163)	(0.593)	(1.019)	(0.557)	(0.240)	(0.326)	(0.372)	(0.898)	(0.102)	(0.112)
S3Q8	-0.055	0.200	0.256	-0.028	0.199	0.326	**0.931*** **	-0.164	-0.467	**2.092** **	0.132	0.151	-0.301	0.211	0.531	**-0.195***	0.013
	(0.230)	(0.302)	(0.375)	(0.266)	(0.350)	(0.309)	(0.305)	(0.160)	(0.581)	(0.945)	(0.508)	(0.233)	(0.316)	(0.358)	(0.746)	(0.101)	(0.109)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10.*
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

Table 2-8 Section 3 Kamloops-Only Order Logit – Trust: Negatively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q2	**-1.033*** **	-0.447	-0.384	**-0.450***	-0.035	-0.487	-0.275	-0.044	0.853	**-1.975***	**-1.627*** **	-0.093	0.067	-0.127	0.490	**0.363*** **	-0.176
	(0.242)	(0.317)	(0.375)	(0.267)	(0.355)	(0.319)	(0.310)	(0.171)	(0.659)	(1.024)	(0.600)	(0.240)	(0.306)	(0.349)	(0.855)	(0.104)	(0.116)
S3Q4	-0.374	0.237	0.531	0.151	-0.024	-0.141	-0.352	**-0.279***	**-1.173** **	**-1.690***	**-1.126** **	-0.126	0.084	-0.281	0.329	**0.379*** **	-0.002
	(0.231)	(0.299)	(0.368)	(0.258)	(0.352)	(0.312)	(0.298)	(0.163)	(0.578)	(1.024)	(0.507)	(0.236)	(0.311)	(0.354)	(0.796)	(0.101)	(0.111)
S3Q6	0.177	0.385	0.479	0.180	0.341	**0.795** **	-0.037	**-0.329** **	-0.697	**-2.039** **	**-1.316** **	-0.175	0.338	-0.079	-0.020	**0.379*** **	-0.178
	(0.231)	(0.299)	(0.357)	(0.254)	(0.343)	(0.312)	(0.302)	(0.164)	(0.604)	(1.030)	(0.530)	(0.237)	(0.312)	(0.351)	(0.747)	(0.101)	(0.111)
S3Q7	0.298	**0.542***	**0.916** **	**0.460***	0.564	0.317	0.487	-0.094	**-1.022***	-0.077	0.091	-0.069	-0.329	-0.271	-0.962	**0.359*** **	-0.146
	(0.233)	(0.310)	(0.373)	(0.266)	(0.351)	(0.308)	(0.304)	(0.162)	(0.611)	(1.024)	(0.511)	(0.234)	(0.315)	(0.355)	(0.862)	(0.102)	(0.109)
S3Q9	-0.238	0.204	0.601	-0.340	0.088	-0.003	-0.496	-0.182	-0.015	**-2.496** **	-0.152	-0.151	0.033	-0.171	0.200	**0.241** **	-0.133
	(0.235)	(0.299)	(0.370)	(0.262)	(0.355)	(0.317)	(0.306)	(0.174)	(0.600)	(1.054)	(0.490)	(0.239)	(0.312)	(0.354)	(0.810)	(0.105)	(0.109)
S3Q12	0.086	-0.315	0.127	-0.082	0.030	**0.556***	0.106	**-0.275***	-0.297	**-2.504** **	**-1.065** **	-0.315	-0.006	-0.528	0.737	**0.224** **	-0.085
	(0.229)	(0.299)	(0.364)	(0.261)	(0.348)	(0.308)	(0.299)	(0.162)	(0.565)	(1.019)	(0.512)	(0.240)	(0.311)	(0.355)	(0.789)	(0.098)	(0.110)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10.*
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

Table 2-9 Section 3 Merritt-Only Order Logit – Legitimacy: Positively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q1	0.993	1.713	0.232	NA[1]	NA[1]	-1.007	-0.353	-0.058	-0.197	NA[1]	0.905	-1.283	-0.967	NA[1]	NA[1]	**-0.836***	-0.007
	(0.953)	(1.374)	(1.837)			(1.046)	(0.972)	(0.500)	(1.442)		(2.107)	(0.881)	(0.802)			(0.482)	(0.458)
S3Q3	**2.040****	0.401	-2.624	NA[1]	NA[1]	**-2.037***	-0.276	-0.156	-1.711	NA[1]	-2.566	0.032	-0.787	NA[1]	NA[1]	**-0.885***	-0.287
	(0.944)	(1.264)	(1.865)			(1.096)	(0.922)	(0.492)	(1.350)		(2.118)	(0.839)	(0.726)			(0.475)	(0.434)
S3Q11	0.872	1.938	1.486	NA[1]	NA[1]	**-1.078**	**-1.909****	-0.410	0.705	NA[1]	1.823	-0.462	0.342	NA[1]	NA[1]	-0.579	0.029
	(0.826)	(1.330)	(1.751)			(1.005)	(0.880)	(0.480)	(1.215)		(1.820)	(0.824)	(0.742)			(0.426)	(0.406)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10*
[1] Variables did not cover enough respondents in the Merritt dataset.
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

Table 2-10 Section 3 Merritt-Only Order Logit – Legitimacy: Negatively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q10	**-2.425****	-0.709	1.905	NA[1]	NA[1]	**2.549****	0.741	-0.305	0.277	NA[1]	1.553	0.178	-0.257	NA[1]	NA[1]	**1.370*****	-0.142
	(0.951)	(1.418)	(1.957)			(1.164)	(0.919)	(0.503)	(1.359)		(1.942)	(0.870)	(0.746)			(0.519)	(0.431)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10*
[1] Variables did not cover enough respondents in the Merritt dataset.
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

Table 2-11 Section 3 Merritt-Only Order Logit – Trust: Positively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q5	**1.969****	0.743	-0.966	NA[1]	NA[1]	**-3.176*****	**-1.976****	**1.043***	-1.297	NA[1]	0.694	-0.315	0.437	NA[1]	NA[1]	**-1.379*****	0.198
	(0.873)	(1.380)	(1.827)			(1.200)	(0.955)	(0.534)	(1.266)		(1.827)	(0.812)	(0.783)			(0.515)	(0.410)
S3Q8	0.813	0.665	-0.392	NA[1]	NA[1]	**-2.022***	**-2.030****	0.637	-0.913	NA[1]	0.299	0.797	**1.216***	NA[1]	NA[1]	**-1.508*****	-0.040
	(0.831)	(1.256)	(1.727)			(1.127)	(0.992)	(0.505)	(1.245)		(1.797)	(0.871)	(0.726)			(0.526)	(0.447)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10*
[1] Variables did not cover enough respondents in the Merritt dataset.
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

Table 2-12 Section 3 Merritt-Only Order Logit – Trust: Negatively Framed Statements

Statement ID	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EduUni	Enviro	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q2	0.419	**2.508****	NA[1]	NA[1]	NA[1]	0.052	**-2.932*****	**-1.861*****	**3.402****	NA[1]	2.585	**1.622***	**-2.552*****	NA[1]	NA[1]	**1.5067****	-0.2319
	(0.738)	(0.982)				(0.994)	(1.024)	(0.570)	(1.433)		(1.788)	(0.859)	(0..944)			(0.5116)	(0.456)
S3Q4	-1.482	0.569	1.209	NA[1]	NA[1]	1.576	0.109	-0.803	1.303	NA[1]	1.168	-0.203	-0.854	NA[1]	NA[1]	**1.472*****	0.421
	(0.927)	(1.324)	(1.802)			(1.115)	(1.052)	(0.501)	(1.334)		(1.852)	(0.870)	(0.837)			(0.500)	(0.436)
S3Q6	-0.951	0.864	0.513	NA[1]	NA[1]	**1.882***	0.722	**-0.879***	0.773	NA[1]	-0.885	-0.017	-0.493	NA[1]	NA[1]	**0.929****	-0.541
	(0.802)	(1.309)	(1.670)			(0.974)	(0.876)	(0.463)	(1.198)		(1.710)	(0.770)	(0.726)			(0.416)	(0.415)
S3Q7	**-2.053****	1.673	**6.287*****	NA[1]	NA[1]	1.107	0.739	-0.266	2.063	NA[1]	**6.778*****	-0.644	0.454	NA[1]	NA[1]	-0.393	0.517
	(1.005)	(1.460)	(2.138)			(1.145)	(0.849)	(0.566)	(1.640)		(2.479)	(0.875)	(0.804)			(0.507)	(0.462)
S3Q9	**-2.036****	-1.103	-0.143	NA[1]	NA[1]	-1.256	-0.189	-0.359	-0.552	NA[1]	-1.667	0.410	-0.391	NA[1]	NA[1]	**1.376*****	-0.076
	(0.932)	(1.317)	(1.805)			(1.068)	(0.921)	(0.484)	(1.552)		(1.967)	(0.879)	(0.718)			(0.484)	(0.417)
S3Q12	-1.400	1.350	2.398	NA[1]	NA[1]	1.393	0.767	-0.459	2.513	NA[1]	1.669	-0.374	-0.738*	NA[1]	NA[1]	0.334	0.044
	(0.863)	(1.156)	(1.631)			(0.953)	(0.834)	(0.462)	(1.437)		(2.025)	(0.785)	(0.694)			(0.393)	(0.414)

*Note: Logistic regression coefficients in log-odds units. Standard errors are given in parenthesis. *** p <0.01; ** p<.05; * p<0.10*
[1] Variables did not cover enough respondents in the Merritt dataset.
Description of independent variables can be found in Table 2-1; Attitude statement details can be found in Table 2-4.

to understand and accept the practice of land application of biosolids as reported in the 2002 survey completed by Beecher et al (2004).

Trust - Negative Statements

Interestingly, for all statements identified as negative and informing trust, Kamloops respondents who identified as being concerned about waste management were significantly more likely to agree. For the Kamloops data, this trend is only observed with these negative statements and potentially implies the concept of loss aversion, where it is found that people tend to experience loss twice as painful as they experience gains and thus try to avoid a loss more than try to pursue a similar gain (Samson, Loewenstein, and Sutherland 2014). As described above, trust requires being vulnerable to risk or loss through actions of another, and framing statements in a way that poses potential harm to human health or contamination of the environment may warrant a stronger emotional response than a reciprocal positive statement.

Consistent with both positively and negatively framed statements, Merritt respondents who identified as being concerned about waste management were also significantly more likely to agree with the majority of the attitude statements identified as negative and informing trust, suggesting that Merritt respondents concern for waste management may be closely tied to the community's recent experience with application sites and proximity to biosolids projects and the associated local media attention. This supports the notion presented by Beecher et al. (2004) that public's mind is a relatively blank slate regarding the knowledge of biosolids and that the public's perception may be significantly influenced by their first introduction to the topic. When considering broad public awareness regarding biosolids is low (Beecher et al. 2004; Robinson et al. 2012; Youngquist et al. 2015; McCarthy and Loyo-Rosales 2015), community outrage and the resulting media attention has the potential to be the first introduction to general community members on the topic.

Further to that, in alignment with the above results, Kamloops respondents who identified as living on rural agricultural land are significantly more likely to disagree with these negatively framed statements. This continues to support the notion that people with agricultural experience are more likely to understand and accept the practice of land application of biosolids. The statement, "My family would be at a higher health risk if my neighbours

applied animal manure to their land," is the one exception where Kamloops respondents on rural agricultural land was not identified as significant. This statement however, was included as a control to assess how respondents perceive animal manure compared to biosolids. Consistent with above, Merritt respondents who are female were significantly more likely to agree with the statement.

Gender was also found to be a significant variable for Kamloops respondents regarding the statement "Not enough is known about biosolids," where females were significantly more likely to agree with the statement than males ($p<0.0000$). This continues to support the idea that women perceive higher health and safety risks. Additionally, it was found that those whose wastewater is managed by a municipal sewer system and are from Kamloops are significantly more likely to disagree with the majority of the negative trust related statements. This also supports the idea that the general public is more trusting than perhaps those who are on septic systems (assumed to be in rural areas) and may have the potential to me more impacted by biosolids land application projects.

Obtaining Community Support

To assess these results in context of social approval, we use the community support conceptual framework displayed in Figure 2-3. This framework highlights that not only does the community provide the necessary ongoing support as typically seen in SLO models (Boutilier and Thomson 2011; Hall et al. 2015; Thomson 2016; Gehman, Lefsrud, and Fast 2017), but also that the company/project seeks to obtain this support. Ultimately, it's important to consider that the minimum requirements demanded by the community must not exceed the maximum that the proponent is willing to supply in order to move the project forward successfully. Common challenges often experienced in attempting to establish ongoing community support is public risk perceptions and transparency on risk management. It is found that risks associated with health, safety and environment can be difficult to effectively engage on because of the generally low level of public trust (Lincoln 2015). Further to this challenge, proponents are now faced with social media, where a potential vocal minority are offered a platform to publicly voice their differing expectations to a broad

audience (Gehman, Lefsrud, and Fast 2017). This proves to be important when taking into account the suggestion that public perception may be significantly influenced by their first introduction to the topic (Beecher et al. 2004). Social media could potentially make or a break a project if not engaged on proactively.

When considering the roles of legitimacy and trust, it is suggested that legitimacy is necessary for acceptance, but trust is required for approval (Boutilier and Thomson 2011; Goven et al. 2012; Lincoln 2015). Boutilier and Thomson (2011) propose that legitimacy is a necessary but not sufficient condition for trust and that a weak community support may be

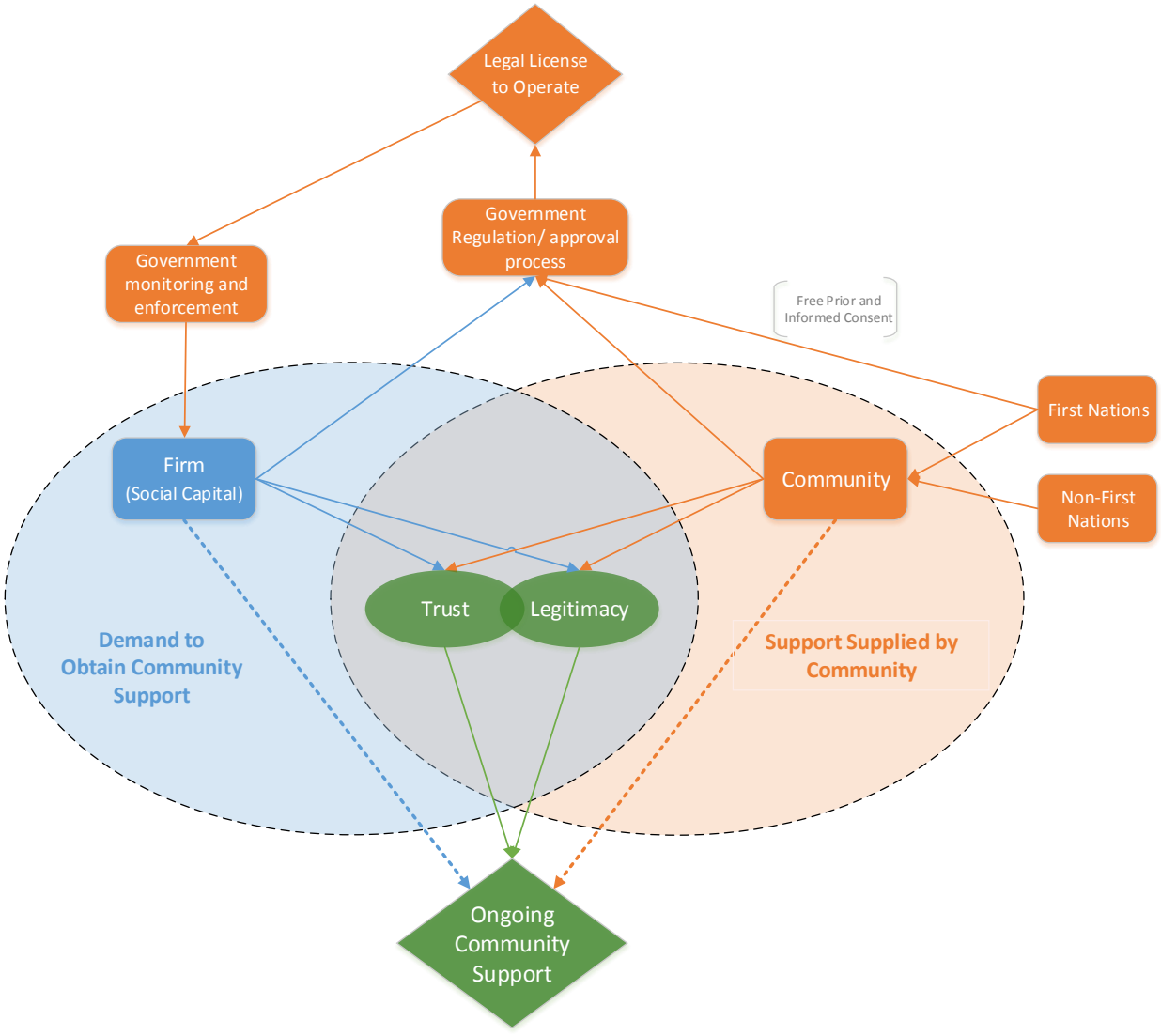

Figure 2-3 Community support conceptual framework.

obtained with only legitimacy but this has the potential to fall through as stakeholders continue to take in new information. This is reflected in the three levels of community acceptance they propose: (1) Acceptance – basic level, where acceptance is considered a tentative willingness for the project to proceed; (2) Approval – established credibility, where stakeholder support is resistant to ideas projected by critics; and (3) Identification – full legitimacy and trust, where the community sees its future tied to the future of the project (shared interests) (Boutilier and Thomson 2011; Boutilier, Black, and Thomson 2012). It is worth considering that the basic level, "Acceptance," may be more appropriately termed "Acquiescence," as non-opposition does not necessarily imply acceptance.

Further to this, Hall et al. (2015) suggest that there is evidence to support that a social gap between public support for the general goal of more "sustainable" practices and the level of local support for specific projects. While the general public remains favourable to the idea of new technologies, host communities are not as supportive, thus there may be socio-political acceptance and market acceptance, but community acceptance is still lacking (Hall et al. 2015). This proposed social gap is supported by Kamloops and Merritt responses to this survey, where it is observed that the community that is reportedly less impacted by biosolids projects, Kamloops, is more supportive of biosolids projects than Merritt, where the topic of biosolids has become a rather controversial issue.

Additionally, it's important to consider the legal license as an input into "Social Capital," where when community members lose faith in the regulatory structure, increased pressure is placed on the project proponent to make up for this gap. This is one of the drivers of the beyond compliance approach, where expectations must be managed and the challenges of "perception is risk" are presented.

Kamloops respondents provide a good example of what Boutilier and Thomson (2011) and Thomson (2012) refer to as the basic level of community acceptance. Kamloops respondents prove to be supportive of productive uses of biosolids, however response means for statements regarding trust don't stray too far from "Neutral," suggesting that these views may be easily reassessed as new information is received. This is demonstrated by Kamloops residents' responses to the statement "The odor emitted by biosolids is harmful to my health when breathed" ($p=0.3569$) and "I trust government regulatory agencies to monitor the safe

use of biosolids" ($p=0.0556$), where responses were not found to significantly differ from neutral or where they were only marginally significantly different from neutral. This is further supported by the perceived lack of knowledge about biosolids.

The opposition exhibited by Merritt residents demonstrates a clear lack of acceptance for biosolids land application projects. Merritt respondents generally perceived the land application of biosolids to offer unsuitable risk and a low level of value. As proposed above, without legitimacy, the project will not even make it to the basic level of community acceptance.

In the case of Kamloops, where there's the potential that legitimacy is somewhat established, weak project acceptance may be provided. Trust however, cannot be discounted. If trust is not established, there is a high probability of opposition within the host community. As a driver to go beyond compliance, Morrison (2014) proposes that two of the five following factors are salient, (1) Environmental impacts of firms product and process, (2) Customer power, (3) Customer interest, (4) Corporate/brand visibility and (5) Community pressure. In the case of biosolids in BC's southern interior, these factors can be paralleled to (1) Environmental impacts of land application projects, (2) Host community power, (3) Host community interest, (4) Project visibility, and (5) Host community pressure.

Perceived environmental impacts related to biosolids projects can very quickly escalate, and although the BC government indicates that the OMRR is designed to be protective of human health and the environment there exists a general distrust in the government's oversight on land application projects to be safely practiced. Further to that, it was demonstrated that the communities feel that not enough is known about biosolids. Combining this with project visibility, where complaints about odours and reports of environmental spills bring negative attention to the project, weak community support may be obtained but could quickly deteriorate as community members begin to seek more information.

If a host community has a strong negative experience, community interest and community pressure will continue to grow as projects continue to be proposed. And in the case of biosolids, where most developed nations are highly dependent on effective wastewater treatment, something must be done with the residuals. It is said that it takes a lot to get the public to care, but once they care it can be hard to shift that perception (Sandman 1993).

Again, this is significant when considering the potential for perceptions to be significantly influenced by an individual's first introduction to the topic. This emphasizes the risk that biosolids managers take when choosing not to proactively engage with the host community on projects, particularly within this region.

Host community power, interest and pressure are of particular interest with respect to this region. Within Kamloops and the broader Thompson Nicola Regional District (TNRD), workshops and working groups have recently been established to assess biosolids management options (Rothenburger 2018 May 4; Rothenburger 2018 May 25). While the TNRD has committed to assessing options to eliminate land application within the region, the Kamloops working group members have committed to an approach that will consider the economic, environmental and social impacts of different management options and establish a long term plan for the city's biosolids – this approach doesn't exclude the possibility of continued land application. These approaches are generally supported by the outcomes of this research, where the Lower Nicola Region of the TNRD has placed increasing pressure on all levels of government to move away from the practice of biosolids land application. Although pressure is growing in Kamloops, the opportunity to conduct more proactive engagement on different management practices still exists.

Conclusions

This research supports the notion that this beyond compliance approach is valuable for any potentially controversial natural resource project, such as with biosolids land application projects. The findings of this survey can be used to assist with designing stakeholder-centric engagement around potentially controversial natural resource projects. Although expectations of each community will differ, several general conclusions can be drawn to support addressing risk perceptions associated with management and regulation:

- Merritt residents who, in general, reported to be more familiar with biosolids and subsequent related issues within their community, demonstrated significantly stronger attitudes opposing land application practices than the reportedly less familiar Kamloops residents.

- Kamloops respondents who were generally more familiar with the term biosolids demonstrated significantly stronger attitudes towards support of the value biosolids offers as a fertilizer.
- Kamloops residents who reported to be more concerned with waste management, demonstrated significantly stronger attitudes against biosolids land application when attitude statements are negatively framed.
- While Merritt respondents reported significantly greater perceived health risks from exposure to biosolids than animal manure, Kamloops respondents generally disagreed that biosolids exposure would lead to increased health risks.
- Kamloops residents who reported to live on rural agricultural land had significantly stronger attitudes towards acceptance of biosolids land application practices.
- Women were found to generally perceive significantly higher health and safety risks, this was particularly emphasized within the Merritt community where attitudes may be emotionally influenced.
- Based on the current knowledge base, neither community perceives there to be a strong enough body of knowledge on biosolids.
- There is a general lack of trust in the government oversight for land application projects to ensure the safety of human health and the environment.
- Kamloops respondents support the general idea of recycling biosolids but lack the necessary overall trust for a biosolids project to receive stable social acceptance.
- Merritt respondents reported that the benefits of biosolids do not outweigh the perceived health and safety risks and that biosolids do not offer value as a fertilizer highlighting lack of overall community acceptance.

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Chapter 3 Assessing the Benefits of Alternative Uses of Biosolids Using Willingness to Pay

Introduction and Relevance

Within the Southern Interior of British Columbia (BC), there has been a growing resistance to biosolids land application projects. Biosolids, the nutrient-rich solids that are a by-product of wastewater treatment, have resulted in many community complaints within the Southern Interior region particularly centered on land application projects. In BC, biosolids are often used as a soil amendment for improving soils and plant growth (CCME 2012; McCarthy and Loyo-Rosales 2015). The opposition to land application projects within select community groups has resulted in increased pressures on government and biosolids managers to implement socially acceptable projects in a growingly contentious culture.

The Canadian Council of Ministers of the Environment (CCME) encourages the beneficial use of municipal biosolids, while maintaining protection of the environment and human health. Beneficial management includes practices such as composting, agricultural land application and combustion for energy. While biosolids land application projects continue to be subject to questions and concerns, not only do we need to understand how to most effectively address the differences between the public perception of biosolids and the promotion of the safety and sustainability of current waste management practices, but consideration needs to be given to alternate beneficial use practices and the resulting social implications.

Social science literature has demonstrated the important role social trust plays in societal judgments about technological risks and benefits, and subsequent views on acceptability of technologies (Slovic 1987; Slovic 1993; Beecher et al. 2005; Wu, Wolsink, and Bu 2007; Eggers et al. 2011). Biosolids managers have expressed particular frustration around the concept of "perception is reality," where concerns are raised about anything that might be disposed of down the drain that may potentially impact biosolids quality (Beecher et al. 2004). Social science research has indicated there exists a considerable gap in risk perception between the technical "experts" and the lay public, highlighting that people who regard

themselves as "expert" tend to perceive a lower risk about that topic, whereas non-experts will perceive a higher risk (Neil, Malmfors, and Slovic 1994; Slovic et al. 1995; Beecher et al. 2004; Beecher et al. 2005). It is worth considering that public risk perceptions may also act as a surrogate for other social-political concerns (Slovic 1987).

There have been a limited number of surveys conducted to understand biosolids management preferences in communities with minimal engagement on biosolids issues. One of the key studies on this topic is the 2002 Biosolids Public Knowledge and Perception Survey, where it was reported that one of the most important findings of the survey is that the public mind is a relatively blank slate regarding the knowledge of biosolids suggesting that the public's perception of biosolids may be significantly influenced by their first introduction to the topic (Beecher et al. 2004). This is significant given the low level of public awareness regarding biosolids management. Highlighting the influence community opposition can have, Robinson et al. (2012) conducted a study in south-eastern USA assessing attitudes and risk perceptions of two communities that utilize the land application of biosolids as part of their waste management strategies, Amelia County and Knoxville, Tennessee. It was found that the Amelia County residents, who had reported many community complaints, responded with stronger attitudes against biosolids land application than Knoxville residents. Highlighting some of the challenges in effective community engagement, Younquist et al. (2015) found that there was a lack of overall community participation when exploring community engagement strategies around biosolids management in the town of La Conner in Skagit County, Washington, suggesting that biosolids management may be a topic people do not see as a relevant issue.

Estimating the external costs of the land application of biosolids is difficult because of the non-market nature of environmental goods, such as clean air or clean water. External costs of land applied biosolids could include the cost of the number of community concerns presented in Chapter 1, such as the cost of impacts on an individual's ability to enjoy their surrounding environment or reduced property value resulting from proximity to land application projects. Economists often use the contingent valuation method (CVM) for valuations of these non-market goods. CVM enables the researcher to directly observe the relationship between an economic decision and particular non-market goods (Carson 2000).

Through this research we attempt to measure the benefits of alternative uses of biosolids in dollar values at the individual level, which can then be aggregated to the community level. By using CVM, we determine the willingness to pay (WTP) of local residents to support a proposal to use biosolids generated from their own community as a fuel for energy production as an alternative to using it for land application projects.

Willingness to pay for alternative biosolids management practices can be used as a surrogate for willingness to pay to divert biosolids from land application. Thus this research estimates indirectly the perceived external cost of land applied biosolids. Additionally, by proposing an alternative method of biosolids management, it is reinforced that biosolids are a product that communities need to effectively manage long-term. This research aims to offer policy makers, regulators, and biosolids management tools for valuing changes in biosolids management practices, ultimately supporting the implementation of publicly successful biosolids management programs.

Methods

Sample Selection and Survey Delivery

Please see discussion on sample selection and survey delivery in Chapter 2.

Survey Design

For detailed discussion on survey design, please see Chapter 2.

For the purpose of this chapter, I focus on results from sections one, two and four. Section one captured general sociodemographic information, inclusive of gender, age, income, education level, and description of residence (urban/rural). Given the importance of demographics to this research, this section was placed in the beginning to promote completeness of responses (Teclaw, Price, and Osatuke 2012). A subsection of the data from section two was used for to construct estimates of WTP, this included respondents level of familiarity with biosolids, level of comfort regarding the use of biosolids as a fertilizer within

their community, and level of concern regarding waste management as potential explanatory variables.

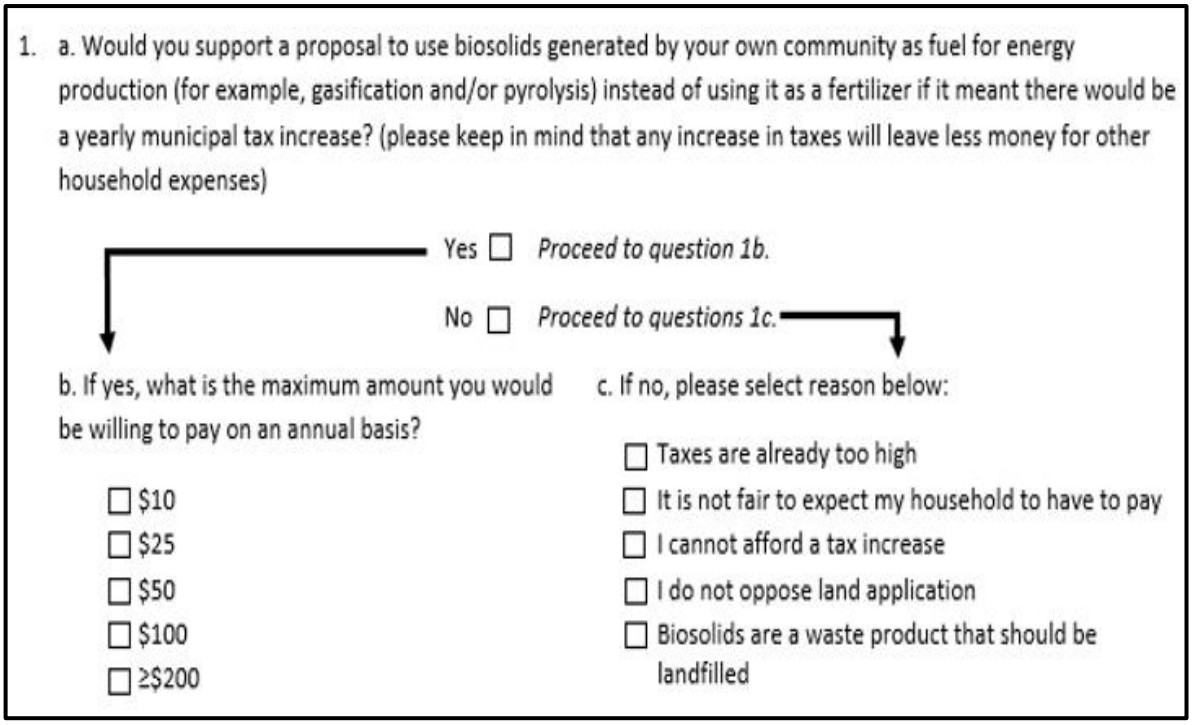

Figure 3-1 Section 4: Biosolids Management, willingness to pay questions

Section four was designed as an assessment for alternative uses of biosolids management. Respondents were asked if they would support a proposal to use biosolids generated from their own community as a fuel for energy production as an alternative to using it as a fertilizer if it meant that there would be a municipal tax increase (Figure 3-1). Using contingent valuation methodology (CVM), we attempt to measure the benefits of alternative uses of biosolids in dollar value at the individual level, which can then be aggregated to the community level.

Contingent Valuation and Empirical Analysis

Due to the opposition to the land application of biosolids experience within the region, in section 4 we attempt to assess an alternative use of biosolids management using CVM. Contingent valuation is a common survey method used to place monetary values on goods and services not bought or sold in the market place (Carson 2000; Boyle 2003; Androkovich et al. 2008). There are three classifications of elicitation methods in the design of CVM: open-ended, payment card, and dichotomous choice. At the basic level, dichotomous choice

represents a two cell payment card (yes or no to the proposed dollar value), while open-ended CVM has an infinite number of cells (no restriction on the dollar value reported). Using dichotomous choice CVM, a participant would be presented a proposal and asked whether or not they will support the proposal if it meant they had to pay a set dollar value, whereas open-ended CVM would present the same proposal but directly ask participants how much they are willing to pay, not leading them to any specific dollar amount. It is well documented that mean WTP from dichotomous choice CVM generally exceeds that from open-ended approaches (Boyle 2003; Androkovich et al. 2008). There are arguments made against all three question formats, open-ended CVM are hard to answer but dichotomous choice CVM pose a "take it or leave it" approach telling us limited information about the distribution. Dichotomous choice CVM is known to be subject to bias resulting from yea saying, where respondents may say yes to an amount even though the their true willingness to pay is less than the amount asked about, and anchoring, where the proposed dollar amount may serve as a reference point and influence respondents subsequent judgments about value. Similarly, payment card CVM results in potential biases from anchoring (i.e. range and end point bias) (Carson 2000; Boyle 2003; Androkovich et al. 2008).

Given the relatively low public awareness on biosolids management practices, payment card CVM was selected to promote survey response and to gain information about the broad distribution. Respondents were asked if they would support a proposal to use biosolids generated from their own community as a fuel for energy production as an alternative to using it as a fertilizer if it meant that there would be a municipal tax increase. Bid options were presented at \$10, \$20, \$50, \$100, ≥\$200. If respondents were not willing to pay, they were asked to select one of the following reasons: (1) Taxes are already too high; (2) It is not fair to expect my household to have to pay; (3) I cannot afford a tax increase; (4) I do not oppose land application; (5) Biosolids are a waste product that should be landfilled.

Respondents that identified they felt biosolids were "a waste product that should be landfilled," were then asked about supporting an alternate proposal to landfill biosolids if it meant that there would be a municipal tax increase. This second component was filled out by many respondents unnecessarily, as such, the landfill component was not assessed and is not further discussed in this report. Descriptive statistics were generated for all questions.

Table 3-1. Variables used in the Tobit 2-step Procedure

Variable	Name	Description
Gender	Gender	Gender of the Respondent (1 = Male, 0 = Female)
Age (base case: Age 18-34)	Age3549	Respondents who are of the age of 35-49 years old (1 = Yes, 0 = No)
	Age5064	Respondents who are of the age of 50-64 years old (1 = Yes, 0 = No)
	Age65+	Respondents who are of the age of 65 years or older (1 = Yes, 0 = No)
Children	Child	Respondents who have children currently living at home (1= Yes, 0 = No)
Education (base case: highest level of education attained college or trade school graduate)	EduUni	Respondents whose highest level of education is university (bachelors degree) (1 = Yes, 0 = No)
	EduGrad	Respondents whose highest level of education is post graduate studies (1 = Yes, 0 = No)
Environmentalist	Enviro	Respondents opinion of how applicable the term "Environmentalist" applies to them (1 = Strongly Disagree, 5 = Strongly Agree)
Location (base case: residents live in Merritt)	Kam	Respondents whose residence was located in Kamloops (1 = Yes, 0 = No)
Community Biosolids Management	BioMngt	Respondents who know how Biosolids are managed in their community (1 = Yes, 0 = No)
Income (base case: respondents for whom annual household income was less than $75,000)	Inc75100	Respondents for whom annual household income was in the range $75,000 to $100,000 (1 = Yes, 0 = No)
	Inc100+	Respondents for whom annual household income was $100,001 or more (1 = Yes, 0 = No)
Biosolids Familiarity	BioEd	Respondents opinion of how familiar they were with the term "Biosolids" prior to receiving the survey (1 = Not Familiar, 5 = Extremely Familiar)
Waste Management	WasteMngt	Respondents level of concern regarding Waste Management (1 = Not Concerned, 5 = Very Concerned)
Biosolids Fertilizer	Fertilizer	Respondents level of comfort regarding the use of Biosolids as a fertilizer within their community (1 = Very Uncomfortable, 5 = Very Comfortable)

For an estimate of aggregate individual household willingness to pay, individual household willingness to pay was related to explanatory variables in a manner that is consistent with CVM, inclusive of income. StataSE 15 was used to construct our most conservative WTP estimates.

Those who were not willing to pay and selected, "taxes are already too high" or "it is not fair to expect my household to have to pay" were considered protest responses. These responses are important to consider, as WTP data contains an inherent selectivity bias. In contingent valuation surveys, there is typically a proportion of respondents who are not willing to pay to support a proposal for some attribute of a particular environmental good; a respondents' attitude toward paying for the good may manifest in protest responses as a reaction to higher prices and/or methodological factors (i.e. tax increase). In addition to that, respondents attitudes toward the behavior of paying for the public good in question, may contribute to the decision to pay independent of other explanatory variables, such as the price of the intervention, household income, or selected elicitation method the CV survey (Heckman 1976; Heckman 1979; Carson 2000). In order to correct the estimated WTP for selectivity bias, we followed a two-step Heckman procedure. This included running a probit regression to estimate the participation equation, from which we calculated the inverse mills ratio and included this series as a variable in the WTP estimation to correct for selectivity bias. The probit regression was run against explanatory variables reported Chapter 2 of this thesis, as well as in previous related studies (e.g Beecher et al. 2004; Robinson et al 2012). This included gender, community, education level, and level of comfort with biosolids as a fertilizer (shown in Table 1).

The first step of the Heckman procedure is to estimate a model that determines the propensity of the respondent to submit a non-protest response as a function of a set of socio-economic variables. Namely,

$$y_i^* = x_i^{'}\beta + \varepsilon_i$$

where y_i^* is a latent variable which reflects the propensity of the respondent i to submit a non-protest response and x'_i is a 1xk vector of k independent variables of the ith observation, i=1 to n, that may influence an individual's submission of a non-protest response and β is kx1

vector to be estimated which reflects the impact of changes in x on y_i^* and ε_i is an identically and independently distributed stochastic error term with mean zero. Since y_i^* is unobservable, we use a dummy variable to observe response as follows:

$$y_i = 1 \quad if \quad y_i^* > 0$$
$$y_i = 0 \quad if \quad y_i^* < 0$$

And estimate the relationship using the probit model:

$$\text{prob}(y_i = 1 | \, x_i) = \Phi\,(x_i'\beta)$$

Where prob indicates a probability function where the respondent either submits a non-protest response ($y_i = 1$) or a protest response ($y_i = 0$) and Φ is the cumulative distribution function of the standard normal distribution. From the above participation equation, we then calculated the inverse mills ratio, λ_i, using the following:

$$\lambda_i = \frac{\phi(x_i'\beta/\sigma)}{\Phi(x_i'\beta/\sigma)}$$

Where ϕ and Φ represent the probability density and distribution functions of the standard normal distribution, and σ is the standard error. The inverse mill's ratio is used as a control variable in the willingness to pay equation to account for the selectivity bias. The next step is to estimate the willingness to pay equation pay for alternative biosolids management practices by including the inverse mills ratio. However, there is another problem in the second stage that needs to be dealt with and that is censoring. Censoring in the data is present due to the truncation at zero – it is worth considering that those who selected "I do not oppose land application" or "Biosolids are a waste product that should be land filled" may have a negative willingness to pay.

The willingness to pay variable is censored at zero not allowing negative willingness to pay to be observed amongst the non-protest responses. If the survey allowed negative willingness to pay to occur, the respondent could have responded to agree with the alternative use of biosolids. Since the survey excluded such a possibility, negative values are not observed in the sample and this leads to the censoring problem. Usage of the ordinary least squares regression will lead to biased and inconsistent estimated coefficients, abstracting from the moment from the selectivity problem, since the distribution of the error term is truncated and

thus depends on the parameters, the explanatory variables as well as the variance of the error term. The censoring problem can be dealt with Tobit's regression method. The Tobit model can be represented by the following system and includes the inverse mills ratio to account for the selectivity problem.

$$wtp_i^* = z_i'\gamma + \rho\sigma\lambda_i + u_i$$

with

$$wtp_i = 0 \quad if \quad wtp_i^* \leq 0$$
$$wtp_i = wtp_i^* \quad if \quad wtp_i^* > 0$$

Where wtp_i^* is the unobservable (latent) willingness to pay of the ith observation, z_i' is a 1xg vector on the g independent variables some of which can be the same as in the x_i' which is used in the probit regression, γ is a gx1 vector of parameters to be estimated, u_i is a well behaved (i.e., identically and independently distributed) random error term with mean zero and constant variance, and wtp_i is the ith observed value of willingness to pay.

Community was found to be a significant factor for both the participation equation and willingness to pay, as such, WTP was estimated separately for the individual communities as well as for the entire sample. This was done by using the variable means for the individual community observations, as well as for the variable averages for the entire sample (not just Tobit sample).

Results and Discussion

As discussed in Chapter 2, Kamloops and Merritt were selected for this survey based on the recent significance of biosolids within the Thompson Nicola Regional District, and Princeton due to the community's previous experience with biosolids projects. A total of 423 surveys were returned (including 2 blank) for a 22% return rate. Some surveys were only partially completed but still contained usable data for some questions, this information was included in the results. A total of 421 surveys were used in the final analysis. Response rates for Kamloops and Merritt were 22 and 24 percent respectively; no survey responses were received from Princeton (Table 3-2). The lack of survey response from Princeton suggests

that this may not be a significant topic within the community, Princeton is not further discussed in this paper. In general, Kamloops and Merritt identified differing risk perceptions around the management of biosolids. Kamloops respondents were generally more accepting toward the practice of land application than Merritt respondents.

Table 3-3 Community response rates based on 423 surveys.

Community	Number Mailed	Number Returned	Community Response Rate
Kamloops	1761	382	22%
Merritt	173	41	24%
Princeton	66	0	0%

Respondents were asked if they were willing to pay to support a proposal to use biosolids generated from their own community as a fuel for energy production as an alternative to using biosolids for land application projects if it meant that there would be a municipal tax increase. Of the 423 respondents, 388 responded to the WTP questions, where 43.6% of respondents (173) were willing to pay. These results are shown in Table 3-3. Of the

Table 3-2 Willingness to Pay Responses

	Total Count	%	Kamloops Count	%	Merritt Count	%
Total respondents willing to pay	173	43.6	153	42.3	20	54.1
Total respondents not willing to pay	224	56.4	209	57.7	17	45.9
Respondents Not Willing to Pay – Reasons:						
a. Taxes are already too high[P]	75	35.7	72	34.4	7	41.2
b. It is not fair to expect my household to have to pay[P]	15	7.1	15	7.2	2	11.8
c. I cannot afford a tax increase	26	12.4	28	13.4	3	17.6
d. I do not oppose land application	85	40.5	83	39.7	5	29.4
e. Biosolids are a waste product that should be landfilled	9	4.3	11	5.3	0	0.0

[P]Denotes protest response.

respondents not willing to pay, 42.9% were considered protest responses. It's also worth noting that 40.5% of those not willing to pay identified as not opposing land application.

Communication from local community groups expressing opposition to biosolids land application practices identified using biosolids to generate energy as a preferred management practice. The BC MOE have indicated that all practices that transform biosolids to an energy product – incineration (low-grade coal), pyrolysis (bio-oil or py-gas), and gasification (syngas), are net-negative with regards to economics (BC MOE 2016). These survey results help support if there exists an interest from the surveyed communities to support the increased cost of these alternative management practices in order to divert biosolids from land application.

Factors Determining the Likelihood of a Nonprotest Response

The results reported in Table 3-4 indicate that respondents who reported as being concerned about waste management were more likely to submit a nonprotest response. This suggests concern for waste management may be directly linked with an individual's concern with biosolids management, and those who express interest in alternative biosolids management practices are more likely to submit a nonprotest response.

Alternatively, those who expressed comfort with using biosolids within their community as a fertilizer are more likely to submit a nonprotest response. This may be reflected in the proportion of respondents who indicated "I do not oppose land application" as an explanation to why they were unwilling to support the alternative to biosolids land application proposal.

Additionally, education level was found to be a significant variable. Those who reported having a bachelor's degree or graduate degree, were more

Table 3-4 Selection Equation (Probit model with nonprotest as dependent variable)

Variables	Probit Estimated Coefficients
Gender	-0.206
	(0.156)
WasteMngt	**0.144****
	(0.0646)
EduUni	**0.605*****
	(0.199)
EduGrad	**0.429***
	(0.233)
Fertilizer	**0.152*****
	(0.0589)
Constant	-0.289
	(0.331)
Observations	369

Standard errors in parentheses;
*** p<0.01, ** p<0.05, * p<0.1

likely to submit a nonprotest response. This finding is consistent with contingent valuation studies (Halstead, Luloff, and Stevens 1992).

Determinants of Willingness to Pay

For comparative purposes, factors determining willingness to pay were estimated using the Tobit model for both the 2-step procedure and the standard Tobit regression. The 2-step procedure involved generating the Inverse Mills Ratio (IMR) series from the participation equation, and running the Tobit model including IMR variable to correct for selection bias.

Table 3-5 Tobit model with Willingness to Pay as the Dependent Variable.

Variables	WTP-Tobit (2-Step)	WTP-Tobit (standard)
Gender	-9.151	-7.981
	(8.177)	(7.887)
WasteMngt	**13.72*** **	**13.03*** **
	(3.825)	(3.605)
Inc75100	**18.99** **	**17.49** **
	(9.119)	(8.898)
Inc100+	**19.56***	**19.13***
	(10.06)	(9.982)
Kam	**-30.39** **	**-32.81** **
	(13.52)	(12.28)
BioEd	-3.325	-3.989
	(3.694)	(3.653)
MillsRatio	21.75	-
	(29.11)	-
Constant	-12.83	1.485
	(30.12)	(23.05)
Observations	261	

Standard errors in parentheses;
*** p<0.01, ** p<0.05, * p<0.1

The IMR was not found to be a significant variable, suggesting that selection bias is not significant within this dataset. This is supported by the minimal difference between the estimated coefficients of the two regressions.

As expected, an increase in household income resulted in an increase in willingness to pay. This is consistent with contingent valuation studies. Another expected result was the influence of the waste management variable. As level of concern for waste management increased, willingness to pay increased. This supports that concern for waste management is directly related to concern for biosolids management.

Community was found to be a significant determinant of willingness to pay, where Kamloops respondents were willing to pay significantly less than Merritt respondents. This is a likely result of Merritt residents' recent experience with application sites and proximity to biosolids projects, and the associated local media attention. This is in alignment with the

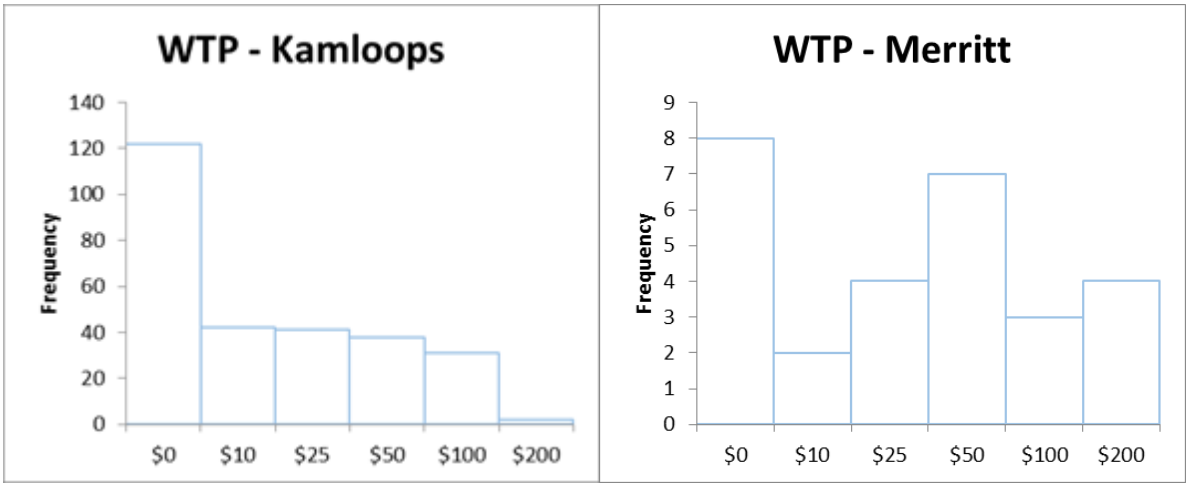

Figure 3-2 Nonprotest response distribution – Kamloops and Merritt.

results discussed in chapter 2, where Merritt respondents demonstrated significantly stronger attitudes opposing land application practices than Kamloops residents.

Willingness to Pay

Of the nonprotest responses, 173 (43.6%) were willing to accept some increase in their households' yearly income taxes to support a proposal to use biosolids generated from their own community as a fuel for energy production as an alternative to using biosolids for land application projects (distribution of nonprotest responses shown in Figure 3-2). Due to the significance of community in determining willingness to pay, estimates were generated based on individual communities. The raw mean annual household willingness to pay for nonprotest respondents for Kamloops and Merritt was Can$25.55 and Can$60.38, respectively. These estimates are the least conservative, not accounting for selection bias or truncation at $0.

A second more conservative estimate of household willingness to pay was obtained by including protest responses with a willingness to pay of zero. This resulted in mean annual household willingness to pay for Kamloops and Merritt respondents of Can$19.13 and Can$41.32, respectively.

A final, and even more conservative, estimate of willingness to pay was based on the 2-step Tobit procedure outlined above. An estimate of expected individual community household willingness to pay was generated by substituting the mean values of the explanatory variables

for each community. This resulted in mean annual household willingness to pay for Kamloops and Merritt respondents of Can$5.46 and Can$40.20, respectively (Table 3-6). For comparative purposes we included the combined sample estimate of Can$10.90, highlighting the significant influence of community. Kamloops household willingness to pay was ultimately found to not significantly differ from Cad$0 once corrected for truncation at zero (95% confidence interval spans Cad$0). This indicates that there are some individuals that may have a negative willingness to pay.

Table 3-6 2-Step Tobit Procedure – WTP estimate.

WTP	Coefficient	95% Confidence Interval	
Kamloops	5.46	-3.19	14.11
	(4.39)		
Merritt	40.20***	15.32	65.09
	(12.63)		
Combined	10.90***	2.849	18.95
	(4.09)		

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

It is worth considering that although aggregated household willingness to pay within the community of Merritt does not generate a large enough increase in tax revenue to offset a transition in biosolids management as proposed (2,275 households at $40.20 per household = Cad$91,455 annual tax revenue), respondents were willing to accept a 21% increase in annual tax rates related to municipal sewer systems (when compared against single family residential dwelling sanitary sewer rates) (City of Merritt 2016). Comparatively, a significant increase.

Willingness to pay for alternative biosolids management practices can be used as a surrogate for willingness to pay to divert biosolids from land application. Thus this research indirectly estimates the external cost of applying biosolids to land application. Assuming that an individual will not accept what is viewed as an unnecessary tax rate increase, those who support the proposed biosolids energy project may view the land application of biosolids as an undesirable practise – while 40.5% of those not willing to pay (22.3% of total respondents) identified themselves as “not opposing land application,” it can be anticipated that the 43.6% of total respondents supporting the proposal would prefer to see biosolids managed in a manner alternative to land application. The intent of this research is not to specify one management practise as better than another, but rather to highlight there are

perceived external costs within select communities resulting from the current management systems in place that are not well accounted for.

It is also worth noting that, although research suggests that there may be no significant external costs experienced by the Kamloops-area respondents (willingness to pay not significantly different from Cad$0), there are individuals within the Kamloops area that have demonstrated a strong opposition to land applied biosolids. If opposition continues to grow, there's potential for this attention to be community member's first introduction to the topic. This is an important point when considering relatively low public awareness about biosolids management and the significant influence first introductions to a topic can have. Without increasing public engagement and education, the distribution could quite readily shift.

Conclusions

By using contingent valuation methodology, we determined the willingness to pay of local residents to support a proposal to use biosolids generated from their own community as a fuel for energy production as an alternative to using it for land application projects if it meant that there would be a municipal tax increase. These results can be used to support whether there exists an interest from the surveyed communities to support the increased cost of these alternative management practices in order to divert biosolids from land application projects

Factors underlying public support for willingness to pay for alternative biosolids management practices were consistent with contingent valuation studies on other topics, where those with higher education were less likely to submit a protest response and those with higher a household income were willing to pay more. Consistent with our overall findings from the "Biosolids: Community Engagement and Risk Perception" survey, level of concern for waste management and community significantly influenced willingness to pay. Those who were concerned about waste management were willing to pay more to support alternative biosolids management strategies, suggesting concern for waste management is directly linked to concern for biosolids management. Merritt respondents demonstrated stronger attitudes opposing the land application of biosolids than Kamloops respondents, where Merritt respondents demonstrated a willingness to pay of Can$40.20 per household

and Kamloops respondents demonstrated a willingness to pay that was not significantly different from Can$0.

It is important to consider that willingness to pay for alternative biosolids management practices can be used as a surrogate for willingness to pay to divert biosolids from land application. As such, this research indirectly estimates the perceived external cost of applying biosolids to land application. It finds that in Kamloops there may be no perceived external costs but in the neighboring city of Merritt there are.

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Chapter 4 RESEARCH SUMMARY AND MANAGEMENT IMPLICATIONS

As our global population continues to grow, discussions on the need to move towards sustainable waste management are going to continue to come to the forefront. Being that wastewater residuals are an unavoidable aspect of modern day society, these conversations need to consider topics such as biosolids management. Sustainable solutions need to establish not only economically feasible and environmentally sound practices, but practices that are socially just. In order to do that, we need to understand how much people know about the topic, existing perceptions and what impacts an individual's attitudes.

Information sharing, both at the local- and global-scale, is going to continue to play a large role in individual perceptions. Modern day information sharing platforms via internet-enabled technology (News Websites, YouTube, Wikipedia, Facebook, LinkedIn, Twitter) allows for unmediated conversations between an array of widespread individuals at an almost instantaneous rate. When it comes to social media, anyone can share information, criticize issues, and connect with like-minded individuals (Beecher et al. 2004; Gehman, Lefsrud, and Fast 2017). This proves to be important when considering the generally low level of public awareness regarding biosolids management and that public perception may be significantly influenced by their first introduction to the topic (Beecher et al. 2004).

Social science literature has demonstrated the important role social trust plays in societal judgments about technological risks and benefits, and subsequent views on acceptability of technologies (Slovic 1987; Slovic 1993; Beecher et al. 2005; Wu, Wolsink, and Bu 2007). Biosolids managers have expressed particular frustration around the concept of "perception is reality," where concerns are raised about anything that might be disposed of down the drain that may potentially impact biosolids quality (Beecher et al. 2004).

There exists processes for engaging concerned or impacted communities and other stakeholders to understand and review options regarding potentially controversial natural resource projects, but there must be a determinant to trigger proponents to pursue this proactive measure. Understanding the role that social media, and more broadly, the internet plays in the dissemination of information will prove to be critical for achieving wide-spread acceptance of such projects. Proponents for biosolids land application projects will need to

recognize the potential for community outrage given the public's lack of understanding of biosolids management, and more broadly, their disconnection and perhaps general lack of interest on how wastewater is managed.

The overarching goal of this research was to understand how to effectively address the gap between the public perception of biosolids and the promotion of the safety and sustainability of current waste management practices, aiming to support socially accepted biosolids management programs. This included understanding factors that influence acceptance/opposition of current biosolids management practices and identifying the perceived external costs of biosolids land application projects.

Research Summary

General Knowledge and Attitudes

This research assessed the community risk perceptions of biosolids management in Kamloops and Merritt against the overarching concepts of Social License to Operate (SLO) as a framework to understand how to most effectively address the difference between the public perceptions of biosolids and the promotion of the safety and sustainability of current waste management practices. The outcomes of this research support the notion that the "beyond compliance" approach may be valuable for any potentially controversial natural resource project, such as with biosolids land application projects.

The communities of Kamloops and Merritt are relatively close together, less than 100 km, so it can be assumed that community members are exposed to a similar level of media coverage on the topic of biosolids management. Despite the proximity of Kamloops and Merritt, clear differences were demonstrated between the individual communities regarding level of familiarity and acceptance for biosolids land application projects. As previously discussed, this was an anticipated result of Merritt residents' recent experience with application sites and proximity to biosolids projects, and the associated local media attention. An additional consideration is that biosolids management is a topic people do not want to think about or do not see as a concern (Youngquist et al. 2015), and that achieving effective community input on the matter can be challenging.

In general Merritt residents reported to be more familiar with biosolids and subsequent related issues within their community than Kamloops respondents, and demonstrated significantly stronger attitudes opposing land application practices. Although familiarity with biosolids was not found to be a significant variable for Merritt respondents, Kamloops respondents that did report a higher level of familiarity with the term demonstrated significantly stronger attitudes towards support of the value biosolids offers as a fertilizer.

Interestingly, it was found that Kamloops respondents who reported to be more concerned with waste management, demonstrated significantly stronger attitudes against biosolids land application when attitude statements were negatively framed. This was not consistent with Merritt respondents, where respondents from Merritt who identified as being concerned about waste management generally disagreed with positively framed statements and agreed with negatively framed statements. This suggested that for the Merritt respondents, waste management was likely directly related to concern for biosolids management. Although this relationship of waste management and biosolids management would exist for Kamloops respondents too, the pattern demonstrated with the negatively framed statements suggested the concept of risk aversion.

When comparing risk perceptions against well accepted fertilizers such as animal manure, Merritt reported significantly greater perceived health risks from exposure to biosolids than animal manure. This was not paralleled by Kamloops respondents, who generally disagreed that biosolids exposure would lead to increased health risks.

In alignment with the findings from the 2002 survey completed by Beecher et al. (2004), Kamloops respondents demonstrated that individuals with agricultural experience are more likely to understand and accept the practice of land application of biosolids. Although Merritt respondents didn't demonstrate the same outcomes, it can be assumed this is due to Merritt residents' recent experience with application sites and proximity to biosolids projects.

Additionally, women were found to generally perceive significantly higher health and safety risks. These findings were particularly emphasized within the Merritt community where attitudes may be more strongly emotionally influenced as a result of residents' recent experience with application sites and proximity to biosolids projects. These results are consistent with the findings of similar studies (Robinson et al. 2012).

Based on the current knowledge base, neither community perceived there to be a strong enough body of knowledge on biosolids. Further to this, there is a general lack of trust in the government oversight for land application projects to ensure the safety of human health and the environment. Assessing these results against the factors necessary to obtain community support, Kamloops respondents generally support the idea of recycling biosolids but lack the necessary overall trust for a biosolids project to receive stable social acceptance, while Merritt respondents reported that the benefits of biosolids do not outweigh the perceived health and safety risks and that biosolids do not offer value as a fertilizer highlighting lack of overall community acceptance.

Willingness to Pay for Alternative Biosolids Management Practices

Respondents were asked if they were willing to pay of local residents to support a proposal to use biosolids generated from their own community as a fuel for energy production as an alternative to using it for land application projects if it meant that there would be a municipal tax increase. Of the 423 survey respondents, 388 responded to the WTP questions, where 43.6% of respondents (173) were willing to pay. Of the respondents not willing to pay, 42.8% were considered protest responses and 40.5% identified as not opposing land application. Additionally, 12.4% of the respondents not willing to pay indicated they could not afford a tax increase and 4.3% indicated that they felt biosolids are a waste product that should be landfilled.

Factors underlying public support for willingness to pay for alternative biosolids management practices were consistent with contingent valuation studies, where those with a higher education were less likely to submit a protest response and those with higher a household income were willing to pay more. Findings were also consistent with the "General Knowledge and Attitudes" outcomes from the "Biosolids: Community Engagement and Risk Perception" survey; level of concern for waste management and community significantly influenced willingness to pay. Those who were concerned about waste management were willing to pay more to support alternative biosolids management strategies, suggesting concern for waste management is directly linked to concern for biosolids management. Merritt respondents demonstrated stronger attitudes opposing the land application of biosolids than Kamloops respondents. Once corrected for censoring and selectivity bias,

Merritt respondents demonstrated a willingness to pay of Can$40.20 per household and Kamloops respondents demonstrated a willingness to pay that was not significantly different from Can$0.

It is important to consider that willingness to pay for alternative biosolids management practices can be used as a surrogate for willingness to pay to divert biosolids from land application. Thus this research indirectly estimates the external cost of applying biosolids to land application. It finds that in Kamloops there may be no external costs but in the neighboring city of Merritt there are.

Limitations

Limitations of the study were that cultural groups may not have been evenly distributed within the survey region, and thus may not be equally represented in these results. In particular, survey respondents did not reflect the demographics in the region, where indigenous community members were underrepresented in this dataset. It is also worth noting that this study focused on the general public perceptions of biosolids management and not perceptions of the specifically impacted community groups. Although this provides a good baseline for understanding the current state of knowledge, it may be of too broad focus to identify the key factors that resulted in the strong opposition experienced within the Lower Nicola Valley.

Additional limitations include that the Kamloops sample had a significantly larger dataset than Merritt, where conclusions could be drawn for Kamloops that couldn't be compared against Merritt due to limitations in survey sample size. Princeton and Merritt response may have been larger is more surveys were sent out. Additionally, for both Kamloops and Merritt respondents, the 18-34 age group was not well represented within the dataset. This may have been a result of using a mail-out survey as the survey instrument.

Finally, additional limitations of the study may also be that it was conducted in one region, and conclusions may not be applicable to areas outside the survey area.

Management Implications for Biosolids Management

The relatively low level of public awareness on wastewater and biosolids management, suggests that there exists a disconnection amongst the general public with what happens once the toilet is flushed or the sink drains. This disconnection may result in a lack of responsibility for our decisions regarding household wastewater (i.e. what we put down the sink/what we flush down the toilet) and promotes aversion to considering biosolids land application options for fear that they may ultimately make their way back to us (through food we eat, air we breathe, or water we drink). While there is a need to ensure biosolids are applied in an environmentally sound and socially just manner, there is a need to redevelop a connection to our contributions to wastewater and their subsequent impacts.

Survey results suggest the need for public education programs that clearly outline the potential risks and benefits associated with the land application of biosolids, including the economic implications. To complement these public education programs, there is a need for studies to be undertaken by trusted sources that consider the concerns of stakeholders. This is best carried out proactively, where strong relationships can be built. These proactive measures will provide community members the tools to assess the relative benefits and risks, and comfort with their personal level of knowledge to decide on their position regarding biosolids management practices.

Further to this, survey results suggest community members can be strongly influenced by the information presented by the media. It is important that news outlets place a high priory on presenting as accurate and unbiased information as possible. It is also important to consider that proactive engagement will enable stakeholder support that is more resistant to ideas projected by critics, helping reduce the impact of potentially negative the media attention.

While acknowledging the reuse of wastewater residuals has the potential to contribute to improved management of our natural resources, care must be taken to minimize environmental harm and risks to human health. It can be challenging to assess the benefits and risks of biosolids reuse from a monetary perspective for decision making purposes. Economics strongly influence decision making from a business standpoint. Economic analysis such a contingent valuation can offer the information needed to support public

policy in a manner that enables the internalization of external costs to better inform true costs of biosolids management decisions. There may be circumstances that once the external costs are factored in, the preferred management practice may change despite the lack of total cost recovery.

Ultimately, the sustainable management of wastewater residuals should not be treating this by-product as a waste for disposal. Consideration needs to be given to how and where we can utilize this resource in an environmentally sound and socially just manner. An imperative step to this should be through reestablishment of our connection to the decisions we make that impact our waste-streams, where first and foremost we should be looking at how source reduction initiatives can support successful biosolids management programs.

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APPENDICES

Appendix A: Survey

THOMPSON RIVERS UNIVERSITY

Biosolids: Community Engagement and Risk Perception

This survey supports research being conducted as a component of a Master of Science in Environmental Science Degree. The goal of this survey is to provide a better understanding of public perception towards biosolids and how they are managed, so that practices can be improved.

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A summary of the completed research will be available online at www.tru.ca.science/programs/msces/msc-theses.html

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BACKGROUND INFORMATION:

In order to prevent the disposal of raw sewage directly into our nation's waterbodies, local governments are required to treat their wastewater to protect human health and the environment. Biosolids are produced from the nutrient-rich solids that are a by-product of wastewater treatment. These solids have been separated from the liquids during the wastewater treatment process and then treated to kill the harmful bacteria. Most communities produce biosolids, and in BC biosolids are often used as a fertilizer. There is a provincial regulation that sets out rules for the treatment and land application of biosolids. Local governments can either recycle biosolids as a fertilizer, incinerate it, or dispose of it in a landfill – Although there are different ways of producing biosolids in BC, Figure 1 below shows one of these processes.

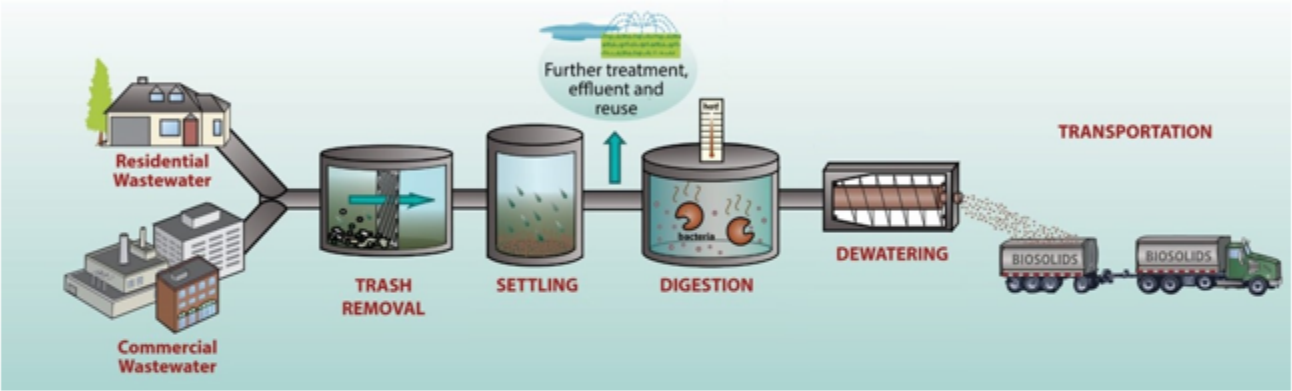

Figure 1. Biosolids production.

Biosolids management is a recent topic of public interest, particularly within the interior of BC. There is a need to better understand the public's perceptions around biosolids use as well as understand how to most effectively address pressing topics regarding biosolids management.

CONSENT, PRIVACY AND RIGHT TO REFUSE

By participating in this survey, you the participant are providing your consent. You have the right to refuse or cease participation at any time. The survey is designed to be **completely anonymous** and no identifying information (name, address, etc.) will be collected.

INSTRUCTIONS:

Time: You will need approximately 15 minutes to complete the survey.

- Please indicate how well each statement describes your view.
- Please mark one box only per statement, except where otherwise indicated.
- Once you have completed this questionnaire, please mail it in the pre-posted envelope provided.
- Please submit your completed questionnaire no later than **June 30th, 2016.**

SECTION 1: About Yourself

1. What is your gender? Female ☐ Male ☐

2. Please indicate your age: 18-24 ☐ 25-34 ☐ 35-49 ☐ 50-64 ☐ 65 or older ☐

3. Do you have children currently living at home? Yes ☐ No ☐

4. What is the highest level of education that you have attained?

   ☐ Some high school or less
   ☐ High school diploma or equivalent
   ☐ Some college or trade school
   ☐ College or trade school graduate
   ☐ University graduate (bachelor's degree)
   ☐ Post graduate studies

5. How much would you agree the term environmentalist applies to you?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

6. What community do you live in? Kamloops ☐ Merritt ☐ Princeton ☐

7. Which of options listed below best describe your residence?

   ☐ Urban
   ☐ Suburban
   ☐ Non-farm Rural
   ☐ Rural Agriculture

8. Do you know where your home sewage goes?

   ☐ Septic tank
   ☐ Municipal sewer system
   ☐ Other:_____
   ☐ Don't know

9. Do you know how the biosolids from your community are managed? Yes ☐ No ☐

10. Please indicate your total annual pre-tax household income:

    ☐ <$25,000
    ☐ $25,000 - $49,999
    ☐ $50,000 - $74,999
    ☐ $75,000 - $100,000
    ☐ >$100,000

11. Do you identify yourself as Aboriginal? Yes ☐ No ☐

SECTION 2: General Questions

1. How do you feel about the following issues?

	Not Concerned	Slightly Concerned	Somewhat Concerned	Moderately Concerned	Very Concerned
Climate change	☐	☐	☐	☐	☐
Health Care	☐	☐	☐	☐	☐
The state of the economy	☐	☐	☐	☐	☐
Waste Management	☐	☐	☐	☐	☐

2. Before receiving this survey, how familiar were you with the term "biosolids"?

Not Familiar	Slightly Familiar	Somewhat Familiar	Moderately Familiar	Extremely Familiar
☐	☐	☐	☐	☐

3. What comes to mind when you think of biosolids?

_____

_____

_____

4. Have you ever participated in the following regarding biosolids in your community?

	Yes	No
Written a letter to a local paper or local politician in favour of biosolids	☐	☐
Written a letter to a local paper or local politician against biosolids	☐	☐
Joined a group in support of biosolids	☐	☐
Joined a group opposing biosolids	☐	☐

5. If you were seeking information about biosolids, how trustworthy do you feel the following sources of information would be?

	Not Trustworthy	Slightly Trustworthy	Unsure	Moderately Trustworthy	Very Trustworthy
BC Government	☐	☐	☐	☐	☐
Environmental Organizations (e.g. David Suzuki Foundation)	☐	☐	☐	☐	☐
Friends or Neighbours	☐	☐	☐	☐	☐
Local Media	☐	☐	☐	☐	☐
University Researchers	☐	☐	☐	☐	☐

6. How would you like to learn more about biosolids? (select all that apply)

☐ Local Media (e.g. TV, radio, newspapers)
☐ Information pamphlet received in the mail
☐ Personal visit from a biosolids manager
☐ Public open house in your community
☐ Public Meeting with scientists
☐ Not interested
☐ Regional Government websites
☐ Other_____

7. How would you feel about biosolids being used as a fertilizer in your community?

Very Uncomfortable	Somewhat Uncomfortable	Don't know	Somewhat Comfortable	Very Comfortable
☐	☐	☐	☐	☐

8. How do you feel about the following in regards to the use of biosolids as a fertilizer?

	Not Concerned	Slightly Concerned	Somewhat Concerned	Moderately Concerned	Extremely Concerned
Your Health	☐	☐	☐	☐	☐
Your property value	☐	☐	☐	☐	☐
Odors	☐	☐	☐	☐	☐
Environmental Impact	☐	☐	☐	☐	☐
If you have any specific concerns, please list and rank them below:					
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

9. How appropriate do you feel the following uses of biosolids would be?

	Not Appropriate	Slightly Appropriate	Somewhat Appropriate	Moderately Appropriate	Extremely Appropriate
Growing animal feeds such as hay	☐	☐	☐	☐	☐
Fertilizing forests for timber production	☐	☐	☐	☐	☐
Fertilizing home vegetable gardens	☐	☐	☐	☐	☐
Making topsoil for Public parks, playgrounds, and athletic fields	☐	☐	☐	☐	☐
Making topsoil for areas such as municipal flower gardens and highway	☐	☐	☐	☐	☐
Restoring plant growth in areas damaged by mining or construction	☐	☐	☐	☐	☐

10. How would you feel about using the following products for your lawn, flower garden or farm?

	Not Concerned	Slightly Concerned	Somewhat Concerned	Moderately Concerned	Extremely Concerned
Animal Manures	☐	☐	☐	☐	☐
Biosolids	☐	☐	☐	☐	☐
Chemical fertilizer	☐	☐	☐	☐	☐
Mushroom Compost	☐	☐	☐	☐	☐

11. Which of these do you think is the **strongest** argument for using biosolids as a fertilizer? (check only one box)

- ☐ Cost-effective alternative fertilizer
- ☐ Diverts waste from landfills that are costly to operate and have limited capacity
- ☐ Reduces dependency on chemical fertilizers
- ☐ Recycles nutrients and organic matter back into the soil
- ☐ Sustainable disposal of a waste product
- ☐ I don't feel there is any favourable argument

12. Would it change how you feel about biosolids being used near your home if:

	Greatly Increase Comfort	Somewhat Increase Comfort	No Change	Somewhat Increase Concern	Greatly Increase Concern
A biosolids manager contacted you in advance to discuss the nearby use of biosolids	☐	☐	☐	☐	☐
Biosolids were more strictly regulated or controlled by the government	☐	☐	☐	☐	☐
The biosolids came from a larger city such as Vancouver	☐	☐	☐	☐	☐
The biosolids came from sources free of industrial waste	☐	☐	☐	☐	☐
The biosolids came from your own community	☐	☐	☐	☐	☐

SECTION 3: Your Thoughts on Biosolids

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
1. Biosolids are a valuable resource that should be used as a fertilizer	☐	☐	☐	☐	☐
2. Not enough is known about biosolids	☐	☐	☐	☐	☐
3. Using biosolids as a fertilizer is better than incineration or landfilling	☐	☐	☐	☐	☐
4. The use of biosolids as a fertilizer makes me concerned about my surrounding environment	☐	☐	☐	☐	☐
5. Biosolids receive adequate treatment at the wastewater treatment plant to protect public health	☐	☐	☐	☐	☐
6. My family would be at a higher health risk if my neighbours applied biosolids to their land	☐	☐	☐	☐	☐
7. My family would be at a higher health risk if my neighbours applied animal manure to their land	☐	☐	☐	☐	☐
8. I trust government regulatory agencies to monitor the safe use of biosolids	☐	☐	☐	☐	☐
9. The odor emitted by biosolids is harmful to my health when breathed	☐	☐	☐	☐	☐
10. The risks to public health of using biosolids as a fertilizer outweigh the benefits	☐	☐	☐	☐	☐
11. Using biosolids as a fertilizer in our community will bring economic benefits	☐	☐	☐	☐	☐
12. Even if used properly, biosolids can still lead to land or water contamination	☐	☐	☐	☐	☐

SECTION 4: Biosolids Management

1. a. Would you support a proposal to use biosolids generated by your own community as fuel for energy production (for example, gasification and/or pyrolysis) instead of using it as a fertilizer if it meant there would be a yearly municipal tax increase? (please keep in mind that any increase in taxes will leave less money for other household expenses)

Yes ☐ *Proceed to question 1b.*

No ☐ *Proceed to questions 1c.*

b. If yes, what is the maximum amount you would be willing to pay on an annual basis?

- ☐ $10
- ☐ $25
- ☐ $50
- ☐ $100
- ☐ ≥$200

c. If no, please select reason below:

- ☐ Taxes are already too high
- ☐ It is not fair to expect my household to have to pay
- ☐ I cannot afford a tax increase
- ☐ I do not oppose land application
- ☐ Biosolids are a waste product that should be landfilled (*Proceed to question 1 d.)*

d. If you answered that you feel biosolids are a waste product that should be landfilled, how much would you be willing to pay in order to divert biosolids to a landfill with a yearly municipal tax increase? (Increase in taxes due to additional costs associated with landfill use, please keep in mind that any increase in taxes will leave less money for other household expenses)

$0	$10	$25	$50	$100	≥$200
☐	☐	☐	☐	☐	☐

SECTION 5: Please provide your feedback or comments

(If you are expanding on a question above, please indicate the section and question number)

Appendix B: Reminder Card

THOMPSON RIVERS UNIVERSITY

Biosolids: Community Engagement and Risk Perception

This is a follow-up reminder regarding a voluntary survey being conducted at Thompson Rivers University that was recently sent to you by mail. Please take a few minutes to share your opinions – your input is critical. Your answers are completely confidential and will be released only as summaries.

If you have any questions please contact Sarah Whitehouse, MSc Environmental Science Candidate at sarah-whitehouse@myTRU.ca or 250-852-6283

Appendix C: Survey Results, 'Biosolids: Community Engagement and Risk Perception' - Kamloops

SECTION 1: About Yourself

1. What is your gender?

Response option	Frequency
Female	143
Male	234
Total	**377**

2. Please indicate your age:

Response option	Frequency
18-24	2
25-34	9
35-49	61
50-64	161
65 or older	147
Total	**380**

3. Do you have children currently living at home?

Response option	Frequency
Yes	128
No	233
Total	**379**

4. What is the highest level of education that you have attained?

Response option	Frequency
Some high school or less	23
High school diploma or equivalent	55
Some college or trade school	60
College or trade school graduate	92
University graduate (bachelor's degree)	94
Post graduate studies	52
Total	**377**

5. How much would you agree the term environmentalist applies to you?

Response option	Frequency
Strongly Disagree	3
Disagree	16
Neither Agree nor Disagree	142
Agree	182
Strongly Agree	36
Total	**379**
Mean	3.61

6. What community do you live in? [KAMLOOPS ONLY RESULTS]

Response option	Frequency
Kamloops	382
Merritt	41
Princeton	0
Total	**423**

7. Which of the options listed below best describe your residence?

Response option	Frequency
Urban	206
Suburban	150
Non-farm Rural	21
Rural Agriculture	6
Total	**382**

8. Do you know where your home sewage goes?

Response option	Frequency
Septic tank	26
Municipal sewer system	347
Other	6
Don’t know	3
Total	**381**

9. Do you know how the biosolids from your community are managed?

Response option	Frequency
Yes	150
No	221
Total	**371**

10. Please indicate your total annual pre-tax household income:

Response option	Frequency
<$25,000	15
$25,000-$49,999	61
$50,000-$74,999	71
$75,000-$100,000	84
>$100,000	113
Total	**345**

11. Do you identify yourself as Aboriginal?

Response option	Frequency
Yes	5
No	373
Total	**378**

SECTION 2: General Questions

1. How do you feel about the following issues?

	Statement	Not Concerned	Slightly Concerned	Somewhat Concerned	Moderately Concerned	Very Concerned	Total	Average
Q1	Climate change	24	43	73	105	131	376	3.73
Q2	Health Care	5	14	38	115	201	374	4.31
Q3	The state of the economy	12	23	115	138	124	374	3.91
Q4	Waste Management	23	58	201	133	74	372	3.48

147

2. Before receiving this survey, how familiar were you with the term “biosolids”?

Response option	Frequency
Not Familiar	33
Slightly Familiar	60
Somewhat Familiar	103
Moderately Familiar	147
Extremely Familiar	33
Total	**376**
Mean	3.23

3. What comes to mind when you think of biosolids?

**Results available upon request.*

4. Have you ever participated in the following regarding biosolids in your community?

	Statement	Yes	No	Total
Q1	Written a letter to a local paper or local politician in favour of biosolids	0	377	377
Q2	Written a letter to a local paper or local politician against biosolids	0	377	377
Q3	Joined a group in support of biosolids	3	374	377
Q4	Joined a group opposing biosolids	1	376	377

5. If you were seeking information about biosolids, how trustworthy do you feel the following sources of information would be?

	Statement	Not Trustworthy	Slightly Trustworthy	Unsure	Moderately Trustworthy	Very Trustworthy	Total	Mean
Q1	BC Government	55	61	76	154	26	373	3.09
Q2	Environmental Organizations (e.g., David Suzuki Foundation)	33	63	58	139	80	373	3.46
Q3	Friends or Neigbours	68	81	163	55	5	372	2.59
Q4	Local Media	43	116	106	103	5	374	2.76
Q5	University Scientists	5	25	44	173	126	376	4.03

6. How would you like to learn more about biosolids? (listed in decreasing order of priority)

# Respondents	Outreach Activity
189	Local Media (e.g., TV, radio, newspapers)
180	Information pamphlet received in the mail
135	Public open house in your community
111	Public Meeting with scientists
95	Regional Government websites
45	Not interested
28	Other
16	Personal visit from a biosolids manager

7. How would you feel about biosolids being used as a fertilizer in your community?

Response option	Frequency
Very Uncomfortable	35
Somewhat Uncomfortable	46
Don't know	84
Somewhat Comfortable	141
Very Comfortable	65
Total	**371**
Mean	3.41

8. How do you feel about the following in regards to the use of biosolids as a fertilizer?

	Statement	Not Concerned	Slightly Concerned	Somewhat Concerned	Moderately Concerned	Very Concerned	Total	Mean
Q1	**Your Health**	74	78	85	66	64	367	2.91
Q2	Your property value	98	67	74	76	49	364	2.76
Q3	Odors	46	86	60	83	90	365	3.23
Q4	Environmental Impact	66	60	61	89	85	361	3.19

9. How appropriate do you feel the following uses of biosolids would be?

	Statement	Not Appropriate	Slightly Appropriate	Somewhat Appropriate	Moderately Appropriate	Extremely Appropriate	Total	Mean
Q1	Growing animal feeds such as hay	63	38	68	107	93	369	3.35
Q2	Fertilizing forests for timber production	18	29	41	114	170	372	4.05
Q3	Fertilizing home vegetable gardens	167	47	71	55	30	370	2.28
Q4	Making topsoil for Public parks, playgrounds, and athletic fields	89	71	78	82	52	372	2.83
	Statement	**Not Appropriate**	**Slightly Appropriate**	**Somewhat Appropriate**	**Moderately Appropriate**	**Extremely Appropriate**	**Total**	**Mean**

Q5	Making topsoil for areas such as municipal flower gardens and highway meridians	36	44	67	106	119	372	3.61
Q6	Restoring plant growth in areas damaged by mining or construction	13	20	46	90	203	372	4.21

10. How would you feel about using the following products for your lawn, flower garden or farm?

	Statement	**Not Concerned**	**Slightly Concerned**	**Somewhat Concerned**	**Moderately Concerned**	**Very Concerned**	**Total**	**Mean**
Q1	Animal Manures	229	68	33	32	12	374	1.74
Q2	Biosolids	71	100	84	68	50	373	2.80
Q3	**Chemical fertilizer**	70	82	77	68	78	375	3.01
Q4	Mushroom Compost	240	61	38	23	11	373	1.67

11. Which of these do you think is the strongest argument for using biosolids as a fertilizer?

Response option	**Frequency**
Cost-effective alternative fertilizer	13
Diverts waste from landfills that are costly to operate and have limited capacity	51
Reduces dependency on chemical fertilizers	44
Recycles nutrients and organic matter back into the soil	100
Sustainable disposal of a waste product	111
I don’t feel there is any favourable argument	44
Total	**356**

12. Would it change how you feel about biosolids being used near your home if:

	Statement	Greatly Increase Comfort	Somewhat Increase Comfort	No Change	Somewhat Increase Concern	Greatly Increase Concern	Total	Mean
Q1	A biosolids manager contacted you in advance to discuss the nearby use of biosolids	43	123	155	28	17	366	2.60
Q2	Biosolids were more strictly regulated or controlled by the government	71	155	100	24	19	369	2.36
Q3	The biosolids came from a larger city such as Vancouver	3	9	130	102	129	373	3.92
Q4	The biosolids came from sources free of industrial waste	74	121	112	44	24	375	2.53
Q5	The biosolids came from your own community	39	97	184	30	22	372	2.73

SECTION 3: Your Thoughts on Biosolids

Frequency response to question statements relating to respondents thoughts on biosolids, including Pearson Chi-Square with p-value for each statement.

	Statement	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree	Total	Mean
Q1	Biosolids are a valuable resource that should be used as fertilizer	25	32	79	161	76	373	3.62
Q2	Not enough is known about biosolids	14	34	77	134	115	374	3.81
Q3	Using biosolids as a fertilizer is better than incineration or landfilling	25	25	43	174	104	371	3.83
Q4	The use of biosolids as a fertilizer makes me concerned about my surrounding environment	36	61	100	125	51	373	3.25
Q5	Biosolids receive adequate treatment at the wastewater treatment plant to protect public health	27	48	132	134	31	372	3.25
Q6	My family would be at a higher health risk if my neighbours applied biosolids to their land	50	91	131	66	34	372	2.85
Q7	My family would be at a higher health risk if my neighbours applied animal manure to their land	91	129	99	42	12	373	2.34
Q8	I trust government regulatory agencies to monitor the safe use of biosolids	62	95	74	111	31	373	2.88
Q9	The odor emitted by biosolids is harmful to my health when breathed	44	77	142	73	36	372	2.95
Q10	The risks to public health of using biosolids as a fertilizer outweigh the benefits	66	113	120	44	29	372	2.62
Q11	Using biosolids as a fertilizer in our community will bring economic benefits	31	38	170	115	19	373	3.14
Q12	Even if used properly, biosolids can still lead to land or water contamination	31	71	117	108	48	375	3.19

SECTION 4: Biosolids Management

1. a. Would you support a proposal to use biosolids generated by your own community as fuel for energy production (for example, gasification and/or pyrolysis) instead of using it as a fertilizer if it meant there would be a yearly municipal tax increase? (please keep in mind that any increase in taxes will leave less money for other household expenses)

Response option	Frequency
Yes	152
No	206
Total	**357**

b. If yes, what is the maximum amount you would be willing to pay on an annual basis?

Response option	Frequency
$10	42
$25	40
$50	37
$100	31
≥$200	2
Total	**152**

c. If no, please select the reason below:

Response option	Frequency
Taxes are already too high	68
It is not fair to expect my household to have to pay	13
I cannot afford a tax increase	23
I do not oppose land application	**80**
Biosolids are a waste product that should be landfilled	9
Total	**193***

**some respondents selected multiple options, this data was not used in the WTP estimate*

Appendix D: Survey Results, 'Biosolids: Community Engagement and Risk Perception' - Merritt

SECTION 1: About Yourself

2. What is your gender?

Response option	Frequency
Female	23
Male	17
Total	**40**

12. Please indicate your age:

Response option	Frequency
18-24	1
25-34	1
35-49	2
50-64	21
65 or older	16
Total	**41**

13. Do you have children currently living at home?

Response option	Frequency
Yes	8
No	32
Total	**40**

14. What is the highest level of education that you have attained?

Response option	Frequency
Some high school or less	3
High school diploma or equivalent	6
Some college or trade school	9
College or trade school graduate	11
University graduate (bachelor's degree)	9
Post graduate studies	4
Total	**42**

15. How much would you agree the term environmentalist applies to you?

Response option	Frequency
Strongly Disagree	0
Disagree	5
Neither Agree nor Disagree	18
Agree	14
Strongly Agree	4
Total	**41**
Mean	

16. What community do you live in? [MERRITT ONLY RESULTS]

Response option	Frequency
Kamloops	382
Merritt	41
Princeton	0
Total	**423**

17. Which of the options listed below best describe your residence?

Response option	Frequency
Urban	26
Suburban	7
Non-farm Rural	5
Rural Agriculture	3
Total	**41**

18. Do you know where your home sewage goes?

Response option	Frequency
Septic tank	4
Municipal sewer system	36
Other	0
Don’t know	1
Total	**41**

19. Do you know how the biosolids from your community are managed?

Response option	Frequency
Yes	21
No	14
Total	**35**

20. Please indicate your total annual pre-tax household income:

Response option	Frequency

<$25,000	3
$25,000-$49,999	10
$50,000-$74,999	6
$75,000-$100,000	7
>$100,000	10
Total	**36**

21. Do you identify yourself as Aboriginal?

Response option	**Frequency**
Yes	4
No	34
Total	**38**

SECTION 2: General Questions

13. How do you feel about the following issues?

	Statement	Not Concerned	Slightly Concerned	Somewhat Concerned	Moderately Concerned	Very Concerned	Total	Average
Q1	Climate change	2	7	8	7	16	40	3.70
Q2	Health Care	0	1	4	7	28	40	4.55
Q3	The state of the economy	1	3	8	5	23	40	4.15
Q4	Waste Management	0	2	11	12	15	40	4.00

14. Before receiving this survey, how familiar were you with the term “biosolids”?

Response option	Frequency
Not Familiar	1
Slightly Familiar	4
Somewhat Familiar	7
Moderately Familiar	24
Extremely Familiar	4
Total	**40**
Mean	3.65

15. What comes to mind when you think of biosolids?

**Results available upon request.*

16. Have you ever participated in the following regarding biosolids in your community?

	Statement	Yes	No	Total
Q1	Written a letter to a local paper or local politician in favour of biosolids	2	38	40
Q2	Written a letter to a local paper or local politician against biosolids	3	37	40
Q3	Joined a group in support of biosolids	1	39	40
Q4	Joined a group opposing biosolids	6	34	40

17. If you were seeking information about biosolids, how trustworthy do you feel the following sources of information would be?

	Statement	Not Trustworthy	Slightly Trustworthy	Unsure	Moderately Trustworthy	Very Trustworthy	Total	Mean
Q1	BC Government	11	9	11	6	3	40	2.53
Q2	Environmental Organizations (e.g., David Suzuki Foundation)	9	3	9	10	9	40	3.18
Q3	Friends or Neigbours	2	8	23	5	2	40	2.93
Q4	Local Media	9	10	13	7	1	40	2.53
Q5	University Scientists	0	5	7	16	12	40	3.88

18. How would you like to learn more about biosolids? (listed in decreasing order of priority)

# Respondents	Outreach Activity
16	Public Meeting with scientists
15	Information pamphlet received in the mail
11	Local Media (e.g., TV, radio, newspapers)
9	Public open house in your community
5	Not interested
4	Regional Government websites
3	Other
3	Personal visit from a biosolids manager

19. How would you feel about biosolids being used as a fertilizer in your community?

Response option	Frequency
Very Uncomfortable	11
Somewhat Uncomfortable	15
Don't know	3
Somewhat Comfortable	9
Very Comfortable	16
Total	**39**
Mean	2.26

20. How do you feel about the following in regards to the use of biosolids as a fertilizer?

	Statement	Not Concerned	Slightly Concerned	Somewhat Concerned	Moderately Concerned	Very Concerned	Total	Mean
Q1	**Your Health**	4	4	4	7	20	39	3.90
Q2	Your property value	6	4	5	8	16	39	3.62
Q3	Odors	3	4	5	8	19	39	3.92
Q4	Environmental Impact	3	3	7	9	17	39	3.87

21. How appropriate do you feel the following uses of biosolids would be?

	Statement	Not Appropriate	Slightly Appropriate	Somewhat Appropriate	Moderately Appropriate	Extremely Appropriate	Total	Mean
Q1	Growing animal feeds such as hay	24	0	3	8	4	39	2.18
Q2	Fertilizing forests for timber production	12	4	4	11	8	39	2.97
Q3	Fertilizing home vegetable gardens	26	2	3	5	3	39	1.90
Q4	Making topsoil for Public parks, playgrounds, and athletic fields	20	5	6	6	3	40	2.18
	Statement	**Not Appropriate**	**Slightly Appropriate**	**Somewhat Appropriate**	**Moderately Appropriate**	**Extremely Appropriate**	**Total**	**Mean**

Q5	Making topsoil for areas such as municipal flower gardens and highway meridians	14	4	6	7	9	40	2.83
Q6	Restoring plant growth in areas damaged by mining or construction	11	4	7	7	11	40	3.08

22. How would you feel about using the following products for your lawn, flower garden or farm?

	Statement	**Not Concerned**	**Slightly Concerned**	**Somewhat Concerned**	**Moderately Concerned**	**Very Concerned**	**Total**	**Mean**
Q1	Animal Manures	25	7	6	0	2	40	1.68
Q2	Biosolids	4	5	2	8	21	40	3.93
Q3	**Chemical fertilizer**	7	8	12	4	9	40	3.00
Q4	Mushroom Compost	22	9	4	2	2	39	1.79

23. Which of these do you think is the strongest argument for using biosolids as a fertilizer?

Response option	**Frequency**
Cost-effective alternative fertilizer	0
Diverts waste from landfills that are costly to operate and have limited capacity	6
Reduces dependency on chemical fertilizers	2
Recycles nutrients and organic matter back into the soil	7
Sustainable disposal of a waste product	8
I don’t feel there is any favourable argument	19
Total	**42**

24. Would it change how you feel about biosolids being used near your home if:

	Statement	Greatly Increase Comfort	Somewhat Increase Comfort	No Change	Somewhat Increase Concern	Greatly Increase Concern	Total	Mean
Q1	A biosolids manager contacted you in advance to discuss the nearby use of biosolids	0	12	16	4	9	41	3.24
Q2	Biosolids were more strictly regulated or controlled by the government	6	12	13	5	4	40	2.73
Q3	The biosolids came from a larger city such as Vancouver	0	1	12	5	23	41	4.22
Q4	The biosolids came from sources free of industrial waste	2	12	14	3	9	40	3.13
Q5	The biosolids came from your own community	4	13	14	5	5	41	2.85

SECTION 3: Your Thoughts on Biosolids

Frequency response to question statements relating to respondents thoughts on biosolids, including Pearson Chi-Square with p-value for each statement.

	Statement	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree	Total	Mean
Q1	Biosolids are a valuable resource that should be used as fertilizer	17	3	8	10	3	41	2.49
Q2	Not enough is known about biosolids	1	7	5	12	16	41	3.85
Q3	Using biosolids as a fertilizer is better than incineration or landfilling	15	3	7	12	4	41	2.68
Q4	The use of biosolids as a fertilizer makes me concerned about my surrounding environment	1	4	9	9	18	41	3.95
Q5	Biosolids receive adequate treatment at the wastewater treatment plant to protect public health	14	7	9	7	4	41	2.51
Q6	My family would be at a higher health risk if my neighbours applied biosolids to their land	3	4	13	9	12	41	3.56
Q7	My family would be at a higher health risk if my neighbours applied animal manure to their land	11	13	12	3	1	40	2.25
Q8	I trust government regulatory agencies to monitor the safe use of biosolids	16	8	6	7	4	41	2.39
Q9	The odor emitted by biosolids is harmful to my health when breathed	2	7	13	8	11	41	3.46
Q10	The risks to public health of using biosolids as a fertilizer outweigh the benefits	3	6	11	7	14	41	3.56
Q11	Using biosolids as a fertilizer in our community will bring economic benefits	12	7	17	5	0	41	2.37
Q12	Even if used properly, biosolids can still lead to land or water contamination	5	4	9	12	11	41	3.49

SECTION 4: Biosolids Management

2. a. Would you support a proposal to use biosolids generated by your own community as fuel for energy production (for example, gasification and/or pyrolysis) instead of using it as a fertilizer if it meant there would be a yearly municipal tax increase? (please keep in mind that any increase in taxes will leave less money for other household expenses)

Response option	Frequency
Yes	21
No	18
Total	**39**

b. If yes, what is the maximum amount you would be willing to pay on an annual basis?

Response option	Frequency
$10	2
$25	4
$50	7
$100	3
≥$200	4
Total	**20**

c. If no, please select the reason below:

Response option	Frequency
Taxes are already too high	7
It is not fair to expect my household to have to pay	2
I cannot afford a tax increase	3
I do not oppose land application	5
Biosolids are a waste product that should be landfilled	0
Total	**16***

**some respondents selected multiple options, this data was not used in the WTP estimate*

Appendix E: Attitude Statement – Ordered Logit Tables: Cumulative Dataset

Table AE a. Ordered Logit – Positively Framed Questions – cumulative dataset

	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EdiUni	Enviro	Community	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q1	0.129	0.257	0.340	0.147	-0.358	-0.596*	0.396	0.193	-2.324***	0.800	2.497**	1.175**	-0.088	-0.560*	-0.035	-0.393	-0.157	0.403***
	(0.226)	(0.296)	(0.350)	(0.255)	(0.339)	(0.307)	(0.299)	(0.155)	(0.417)	(0.529)	(1.032)	(0.511)	(0.228)	(0.300)	(0.341)	(0.753)	(0.099)	(0.110)
S3Q3	0.007	0.108	0.083	-0.032	0.380	-0.263	0.717**	0.101	-1.922***	0.216	1.966**	0.576	-0.105	-0.169	0.650*	-0.843	0.004	0.056
	(0.227)	(0.307)	(0.361)	(0.262)	(0.350)	(0.312)	(0.303)	(0.156)	(0.400)	(0.512)	(0.944)	(0.498)	(0.232)	(0.294)	(0.340)	(0.750)	(0.101)	(0.111)
S3Q5	-0.225	0.041	0.177	-0.115	0.391	-0.214	0.134	0.006	-1.552***	-0.119	3.114***	0.651	-0.014	-0.354	-0.200	-0.740	-0.138	0.099
	(0.225)	(0.293)	(0.351)	(0.252)	(0.342)	(0.311)	(0.291)	(0.153)	(0.427)	(0.497)	(0.901)	(0.512)	(0.225)	(0.302)	(0.341)	(0.763)	(0.099)	(0.107)
S3Q8	-0.037	0.249	0.218	0.080	-0.007	0.185	0.606**	-0.104	-0.817**	-0.662	1.966**	0.260	0.059	-0.091	0.215	0.007	-0.216**	0.055
	(0.218)	(0.291)	(0.355)	(0.257)	(0.330)	(0.296)	(0.289)	(0.150)	(0.398)	(0.506)	(0.833)	(0.483)	(0.220)	(0.291)	(0.328)	(0.667)	(0.098)	(0.104)
S3Q11	-0.193	0.537*	0.442	0.317	0.269	-0.109	-0.172	0.106	-1.670***	0.454	1.973**	0.328	-0.267	0.056	0.381	-1.050	0.038	-0.053
	(0.228)	(0.303)	(0.365)	(0.261)	(0.352)	(0.313)	(0.296)	(0.155)	(0.384)	(0.502)	(0.918)	(0.508)	(0.227)	(0.296)	(0.337)	(0.711)	(0.099)	(0.108)

*Note: Logistic regression coefficients for independent variables for feelings about biosolids in log-odds units. Standard errors are given in parenthesis. *** Significantly different at the 1% level. ** Significantly different at the 5% level. * Significantly different at the 10% level.*

Table AE b. Ordered Logit – Negatively Framed Questions – cumulative dataset

	Gender	Age5064	Age65+	Child	EduPTC	EduGTC	EdiUni	Enviro	Community	RuralNF	RuralAg	Muni-Sewer	Bio-Mngt	Inc50100	Inc100+	Aboriginal	Waste-Mngt	BioEd
S3Q2	-0.913***	-0.303	-0.320	-0.346	0.019	-0.316	-0.242	-0.187	-0.517	0.791	-2.290***	-1.403**	0.104	-0.041	-0.208	0.068	0.392***	-0.189*
	(0.229)	(0.303)	(0.358)	(0.257)	(0.336)	(0.304)	(0.293)	(0.158)	(0.406)	(0.555)	(0.888)	(0.557)	(0.225)	(0.285)	(0.324)	(0.735)	(0.101)	(0.111)
S3Q4	-0.408*	0.204	0.480	0.185	0.161	-0.027	-0.259	-0.304**	0.956**	-0.710	-2.090**	-1.057**	-0.081	-0.009	-0.340	0.692	0.416***	-0.006
	(0.222)	(0.289)	(0.352)	(0.250)	(0.334)	(0.298)	(0.283)	(0.153)	(0.386)	(0.509)	(0.875)	(0.483)	(0.223)	(0.290)	(0.329)	(0.719)	(0.099)	(0.106)
S3Q6	0.128	0.399	0.466	0.213	0.507	0.921***	0.118	-0.395***	1.226***	-0.188	-2.430***	-1.253**	-0.132	0.248	-0.108	0.397	0.391***	-0.196*
	(0.221)	(0.288)	(0.340)	(0.247)	(0.329)	(0.300)	(0.288)	(0.153)	(0.387)	(0.517)	(0.914)	(0.503)	(0.223)	(0.291)	(0.325)	(0.682)	(0.098)	(0.107)
S3Q7	0.149	0.497*	1.079***	0.420	0.474	0.200	0.450	-0.150	0.007	-0.452	-0.889	0.288	-0.004	-0.158	0.019	-1.501*	0.328***	-0.138
	(0.223)	(0.300)	(0.359)	(0.258)	(0.336)	(0.296)	(0.290)	(0.152)	(0.385)	(0.516)	(0.943)	(0.486)	(0.222)	(0.295)	(0.329)	(0.775)	(0.099)	(0.105)
S3Q9	-0.312	0.097	0.451	-0.301	0.117	-0.152	-0.535*	-0.187	0.838**	0.146	-2.028**	-0.337	-0.167	-0.250	-0.507	0.771	0.272***	-0.085
	(0.224)	(0.290)	(0.353)	(0.253)	(0.336)	(0.303)	(0.291)	(0.161)	(0.378)	(0.529)	(0.866)	(0.469)	(0.225)	(0.291)	(0.328)	(0.740)	(0.101)	(0.105)
S3Q10	-0.554**	0.267	0.765**	0.192	0.711**	0.446	-0.392	-0.221	1.622***	-0.370	-1.481*	-0.468	0.216	0.521*	0.269	0.073	0.162*	-0.231**
	(0.223)	(0.292)	(0.353)	(0.248)	(0.329)	(0.297)	(0.288)	(0.153)	(0.392)	(0.494)	(0.880)	(0.488)	(0.225)	(0.295)	(0.333)	(0.711)	(0.098)	(0.109)
S3Q12	0.031	-0.244	0.248	-0.087	0.044	0.578*	0.210	-0.302**	0.296	0.281	-3.271***	-0.919*	-0.253	-0.031	-0.376	1.204*	0.200**	-0.101
	(0.218)	(0.288)	(0.347)	(0.253)	(0.329)	(0.296)	(0.285)	(0.153)	(0.393)	(0.512)	(0.965)	(0.491)	(0.225)	(0.288)	(0.328)	(0.707)	(0.095)	(0.105)

*Note: Logistic regression coefficients for independent variables for feelings about biosolids in log-odds units. Standard errors are given in parenthesis. *** Significantly different at the 1% level. ** Significantly different at the 5% level. * Significantly different at the 10% level.*

Appendix F: Attitude Statements – Kamloops Neutrality Data Tables

Table AF- 1 Kamloops Neutrality hypothesis testing S3Q1

Hypothesis Testing for KS3Q1
Date: 05/29/18 Time: 19:41
Sample: 1 382
Included observations: 373
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.619303
Sample Std. Dev. = 1.104659

Method	Value	Probability
t-statistic	10.82753	0

Table AF- 2 Kamloops Neutrality hypothesis testing S3Q2

Hypothesis Testing for KS3Q2
Date: 05/29/18 Time: 19:42
Sample: 1 382
Included observations: 374
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.807487
Sample Std. Dev. = 1.086277

Method	Value	Probability
t-statistic	14.37575	0

Table AF- 3 Kamloops Neutrality hypothesis testing S3Q3

Hypothesis Testing for KS3Q3
Date: 05/29/18 Time: 19:42
Sample: 1 382
Included observations: 371
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.827493
Sample Std. Dev. = 1.116171

Method	Value	Probability
t-statistic	14.27976	0

Table AF- 4 Kamloops Neutrality hypothesis testing S3Q4

Date: 05/29/18 Time: 19:43
Sample: 1 382
Included observations: 373
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.252011
Sample Std. Dev. = 1.171240

Method	Value	Probability
t-statistic	4.15554	0

Table AF- 5 Kamloops Neutrality hypothesis testing S3Q5

Hypothesis Testing for KS3Q5
Date: 05/29/18 Time: 19:43
Sample: 1 382
Included observations: 372
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.252688
Sample Std. Dev. = 1.025612

Method	Value	Probability
t-statistic	4.751967	0

Table AF- 6 Kamloops Neutrality hypothesis testing S3Q6

Hypothesis Testing for KS3Q6
Date: 05/29/18 Time: 19:43
Sample: 1 382
Included observations: 372
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.846774
Sample Std. Dev. = 1.142497

Method	Value	Probability
t-statistic	-2.58671	0.0101

Table AF- 7 Kamloops Neutrality hypothesis testing S3Q7

Hypothesis Testing for KS3Q7
Date: 05/29/18 Time: 19:44
Sample: 1 382
Included observations: 373
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.343164
Sample Std. Dev. = 1.065181

Method	Value	Probability
t-statistic	-11.9094	0

Table AF- 8 Kamloops Neutrality hypothesis testing S3Q8

Hypothesis Testing for KS3Q8
Date: 05/29/18 Time: 19:44
Sample: 1 382
Included observations: 373
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.876676
Sample Std. Dev. = 1.240368

Method	Value	Probability
t-statistic	-1.92023	0.0556

Table AF- 9 Kamloops Neutrality hypothesis testing S3Q9

Hypothesis Testing for KS3Q9
Date: 05/29/18 Time: 19:44
Sample: 1 382
Included observations: 372
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.946237
Sample Std. Dev. = 1.124254

Method	Value	Probability
t-statistic	-0.92235	0.3569

Table AF- 10 Kamloops Neutrality hypothesis testing S3Q10

Hypothesis Testing for KS3Q10
Date: 05/29/18 Time: 19:45
Sample: 1 382
Included observations: 372
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.615591
Sample Std. Dev. = 1.139856

Method	Value	Probability
t-statistic	-6.50451	0

Table AF- 11 Kamloops Neutrality hypothesis testing S3Q11

Hypothesis Testing for KS3Q11
Date: 05/29/18 Time: 19:45
Sample: 1 382
Included observations: 373
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.142091
Sample Std. Dev. = 0.963681

Method	Value	Probability
t-statistic	2.847661	0.0046

Table AF- 12 Kamloops Neutrality hypothesis testing S3Q12

Hypothesis Testing for KS3Q12
Date: 05/29/18 Time: 19:45
Sample: 1 382
Included observations: 375
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.189333
Sample Std. Dev. = 1.134719

Method	Value	Probability
t-statistic	3.231131	0.0013

Appendix G: Attitude Statements – Merritt Neutrality Data Tables

Table AG- 1 Merritt Neutrality hypothesis testing S3Q1

Hypothesis Testing for MS3Q1
Date: 05/29/18 Time: 19:46
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.487805
Sample Std. Dev. = 1.433910

Method	Value	Probability
t-statistic	-2.28721	0.0276

Table AG- 2 Merritt Neutrality hypothesis testing S3Q2

Hypothesis Testing for MS3Q2
Date: 05/29/18 Time: 19:47
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.853659
Sample Std. Dev. = 1.195010

Method	Value	Probability
t-statistic	4.574089	0

Table AG- 3 Merritt Neutrality hypothesis testing S3Q3

Hypothesis Testing for MS3Q3
Date: 05/29/18 Time: 19:47
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.682927
Sample Std. Dev. = 1.473754

Method	Value	Probability

t-statistic	-1.37761	0.176

Table AG- 4 Merritt Neutrality hypothesis testing S3Q4

Hypothesis Testing for MS3Q4
Date: 05/29/18 Time: 19:48
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.951220
Sample Std. Dev. = 1.139105

Method	Value	Probability
t-statistic	5.346983	0

Table AG- 5 Merritt Neutrality hypothesis testing S3Q5

Hypothesis Testing for MS3Q5
Date: 05/29/18 Time: 19:48
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.512195
Sample Std. Dev. = 1.380615

Method	Value	Probability
t-statistic	-2.26238	0.0292

Table AG- 6 Merritt Neutrality hypothesis testing S3Q6

Hypothesis Testing for MS3Q6
Date: 05/29/18 Time: 19:48
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.560976
Sample Std. Dev. = 1.225740

Method	Value	Probability
t-statistic	2.930471	0.0056

Table AG- 7 Merritt Neutrality hypothesis testing S3Q7

Hypothesis Testing for MS3Q7
Date: 05/29/18 Time: 19:49
Sample (adjusted): 1 41
Included observations: 40 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.250000
Sample Std. Dev. = 1.031553

Method	Value	Probability
t-statistic	-4.59832	0

Table AG- 8 Merritt Neutrality hypothesis testing S3Q8

Hypothesis Testing for MS3Q8
Date: 05/29/18 Time: 19:49
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.390244
Sample Std. Dev. = 1.412056

Method	Value	Probability
t-statistic	-2.76501	0.0086

Table AG- 9 Merritt Neutrality hypothesis testing S3Q9

Hypothesis Testing for MS3Q9
Date: 05/29/18 Time: 19:49
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.463415
Sample Std. Dev. = 1.206183

Method	Value	Probability
t-statistic	2.460075	0.0183

Table AG- 10 Merritt Neutrality hypothesis testing S3Q10

Hypothesis Testing for MS3Q10
Date: 05/29/18 Time: 19:49
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.560976
Sample Std. Dev. =
1.304775

Method	Value	Probability
t-statistic	2.752961	0.0088

Table AG- 11 Merritt Neutrality hypothesis testing S3Q11

Hypothesis Testing for MS3Q11
Date: 05/29/18 Time: 19:50
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 2.365854
Sample Std. Dev. =
1.042979

Method	Value	Probability
t-statistic	-3.89319	0.0004

Table AG- 12 Merritt Neutrality hypothesis testing S3Q12

Hypothesis Testing for MS3Q12
Date: 05/29/18 Time: 19:50
Sample (adjusted): 1 41
Included observations: 41 after adjustments
Test of Hypothesis: Mean = 3.000000

Sample Mean = 3.487805
Sample Std. Dev. =
1.325178

Method	Value	Probability
t-statistic	2.357023	0.0234

Appendix H: Attitude Statement – Test for Equality of Means

Table AH- 1 Test for equality of means S3Q1

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:41
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	412	6.028251	0.0000
Satterthwaite-Welch t-test*	45.36835	4.895544	0.0000
Anova F-test	(1, 412)	36.33981	0.0000
Welch F-test*	(1, 45.3684)	23.96635	0.0000

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	47.29334	47.29334
Within	412	536.1849	1.30142
Total	413	583.4783	1.41278

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q1	373	3.619303	1.104659	0.057197
MS3Q1	41	2.487805	1.43391	0.223939
All	414	3.507246	1.188604	0.058417

Table AH- 2 Test for equality of means S3Q2

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:42
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	413	0.255779	0.7982
Satterthwaite-Welch t-test*	47.53309	0.236902	0.8138
Anova F-test	(1, 413)	0.065423	0.7982
Welch F-test*	(1, 47.5331)	0.056123	0.8138

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	0.07877	0.07877
Within	413	497.261	1.204022
Total	414	497.3398	1.201304

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
MS3Q2	41	3.853659	1.19501	0.186629
KS3Q2	374	3.807487	1.086277	0.05617
All	415	3.812048	1.09604	0.053802

Table AH- 3 Test for equality of means S3Q3

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:42
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	410	6.016408	0.0000
Satterthwaite-Welch t-test*	45.21229	4.822382	0.0000
Anova F-test	(1, 410)	36.19717	0.0000
Welch F-test*	(1, 45.2123)	23.25537	0.0000

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	48.36627	48.36627
Within	410	547.8376	1.336189
Total	411	596.2039	1.450618

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q3	371	3.827493	1.116171	0.057949
MS3Q3	41	2.682927	1.473754	0.230162
All	412	3.713592	1.204416	0.059337

Table AH- 4 Test for equality of means S3Q4

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:43
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	412	-3.6379	0.0003
Satterthwaite-Welch t-test*	49.76463	-3.72017	0.0005
Anova F-test	(1, 412)	13.23433	0.0003
Welch F-test*	(1, 49.7646)	13.83963	0.0005

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	18.05952	18.05952
Within	412	562.2134	1.364596
Total	413	580.2729	1.405019

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q4	373	3.252011	1.17124	0.060645
MS3Q4	41	3.95122	1.139105	0.177898
All	414	3.321256	1.185335	0.058256

Table AH- 5 Test for equality of means S3Q5

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:43
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	411	4.22385	0.0000
Satterthwaite-Welch t-test*	44.9958	3.33441	0.0017
Anova F-test	(1, 411)	17.84091	0.0000
Welch F-test*	(1, 44.9958)	11.11829	0.0017

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	20.24971	20.24971
Within	411	466.4912	1.135015
Total	412	486.7409	1.18141

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q5	372	3.252688	1.025612	0.053175
MS3Q5	41	2.512195	1.380615	0.215616
All	413	3.179177	1.086927	0.053484

Table AH- 6 Test for equality of means S3Q6

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:44
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	411	-3.77125	0.0002
Satterthwaite-Welch t-test*	47.97959	-3.56417	0.0008
Anova F-test	(1, 411)	14.22233	0.0002
Welch F-test*	(1, 47.9796)	12.70327	0.0008

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	18.83728	18.83728
Within	411	544.3637	1.324486
Total	412	563.201	1.366993

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q6	372	2.846774	1.142497	0.059236
MS3Q6	41	3.560976	1.22574	0.191428
All	413	2.917676	1.169185	0.057532

Table AH- 7 Test for equality of means S3Q7

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:44
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	411	-0.52725	0.5983
Satterthwaite-Welch t-test*	48.36247	-0.5411	0.5909
Anova F-test	(1, 411)	0.277992	0.5983
Welch F-test*	(1, 48.3625)	0.292785	0.5909

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	0.313553	0.313553
Within	411	463.5751	1.12792
Total	412	463.8886	1.125943

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
MS3Q7	40	2.25	1.031553	0.163103
KS3Q7	373	2.343164	1.065181	0.055153
All	413	2.33414	1.061105	0.052214

Table AH- 8 Test for equality of means S3Q8

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:45
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	412	2.349985	0.0192
Satterthwaite-Welch t-test*	47.03656	2.117795	0.0395
Anova F-test	(1, 412)	5.522431	0.0192
Welch F-test*	(1, 47.0366)	4.485058	0.0395

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	8.740496	8.740496
Within	412	652.0832	1.582726
Total	413	660.8237	1.600057

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q8	373	2.876676	1.240368	0.064224
MS3Q8	41	2.390244	1.412056	0.220526
All	414	2.828502	1.264934	0.062168

Table AH- 9 Test for equality of means S3Q9

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:45
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	411	-2.7752	0.0058
Satterthwaite-Welch t-test*	47.97939	-2.62279	0.0117
Anova F-test	(1, 411)	7.70175	0.0058
Welch F-test*	(1, 47.9794)	6.879004	0.0117

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	9.877726	9.877726
Within	411	527.1199	1.28253
Total	412	536.9976	1.303392

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q9	372	2.946237	1.124254	0.05829
MS3Q9	41	3.463415	1.206183	0.188374
All	413	2.997579	1.141662	0.056178

Table AH- 10 Test for equality of means S3Q10

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:46
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	411	-4.96576	0.0000
Satterthwaite-Welch t-test*	46.97631	-4.45581	0.0001
Anova F-test	(1, 411)	24.65881	0.0000
Welch F-test*	(1, 46.9763)	19.85427	0.0001

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	33.00604	33.00604
Within	411	550.1271	1.338509
Total	412	583.1332	1.415372

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q10	372	2.615591	1.139856	0.059099
MS3Q10	41	3.560976	1.304775	0.203772
All	413	2.709443	1.189694	0.058541

Table AH- 11 Test for equality of means S3Q11

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:46
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	412	-4.8554	0.0000
Satterthwaite-Welch t-test*	47.81421	-4.55653	0.0000
Anova F-test	(1, 412)	23.57491	0.0000
Welch F-test*	(1, 47.8142)	20.76195	0.0000

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	22.25777	22.25777
Within	412	388.9814	0.94413
Total	413	411.2391	0.995736

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
MS3Q11	41	2.365854	1.042979	0.162886
KS3Q11	373	3.142091	0.963681	0.049897
All	414	3.065217	0.997866	0.049042

Table AH- 12 Test for equality of means S3Q12

Test for Equality of Means Between Series
Date: 05/16/18 Time: 19:46
Sample: 1 382
Included observations: 382

Method	df	Value	Probability
t-test	414	-1.57171	0.1168
Satterthwaite-Welch t-test*	46.63813	-1.38764	0.1718
Anova F-test	(1, 414)	2.470275	0.1168
Welch F-test*	(1, 46.6381)	1.925535	0.1718

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	3.292514	3.292514
Within	414	551.8012	1.332853
Total	415	555.0938	1.337575

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
KS3Q12	375	3.189333	1.134719	0.058597
MS3Q12	41	3.487805	1.325178	0.206958
All	416	3.21875	1.156536	0.056704

Appendix I: Willingness to Pay Data Tables

Table AI- 1 Selection Equation - Nonprotest Response, Probit Regression

Iteration 0: log likelihood = -199.14992
Iteration 1: log likelihood = -186.59898
Iteration 2: log likelihood = -186.50269
Iteration 3: log likelihood = -186.50269

Probit regression — Number of obs = 369
LR chi2(5) = 5.29
Prob > chi2 = 0.0001
Log likelihood = -186.50269 — Pseudo R2 = 0.0635

nonprotest	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
s1q1	-0.2061972	0.1556002	-1.33	0.185	-0.5111679	0.0987736
s2q1d	0.1436782	0.0645983	2.22	0.026	0.0170678	0.2702886
s1q4e	0.6051517	0.1989633	3.04	0.002	0.2151908	0.9951127
s1q4f	0.4290473	0.2328449	1.84	0.065	-0.0273202	0.8854148
s2q7	0.1517111	0.0588775	2.58	0.01	0.0363134	0.2671088
_cons	-0.2893257	0.3313582	-0.87	0.383	-0.9387757	0.3601244

Table AI- 2 Willingness to Pay Estimation - Tobit Model

Grid node 0: log likelihood = -951.50768

Fitting full model:

Iteration 0: log likelihood = -951.50768
Iteration 1: log likelihood = -919.34785
Iteration 2: log likelihood = -915.36508
Iteration 3: log likelihood = -915.29855
Iteration 4: log likelihood = -915.29846

Tobit regression — Number of obs = 259
Uncensored = 154
Limits: lower = 0 — Left-censored = 105
upper = +inf — Right-censored = 0

LR chi2(7) = 5.57
Prob > chi2 = 0.0006
Log likelihood = -915.29846 — Pseudo R2 = 0.0138

wtp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
s1q1	-9.150967	8.177462	-1.12	0.264	-25.25584	6.953909
s2q1d	13.71817	3.825005	3.59	0	6.185114	21.25122
s1q10e	18.99472	9.119074	2.08	0.038	1.035406	36.95402
s1q10d	19.55886	10.05604	1.94	0.053	-0.2457345	39.36346
s1q6a	-30.38838	13.52186	-2.25	0.025	-57.01864	-3.758121
s2q2	-3.325457	3.69352	-0.9	0.369	-10.59956	3.948643
mills	21.75434	29.10942	0.75	0.456	-35.5744	79.08308
_cons	-12.83042	30.1237	-0.43	0.671	-72.15671	46.49586
var(e.wtp)	3172.816	389.4481	2491.493	4040.453		

** mills = exp(-.5*phat^2)/(sqrt(2*_pi)*normprob(phat))*

Table AI- 3 Willingness to Pay Estimate - Variable averages for the entire sample

wtp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	5.455428	4.392204	1.24	0.215	-3.194677	14.10553

Table AI- 4 Willingness to Pay Estimate - Variable averages for the Merritt data-set

wtp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	40.2043	12.63411	3.18	0.002	15.32241	65.0862

Table AI- 5 Willingness to Pay Estimate - Variable averages for the Kamloops data-set

wtp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	10.89968	4.087764	2.67	0.008	2.849148	18.95022