How Effective are Watershed Signs Anyway? Evaluating Visual Environmental Communication in a Small Urban Watershed

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Abstract

Watershed signs are ubiquitous, but a review of recent projects shows most does not have objectives, expected outcomes, or indicators of success or failure. Evaluation outcomes for sign projects are not available, so measurable changes in knowledge, attitude or behavior among target audiences remain largely unknown. A comparison of pre and post sign responses in a rapid and limited survey of pedestrians in a small impaired urban watershed in Burlington, VT, showed no significant differences among respondents in knowledge of the watershed, attitude towards water quality or taking action (seeking additional information about water quality). The lack of significant outcomes suggests that) watershed sign projects may be less effective than anticipated, b) they may be more effective as part of broader water quality outreach efforts, and c) watershed sign projects must be evaluated to determine their effectiveness.

Key Terms: best management practices, education, public participation, restoration

1.0.Introduction

Signs identifying watershed boundaries are commonly seen. Often accompanied by a message about watershed or water quality protection, such signs are found in nearly every state in the US and in many Canadian Provinces. While there are guides on how to develop a signage project (e.g. Hill and Taylor 2007), there is no readily accessible information available on the effectiveness of watershed sign projects in either the peer reviewed or the grey literature. What information is available is found primarily on the internet. This lack of published measurable outcomes or impacts for such a visible education and outreach effort is a serious concern.

Many watershed sign projects are used to satisfy regulatory requirements. Municipal Separate Storm Sewer System (MS4) permits require outreach and education programs (USEPA 2010a). Watershed plans funded with section 319 funds and Total Maximum Daily Load (TMDL) plans for impaired waterways also require public information/education as part of the water quality improvement process (Lunsford and Mueller 2003, USEPA 2013). The implicit point is that these programs have to be effective. Expending funds for watershed sign programs needs to be justified by demonstrating that there are measurable education outcomes that contribute to improving water quality or reducing storm water impacts. In some cases, public access rules require watershed signs for public education about a watershed (e.g. California Coastal Conservancy 2003). These should also be able to demonstrate that they effective and meet funding source public awareness goals.

Costs for watershed signs may run between $200and $500 for smaller signs (e.g. Hill and Taylor 2007, Kentucky River Watershed Watch 2005), while larger interstate size signs averaged about $3,500 (Tennessee DOT 2012). The Russian River signs project budgeted $60,000 for signs at 8 access points, about $7,500 per sign (California Coastal Conservancy 2003). Without a demonstration of the benefits gained from a watershed sign project, it is difficult to refute critics who label such spending wasteful in an era of tight state and local budgets (e.g. Allen 2004, Beasley 2008).

A watershed sign program can be a standalone program or a component of a larger watershed education or stewardship program. And, while common, most also share common failings. A review of watershed sign projects posted on the internet show that most do not have identified objectives for the sign effort, nor any specific sign- associated outcomes or indicators of success or failure. Instead they are to contribute in unspecified ways to the goals of the larger watershed education or stewardship program. Where objectives are identified, they are generic, subjective, and difficult to quantify and evaluate.

Neither the formal literature nor the informal reports or online information provided any information of evaluation of outcomes, of watershed signage programs, measured as change in awareness/knowledge, attitude or behavior. While a number of watershed sign projects were included in larger education and stewardship projects that were evaluated, I found no instance of an evaluation of the impact of a watershed sign project on education and stewardship outcomes. This project provides an evaluation of watershed sign effectiveness in changing public awareness, attitude and behavior among pedestrians in a small urban watershed in Burlington, VT.

Englesby Brook is an impaired stream draining a small (2.43 km²) urban watershed in Vermont that drains directly to Lake Champlain (Fig1). The watershed is 96% developed, primarily as residential (56%) and commercial/institutional/industrial (23%) land use (Roy 2012). The high proportion of impervious cover, estimated at 24% (Center for Watershed Protection 2001, cited by Roy 2012) produces excess storm water runoff leading to stream channelization, high runoff flows, low base flows, stream bank erosion, urban debris, and pollution. Englesby Brook is listed as impaired, with total TMDL established for storm water pollutants (VT DEC 2007a) and bacteria (VT DEC 2011).

A long term project to restore Englesby Brook and improve water quality is underway with education and outreach components as specific Best Management Practices (BMP) (USGS 2007, Roy 2012). The restoration project BMP, the TMDL plans for the brook, and the city's MS4 storm sewer system permit all require public awareness and engagement activities. The watershed sign project that is the subject of this research is part of the outreach and education effort. With its relatively small watershed and an urban location with significant pedestrian traffic, this project provided an opportunity to monitor and evaluate the impact of watershed signs on public awareness, attitude and behavior. Because northwestern Vermont has a number of small, urban impaired watersheds that use or propose to use watershed signs as part of their public education efforts, this research provides an opportunity to evaluate the public education impact of watershed signs in the region.

2.0. Methods

Participation by communities, watershed groups, and other stakeholders is essential to meet water quality standards in the brook. As part of their sustainability curriculum, students at a local elementary school designed signs for the watershed. In June 2008 Burlington DPW staff placed the signs, printed on PVC stock, at 15 locations on the watershed boundary (Figure 3), where streets or foot paths crossed. DPW staff used existing traffic information sign poles for the watershed signs.

2.1. Pedestrian Survey. Because resources for the survey were very limited, the survey design and analysis was kept as simple and as low cost as possible, yet still able to produce statistically significant results.

I developed a simple survey of four questions for the pre-sign survey (Table 1). The interview questions were selected to be short, easily understood, and could be answered by yes/no responses. The questions were used to establish baseline levels of knowledge of the watershed (questions 1 and 2), attitude towards local water quality (question 3) and taking action (question 4) that could contribute to improved water quality. For Question 2, if someone said "yes", they could name the stream, they were asked to name it so their knowledge could be verified. The post-sign survey included the same four questions plus a question about the impact of the sign itself. In addition, respondents were provided an opportunity (check box) to self-identify if they had participated in the pre-sign survey.

Teams of two undergraduate students conducted 16 pedestrian interviews, eight pre-sign interviews in the Maythrough June period, before the signs went up, and eight post-sign, from July through August. The eight pre-sign interview locations were randomly selected from among the 15 available sign locations along the watershed boundary (Figure 2). For the post sign interviews another set of eight sites were randomly selected from the 15site pool using a random number generator.

Interviews were held once a week, during the work week (Mon- Fri), either in the morning (07:30to 09:30 AM) or the afternoon (16:30to 18:30 PM). As with the pre and post-sign interview locations, day of the week for the weekly interviews, and the AM or PM interview times were randomly selected. The target was to fill in a minimum of 20 and a maximum of 30 interviews per interview session. The interview sessions ended when either 30 questionnaires were completed, or when the interview period ended.

2.2. Statistical analysis. I used a two tailed Z Test for 2 population proportions, with p=.05(Zar 1974) to determine if there were significant differences in responses between pre and post-sign surveys.

The null hypothesis is that, for a given question in the survey, there is no difference between the proportion of individuals who answer yes in the pre-sign surveys and the proportion of those who answer yes in the post-sign surveys.

H_0: p_1-p_2 = 0

Wherep_1 is the proportion of Yes answers in the pre-sign interviews and p_2 the proportion of Yes answers in the post-sign interviews. This is a robust test (Zar 1974), so the inclusion of 4 individuals who, by chance, participated in both pre- and post-sign surveys was not sufficient to violate the assumption of independence of the sampled populations.

3.0 Results

3.1. A summary of responses from pre sign (n=173) and post-sign (n=180) interviews is shown in Table 1. The results of the pre-sign survey (Figure 3) provide a baseline against which any impact of a watershed signs project would be measured. About 2 out of 3 respondents were not aware that they were in a watershed. Not surprisingly, only 8 percent could name the nearby brook. However, nearly 3 out of 4 respondents indicated a broad concern for water quality, but only a few (14%) made an effort to seek out additional water quality information.

The results of the post-sign interviews are shown in Figure4.

3.2. Comparisons of pre and post sign responses to Questions 1- 4 showed that the proportion of positive responses (Yes answers) increased for each of the four questions in post-sign interviews. However, the differences were not statistically significant for any of the four comparisons.

For Questions 1 (Do you live in a watershed?), the proportion of Yes answers increased from 0.364 in the pre-sign survey to 0.444 post sign. The difference was not statistically significant at $p < 0.05$ ($p = 0.12356$).
For Question 2 (Do you know the name of the nearest brook?) the proportion of Yes responses increased from 0.081 to 0.122 between pre- and post-surveys. The difference was not statistically significant at $p < 0.05$ ($p=0.20054$)

For Question 3 (Are you concerned about water quality?) the proportion of Yes responses increased from 0.763to 0.783between pre- and post-sign surveys. The difference was not statistically significant at $p < 0.05$ ($p=0.64552$).
For Question 4 (Have you recently looked for more information about local water quality?) the proportion of Yes responses increased from pre to post sign surveys, from 0.139 to 0.178. The result is not significant at $p < 0.05$ ($p= 0.31732$).

The watershed signs were noticed by just under half of the respondents; with 46.1% answering Yes to Question 5 in the post-sign survey (Are you aware of the watershed signs?)

4.0. Discussion

4.1. Based on an overview of published information on project websites, watershed sign projects are implemented to achieve one or more of three broad education or stewardship objectives: to increase public awareness of the resource, to promote a change in attitude among the public, and promote changes in behavior that will contribute to protection and restoration of the watershed, local water quality and/or aquatic resources within the watershed. For example, objectives of a statewide watershed sign program (Tennessee DOT 2012) were to increase public awareness of watersheds, to have the audience recognize the importance of watersheds, and encourage good stewardship.

Proxy indicators of increased knowledge of a watershed cited by watershed sign projects include increased knowledge by the public of the watershed name, to watershed outline or boundary, or relative location (Fight et al 2000). Indicators of changing attitudes and perceptions include increased personal connection to a watershed, the ability to identify threats or concerns in a watershed, or an increased concern for the protection of the values and benefits a watershed provides (Fight et al. 2000, USEPA 2010a, 2012). Indicators of behavior change include having individuals seek out additional information on the watershed or resource, increase involvement in protection activities, and participation in local level decision-making (USEPA 2012).

4.2. The results of this study show that, for the Englesby Brook restoration, the watershed signage project did not demonstrably achieve any of the education or stewardship objectives identified in the restoration project description, the MS4 permit or in the TMDL plan. I did not find a statistically significant increase in public awareness of the resource (Questions 1 and 2), a change in attitude among the public (Question 3),or changes in behavior that would contribute to watershed protection and restoration (Question 4).

4.3. There are limitations to the project and to the study that may have affected the education outcomes and my ability to detect them. This was a small scale study, with less than 200 respondents in each of the pre- and post-sign surveys. The study was also limited to pedestrians, the only segment of the broader road using public it was possible to stop and interview. In addition, the signs themselves may have influenced the results. The design, messaging and placement of environmental signs are highly sophisticated activities. The signs used in this project were not professionally designed. They were relatively plain, two-color (cost limited to blue lines on white background) and designed by school children. They were also small (21.6 x 27.9 cm) because the sign project specifically targeted pedestrians, and they had to fit onto city maintained parking control sign posts. All of these factors may have affected how passersby perceived the signs and how they responded to them, potentially limiting the educational impact of the signs.

4.4. There was a consistent trend of increased positive responses when comparing pre- and post-sign surveys, suggesting that there was a limited (but not statistically significant) impact of the signs on pedestrian knowledge and attitude towards their local watershed. Professionally developed signs that follow recommendations of environmental graphic design criteria could potentially strengthen this trend and significantly increase the educational impact of the signs.

About 3 of 4 respondents answered Yes to Question 3 *are you concerned about water quality?* This was the only question where yes responses exceeded No responses, suggesting that a broader and longer term message about the importance of water quality have had an impact. Residents of the study area have been exposed to numerous public awareness and education efforts to increase support for water quality improvement for a long period. Numerous outreach efforts, since the early 1990's by volunteer organizations, municipalities, university Extension, and state and federal agencies have had a cumulative significant impact on public awareness and concern for water quality in Vermont and in the Lake Champlain basin (Eisenhauer et al. 2010). This positive impact of a separate long term water quality education effort, although hypothetical, suggests that watershed sign projects can benefit from being part of broader water quality awareness efforts that utilize a range of outreach and education methods (Fight et al 2000), rather than as standalone activities.

4.5. On a local scale, the Englesby watershed sign project, as implemented, is not meeting the public outreach and engagement objectives of the Englesby Brook restoration project (USGS 2007, Roy 2012), nor the objectives of the TMDL plan nor the City of Burlington's MS4 permits (VT DEC 2007a, USEPA 2010b, Vermont DEC 2011).This lack of impact has implications for other urban impaired waterways in Vermont that use watershed signs as part of their required outreach and education activities. These include Centennial Brook(VT DEC2007b) and Potash Brook (VT DEC 2011b) in Chittenden Co. , and Stevens Brook in Franklin Co.(VT DEC 2008).At a minimum, such projects need to ensure that watershed signs projects are integrated into a broader public outreach programs, and that all outreach and education activities are evaluated for outcomes and effectiveness.

5.0. Conclusions

Urban-related runoff/storm water is a common source of impairment of small, urban watersheds in urban and suburban areas of the US, especially in the Northeast and New England (USEPA 2010c). Many impaired waterways are bordered by greenways with pedestrian walkways and bike paths, and are marked by waterway or watershed signs, often as part of the public education effort to improve water quality.

These results suggest that watershed sign projects in small unban watersheds may be expanding without a clear understanding of their effectiveness, and that a critical review of a larger number of project is needed. Watershed sign projects must be reviewed to ensure that they have clear objectives and defined expected outcomes, that they are integrated into broader water quality outreach programs, and that evaluation plans are in place to determine if they meet the public outreach and engagement objectives required by restoration plans, TMDL plans or MS4 permits.

6.0. Acknowledgements

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Table 1: Interview Questions and Responses from Pre and Post Sign Interviews. There Were Eight Weekly Pre Sign Surveys of (N=173), and Eight Weekly Post Sign Interviews (N=180)

QUESTIONS	RESPONSES			
	Pre-Sign		Post-Sign	
	No	Yes	No	Yes
Q1: Do you live in a watershed?	110	63	80	100
Q2: Do you know the name of the nearest brook?	159	14	138	42
Q3: Are you concerned about water quality?	41	132	39	141
Q4: Have you recently looked for more information about local water quality?	149	24	148	32
Q5 (post only): Are you aware of the watershed signs?			153	27

Figure 2: Englesby Brook Burlington and South Burlington, Vermont (US EPA 2007). Lake Champlain is on the left

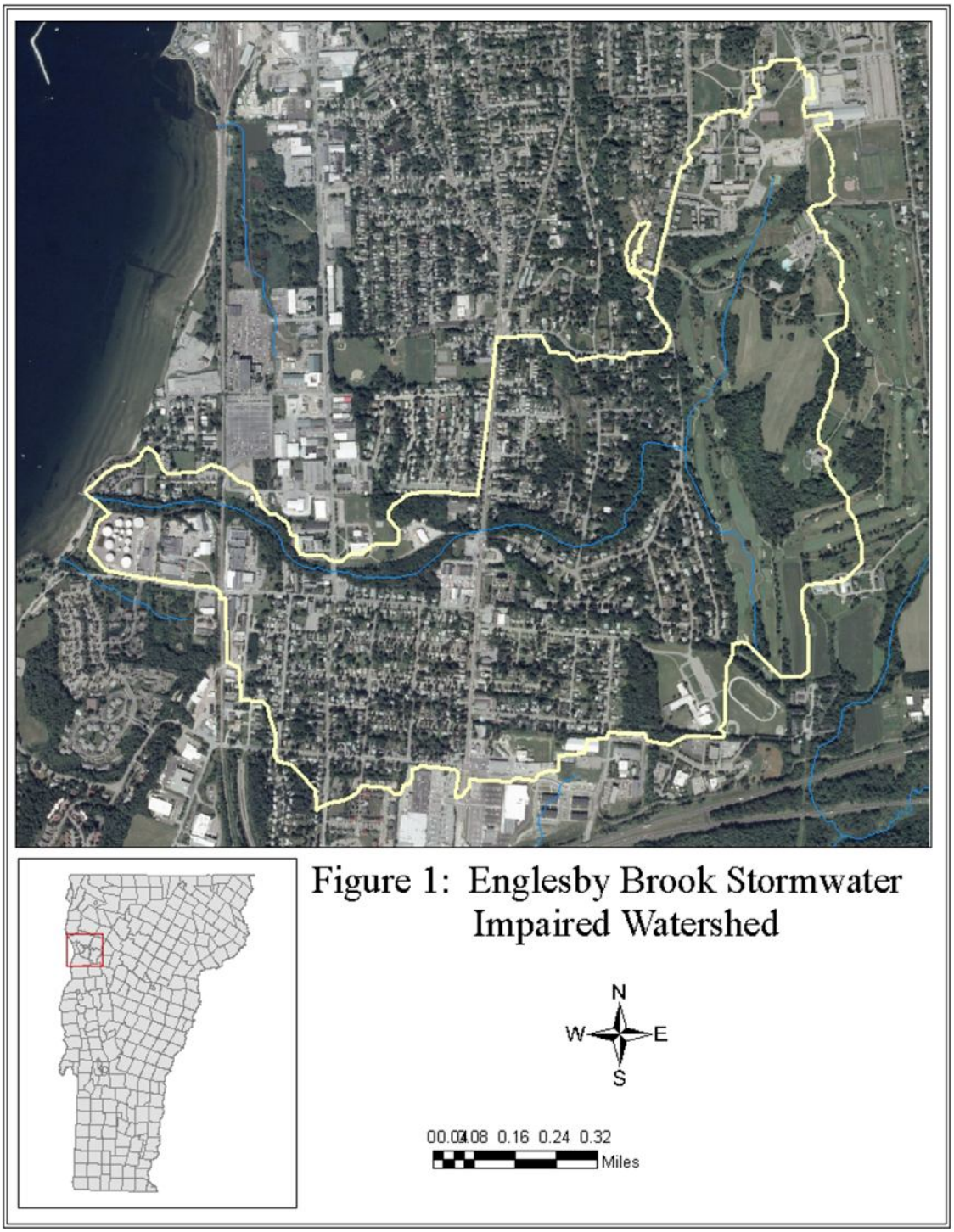

Figure 3: Locations of Watershed Signs, the Sites of the Pedestrian Interviews (Map: USGS 2007)

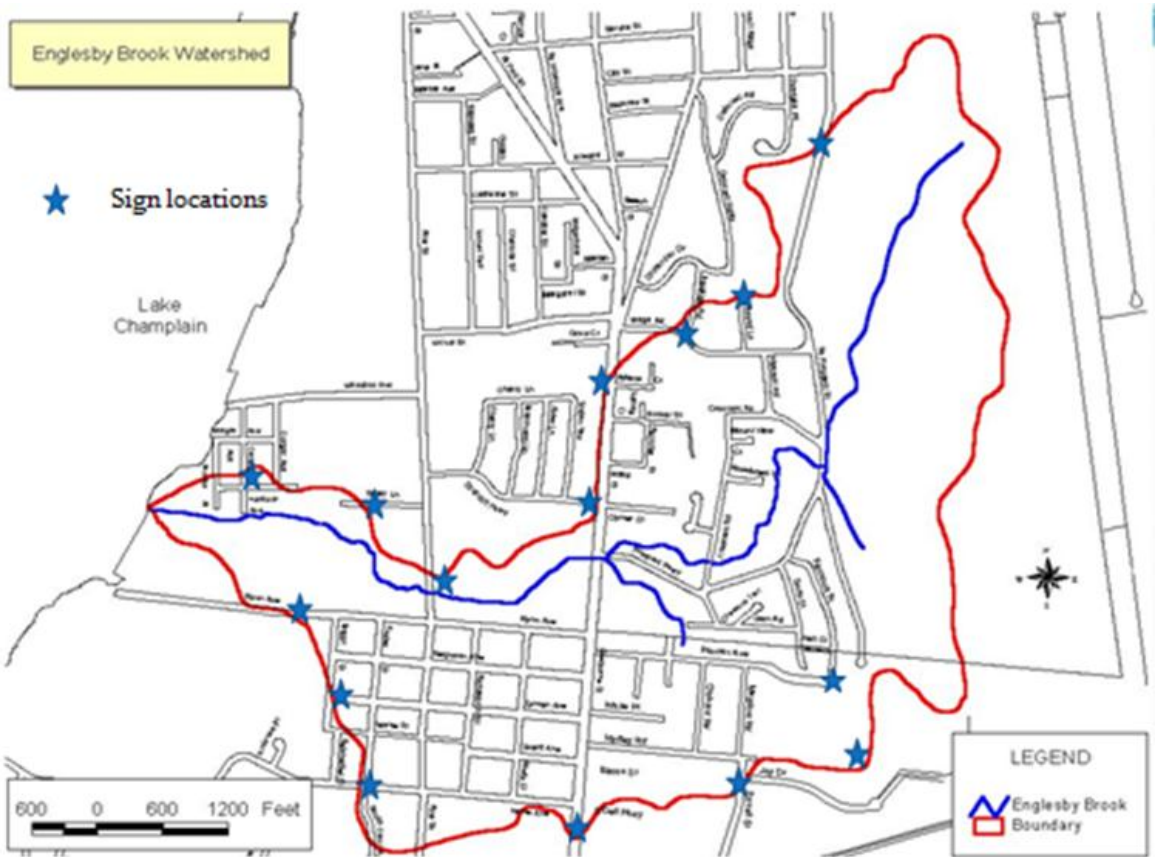

Figure 3: Responses to Four Question Pre-sign Interviews Responses (n=173)

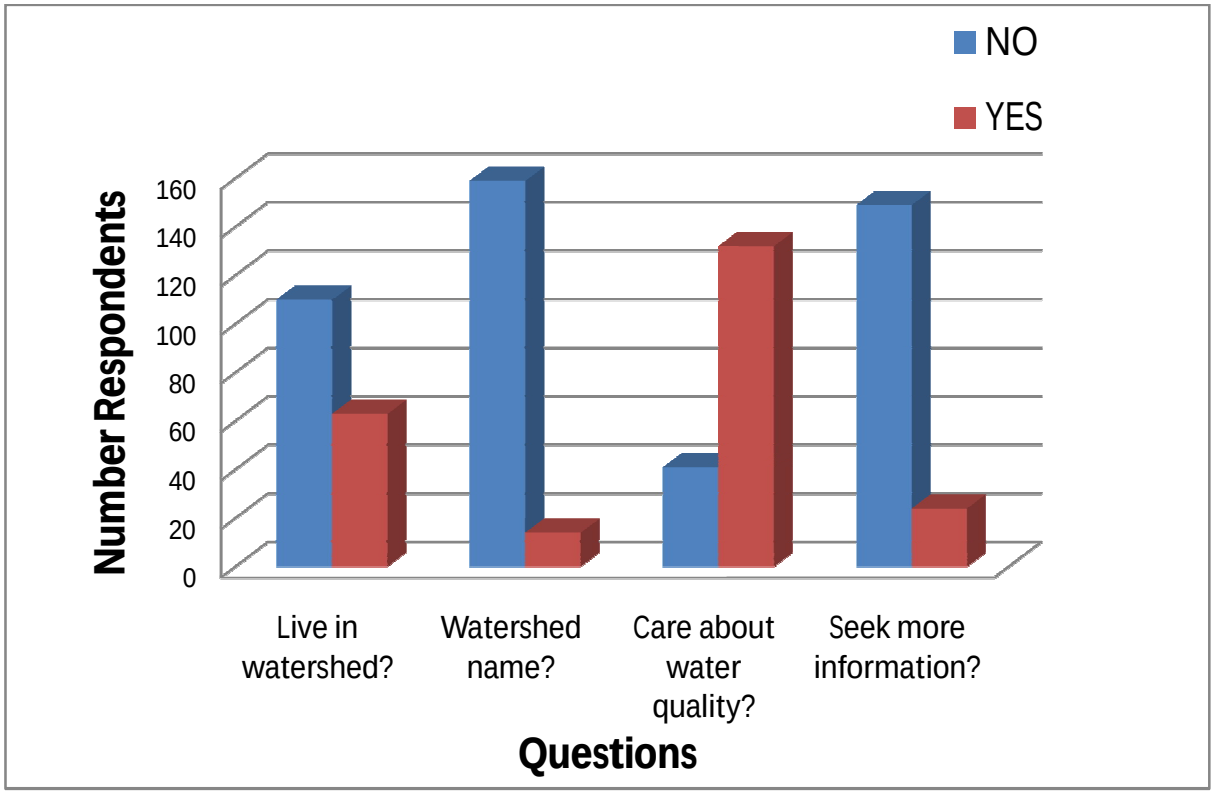

Figure 4: Post-sign Interview Responses