BENTON COUNTY HEALTH IMPACT ASSESSMENT: ROUNDABOUTS

By Benton County Health Department, Health Promotions Division

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Executive Summary

Installation of a roundabout at the intersection of 53rd and West Hills Road has been a topic of debate among Benton County planners, residents, and elected officials in recent years. As the intersection currently stands, it is unsafe and in need of a traffic calming measure. Benton County Public Works has been investigating the feasibility of installing a roundabout at this intersection over a signalized intersection. A Health Impact Assessment was completed by the Benton County Health Department to identify possible health impacts of installation of a roundabout at 53rd and West Hills and to assess potential policy options.

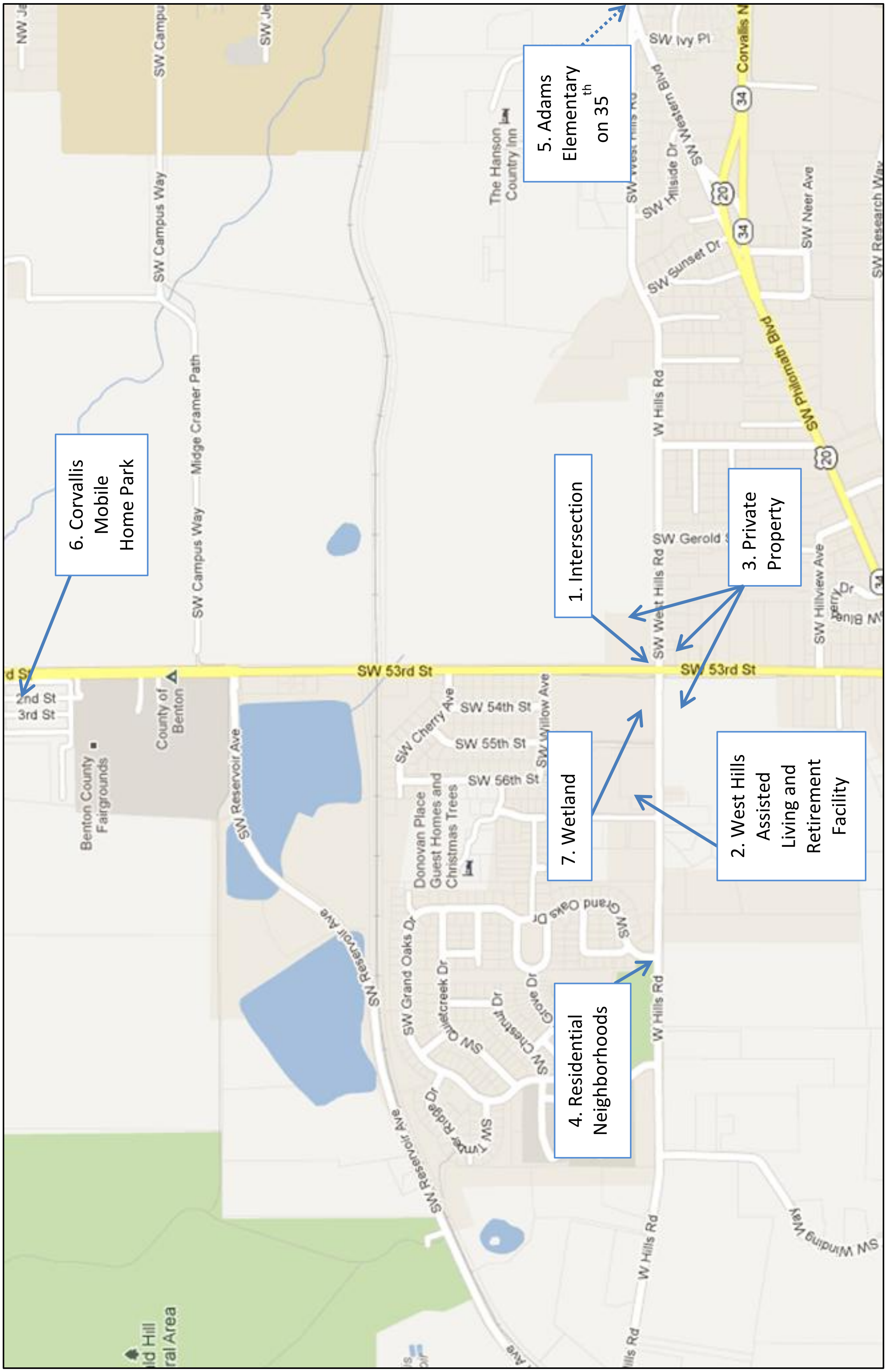
A literature review on the potential positive and negative health impacts of roundabouts was conducted, guided by concerns raised by residents of the County. Through consolidation of the material, we generated a list of broad health impacts including impacts on safety, the environment, and quality of life.

Overall, the health impact of roundabouts on safety is positive. The impact of the modern roundabout on safety is broken down into safety for motorists, pedestrians, and bicyclists. The safety of motorists dramatically increases when a signalized intersection or two-way stop is replaced with a modern roundabout. When converting a traditional, signalized intersection to a modern roundabout, there is a 48% reduction in all crashes and a 78% reduction in severe crashes, including those that cause injury or death. When converting a two-way stop to a modern roundabout, as would be the case at the intersection of 53rd and West Hills, there is a 44% crash reduction overall and an 82% reduction in severe crashes. The safety of pedestrians and bicyclists also increases though less so than for motorists. For these two user groups, the health impact greatly relies upon the individual design of the roundabout. Looking at vulnerable populations does yield mixed results, as roundabouts are significantly harder for visually-impaired pedestrians to navigate. In general, however, a single-lane roundabout is the safest intersection treatment for an at-grade intersection, providing the safest opportunity for travel for all users.

The impact of the modern roundabout on the environment can have many implications on health. In general, research shows that there are 20-30% less toxic emissions and 20-30% less greenhouse gases at roundabouts in comparison to traditional signalized intersections. Reducing air pollution levels can help reduce the burden of disease, since as chronic exposure to airborne particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as lung cancer. The burden of air pollution is often not equitably shared. Poorer individuals, children, the elderly, and some racial and ethnic groups tend to carry more of the burden by facing higher exposure to pollutants. Policy and planning decisions that reduce area-wide sources of air pollution will benefit the health of all community members, including these vulnerable groups.

Finally, the impact of the modern roundabout on quality of life and livability of an area may also be significant, thought there are very few research studies that examine these outcomes. Roundabouts can potentially improve quality of life and decrease stress by reducing human fatalities and injuries, decreasing economic costs by reducing accident rates and lowering fuel consumption. In addition, installing a roundabout and improving the walkability of an area can ultimately result in lower rates of disease and health care costs. Roundabouts can also improve the livability of an area through increased aesthetics of the intersection by way of more landscaping and less noise pollution, congestion, and delay.

Based on the literature review and a review of the comments received by residents and community groups, we recommend that a single-lane roundabout be installed at the intersection of 53rd and West Hills Road. We believe that this will have a positive impact on the health of nearby residents and people traveling through. Special consideration and attention need to be given to the specific design of the intersection, as certain features will be essential in order to mitigate potentially negative impacts and maximize the positive impacts on health for all users. In addition, many of the conclusions reached by this report regarding the safety and benefits of single-lane roundabouts are not true for dual or multi-lane roundabouts. If the County decides to install a single-lane roundabout now, and in the future decides to expand the roundabout to a multi-lane design, many of the recommendations of this report will change, and a follow-up Health Impact Assessment will be needed to evaluate the safety and health impacts of a multi-lane design.


1. Intersection
2. West Hills Assisted Living and Retirement Facility
3. Private Property
4. Residential Neighborhoods
5. Adams Elementary on 35th
6. Corvallis Mobile Home Park
7. Wetland
SW 53rd St
SW West Hills Rd
W Hills Rd
SW Philomath Blvd
SW Reservoir Ave
SW Campus Way
Midge Cramer Path
Benton County Fairgrounds
SW Grand Oaks Dr
Donovan Place Guest Homes and Christmas Trees
The Hanson Country Inn
SW Western Blvd
SW Sunset Dr
SW Hillside Dr
SW Neer Ave
SW Hillview Ave
SW Ivy Pl
SW Winding Way
SW Cherry Ave
SW Willow Ave
SW 54th St
SW 55th St
SW 56th St
SW Chestnut Dr
SW Quietcreek Dr
SW Timber Ridge Dr

Chapter 1: Introduction

Project Background

This Health Impact Assessment, conducted by the Benton County Health Department, analyzes the potential health impacts of installing a new roundabout intersection at the corners of 53rd Street and West Hills Road in Corvallis. Benton County currently has plans to install a traditional traffic signal at the intersection; however the Benton County Public Works department is interested in installing a roundabout intersection instead. The Public Works department has conducted a number of studies looking at cost, traffic flow and safety, public interest, and fuel consumption with the conclusion that installing a roundabout intersection instead of a traditional traffic signal is favorable.

Despite the recommendations of Public Works staff, the Benton County Board of Commissioners recently indicated that they would like more information and public input before making a decision on how to design the intersection. The goal of this project is to provide more information, specifically regarding the projected health impacts of installing a roundabout intersection, to aid the Board of Commissioners in their decision. In addition, this project takes into account public comments on this issue, gathering input on how the installation of a roundabout intersection at the corners of 53rd Street and West Hills Road will impact the health of Benton County and City of Corvallis residents.

Proposal

This Health Impact Assessment (HIA) informs the Benton County Board of Commissioners' decision on whether or not to authorize the construction of a roundabout intersection at the corner of 53rd and West Hills Road in Corvallis. The Commissioners plan to make a decision on the construction of the intersection in the summer of 2012. The results of this HIA study will be presented to the Benton County Board of Commissioners before they make their final decision on the roundabout project.

Also, the HIA's recommendations have the opportunity to affect the final design of the new intersection. Regardless of whether the Commissioners decide to construct the new intersection as a roundabout or a stoplight, this project will recommend measures to promote the health and wellness of Benton County residents, with mitigation recommendations as appropriate. After the Commissioners make their decision, Health Department staff will work with Public Works staff to design an intersection that will best promote health.

Key Stakeholders

The *Benton County Board of Commissioners* will make a decision on how best to design the intersection at 53rd and West Hills Rd by Summer 2012. They are looking to make a decision that will offer the best option for neighborhood residents driving through the intersection and

local landowners while pushing forward County goals regarding sustainability and health and safety. Two other key government stakeholders in this process are the *City of Corvallis* and *CAMPO – the Corvallis Area Metro Planning Organization*. The intersection of 53rd and West Hills Rd sits on County land adjacent to City of Corvallis property and CAMPO seeks to create a long-term sustainable vision for the Corvallis metro area, which includes many areas of Benton County, as growth continues in the decades ahead. The county's decision on the 53rd and West Hills intersection will affect residents in all three jurisdictions, which represent distinct populations and have separate transportation plans.

In addition to the governmental stakeholders, many *local landowners and neighborhood residents* have an interest in how the County decides to move forward with the intersection. The land that would be used to construct a roundabout is owned by 4 individual landowners who would need to offer their land to the County for construction. With the construction of a new subdivision on West Hills Rd., the intersection is currently seeing more traffic than ever before. Thus, many of the main stakeholders in this decision will be the residents of Benton County who use the intersection each day for commuting, recreating, and exercising. High attendance at recent neighborhood meetings about the intersection is evidence of this project's importance to neighbors located along both West Hills Rd and 53rd St.

Methodology

HIA Objectives and Research Questions

The objective of this HIA is to identify and measure the possible health impacts of installing a roundabout at the intersection of 53rd and West Hills in Benton County. The following research questions guided this health assessment and identified areas of focus:

- In general, what are the potential impacts of roundabout intersections on health?
- How does the installation of a roundabout compare to other intersection options when measuring for health?
- What roundabout policy options can be adopted in Benton County?
- What are the specific impacts of these policy options on current health levels?
- What mitigations are available to minimize any negative health impacts associated with proposed policy options?
- Which, if any, is the policy option that would have the most benefit to health?

The Health Impact Assessment Approach

There are many different types and applications of health impact assessments; however, they are generally defined as a set of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population and the distribution of those effects within the population. HIAs are completed before a project, plan, or policy has been approved. They are intended to assist decision makers in determining the option that would most benefit public health while still meeting needed community development and land use goals.

HIAs provide health promoting mitigations and recommendations to minimize the negative effects of land use decisions on public health. HIAs also look at how projects and policies affect certain disadvantaged populations and identify potential social inequities in existing conditions and proposed alternatives. The HIA framework recognizes that there are many considerations that go into decision-making aside from health impacts.

The potential impacts identified by the HIA are based on evidence collected from a variety of resources including peer-reviewed literature, professional expertise, and accepted best practices. Community participation is also a major component of the process and the public should be involved in all aspects from identifying the problem to evaluating the project. Community members are seen as key stakeholders in public health and invaluable resources for guidance and local knowledge.

There are five steps to the HIA process: screening, scoping, analysis, communication, and evaluation. The application of each step in this project is discussed below.

Step One: Screening

The screening process involves determining if a HIA is feasible, timely, or would contribute to the decision making process. During this stage, stakeholders determined that an HIA on the installation of a roundabout at 53rd and West Hills would provide important health-based findings to aid in the final decision on the intersection by the Benton County Board of Commissioners. The timeframe for this decision coincided with the availability of grant funding from the Oregon Health Authority to conduct an HIA, The installation of a roundabout has been a controversial topic of discussion among key stakeholders over the past several years. Our goal is to provide an unbiased analysis of the impacts this decision will have on the overall health of the community.

Step Two: Scoping

Scoping involves creating a plan and timeline for conducting a HIA that defines priority issues, research questions and methods, and participant roles. During this step, stakeholders identified the following focus areas for this assessment: safety and design, environmental effects, and quality of life and livability. Research questions were also developed during scoping based on concerns and issues raised by staff, stakeholders, and community members.

Step Three: Analysis

There are three parts of the analysis step. The first is to develop a profile of existing community health levels that will serve as a baseline from which to predict change. The second part involves evaluating potential health impacts using qualitative and quantitative assessment and determining the magnitude of those impacts. In the third step, evidence-based recommendations are developed to improve the project or policy and minimize any negative effects on health.

For this HIA, general population data was collected from the Benton County Health Status Report in order to establish a baseline health level for Benton County residents. In addition, analysis of the immediate population surrounding the intersection of 53rd and West Hills was conducted to identify any vulnerable populations that may be disproportionately impacted.

Step Four: Communication

Communication involves reporting the findings and recommendations of the HIA to the public and decision makers. Reporting styles vary based on the HIA's purpose and intended audience. Usually, HIAs are presented in a written report and accompanied by a visual presentation or PowerPoint. Including the findings in newspapers or on agency websites are also ways of informing the public of the completed process.

Step Five: Evaluation

The last step of the HIA process is evaluation and monitoring the HIA's influence on the decision making process. This step assesses the incorporation of recommendations and proposed mitigations into the adopted plan or policy. Evaluation may include the successes and shortfalls of the HIA process itself and potential uses of HIA in the future.

Assessment Limitations

Several limitations may affect the validity and applicability of this assessment. We addressed these limitations where possible in the report, and included this information in order to fully inform decision makers of the restrictions of this document. Limitations include:

- Lack of current data for the demographics of the immediate community near the intersection of 53rd and West Hills.
- Due to the limited timeframe in which this assessment was conducted, we were unable to conduct specific outreach activities to gather community input. Instead, we utilized minutes and notes from previous public meetings held by the Benton County Public Works Department.
- Lack of literature on the health impacts of roundabouts outside of well-established safety implications (e.g., air quality, quality of life)

- Dependence on qualitative data from literature reviews, conversations with stakeholders, and community meetings.

Community Input

We analyzed minutes and notes taken at public meetings held by the Benton County Public Works Department from the Fall of 2009 to present to identify community issues, questions and concerns about the proposed roundabout. This report draws heavily on the testimony, ideas, and concerns brought up at these meetings by community residents and seeks, as much as possible, to address concerns and provide feedback to Public Works on how to best design an intersection to meet community needs.

Benton County Public Works held several community meetings to discuss the roundabout in at the intersection of 53rd and West Hills throughout the last 2 years. The meeting in February 2010 revealed legitimate concerns that residents had with the proposed intersection. In light of these concerns, Public Works took a step back from their plans and sought more community input before proceeding.

At a May 2012 meeting, representatives from Public Works and Kittelson & Associates presented information on the proposed design of the intersection while the Health Department presented preliminary findings of the HIA. Residents opposed to the roundabout were upset over the perceived threats to safety, the high costs of the project, and the impact to adjacent property owners.

> *"I dispute your safety arguments (regarding the increased safety benefits of a roundabout). I live out there. I dispute your statistics."*

Residents who were in favor of the roundabout supported the data showing its improved safety.

> *"The roundabout will save a life. It's not to be feared."*

Other residents voiced their opinion that regardless of whether or not the intersection was designed as a roundabout, the intersection as it currently stands is unsafe. One resident stated she was "happy something is going to happen," whatever that something may be.

Chapter 2: Baseline Conditions

The intersection at West Hills and 53rd is located on the western edge of where City of Corvallis and Benton County land meet. It has the look and feel of a rural area. Residents living in the vicinity are placed far away, out of walking distance, from most goods and services and the intersection is located in a largely car-dependent area. Local residents who might be disproportionately impacted by the design of the intersection include:

- the **elderly** from West Hills Assisted Living and Retirement Facility located at the Northwest corner of West Hills and 53rd;
- **children** and parents riding to and from Adams Elementary located approximately 1 mile from the intersection; residents living on West Hills Rd and 53rd St adjacent to the intersection;
- neighborhood residents of Grand Oaks, a large new subdivision located ½ mile west of the intersection that includes a large number of retired and elderly residents;
- residents of the Corvallis Mobile Home Park located ½ mile north of the intersection; and
- **visually-impaired individuals**.

Population Health Vulnerabilities

The 2012 Robert Wood Johnson Foundation County Health Rankings Report names Benton as the healthiest of 36 counties in Oregon. Social and economic factors, health behaviors, access to primary care, and the physical/built environment all play a role in these rankings. Despite the many community assets and natural amenities in Benton County, not all populations have equal access to fresh, healthy foods, safe, affordable recreational opportunities, and tobacco cessation services. Benton County's high overall raking is heavily influenced by affluent majority populations in Corvallis. In contrast, low-income families, persons living with mental health challenges, older adults, and rural residents are disproportionately bearing the burden of chronic disease for the county.

Among Benton County adults, 56% are overweight or obese, with 64% of adults meeting the CDC recommendations for physical activity. Among Benton County youth, 12% of 8th graders are at risk for overweight, and 8% are classified as overweight. Only 54% of 8th graders meet current CDC physical activity recommendations. Benton County 8th and 11th graders participate less in daily physical education (49% and 6% respectively) than the rest of Oregon (55% and 19% respectively). One strategy to encourage physical activity among adults and children is to improve the walkability and bikability of transportation infrastructure in Benton County.

Chapter 3: Issues and Impacts

As it currently stands, the intersection at 53rd and West Hills is unsafe and is in need of traffic calming measures that make the streets safer for all users. We assessed the impact of a roundabout design on the safety of motorists, pedestrians, and bicyclists. We also assessed the potential impacts on air quality, quality of life and livability.

Potential Impacts on Health

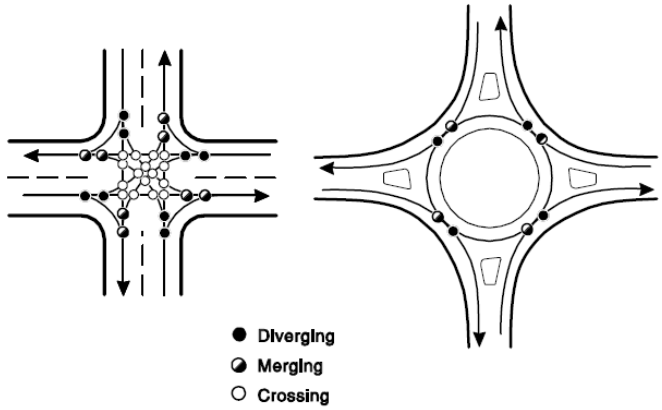
Safety

Motorists

In order to assess the safety of motorists before and after installation of a roundabout, we evaluated data and information from presentations and reports from the 2008 and 2011 National Roundabout Conferences, the AARP's resource database, the U.S. American Journal of Public Health, the NCHRP Report 672, Roundabout USA, and Benton County Public Works. Our research was guided by concerns raised by community members at several Open House events.

An estimated one-third of intersection fatalities occur at signalized intersections each year, resulting in approximately 2,300 deaths. In addition, about 700 people are killed annually in red-light running collisions.[1] The greatest effect that a roundabout will have on the safety of motorists is to decrease the overall number of crashes, with the greatest reductions in fatal and injurious crashes. Studies show a 35% reduction in total crashes, a 76% reduction in injuries, and a 90% reduction in fatalities when a traditional intersection is replaced with a modern roundabout.[2] These benefits are due to the overall slower speeds of travel within a roundabout and a reduced number of conflict points between vehicles, from 32 at a traditional intersection to 8 at a roundabout.[3] Roundabouts are designed to force motorists to travel at slower speeds of approximately 15-20 miles per hour, which allows for safer merges into circulating traffic. The slower speeds also allow motorists more time to make decisions and correct their mistakes, which has particular benefits for elderly drivers.

In combination with the reduced speeds that vehicles travel, the reduction in the number of conflict points from 32 to 8 is essential to the safety of the roundabout. With fewer conflict points, shown below in the figure from the NCHRP Report 672, there is a reduction in crash severity as left turn, head on, and right-angle collisions are nearly eliminated.[4]



The U.S. Department of Transportation's Federal Highway Administration has developed a Toolbox of Countermeasures that provides estimates of the expected crash reductions from implementing specific countermeasures in place of traditional intersections. The available data indicate that converting a two-way stop to a roundabout, similar to the change proposed for 53rd and West Hills, could result in a 44% crash reduction overall and an 82% reduction in severe (injury/fatal) crashes. Converting a signalized intersection to a roundabout could result in a 48% reduction in overall crashes and a 78% reduction in severe (injury/fatal) crashes.[5] Thus, the data regarding motorist safety tends to be in favor of a roundabout over other intersection designs. The only other design option that is comparable to roundabouts in terms of motorist safety is a four-way stop.

From a design and engineering standpoint, there appear to be few disadvantages to motorists from installing a roundabout at the intersection of 53rd and West Hills; however, there are important perception and adaptation issues to consider for people who are not used to roundabout intersections. Roundabouts can initially be confusing for individuals to navigate and therefore, there may be an initial increase in the number of minor, property-damage accidents as people adjust to the change.[6] Roundabouts also place more reliance on individuals to make decisions rather than directing them by traffic control devices. This could pose a problem for elderly drivers; however, as mentioned above, the slower speeds may serve as a counterbalance and accommodate their needs.

Elderly drivers

Although the safety effects of roundabouts specifically for older drivers are unknown, several studies suggest that installation of a modern roundabout will not pose any particular difficulties for older drivers. Further, a roundabout design may reduce some higher-risk situations that senior citizens encounter at traditional intersections. Senior citizens are involved in a disproportionate number of crashes at intersections compared to other age groups. In 2008, 37% of drivers over 70 years of age were involved in fatal, multiple-vehicle intersection crashes compared with 22% of drivers less than 70 years of age. A majority of these crashes resulted from the elderly drivers' failures to yield the right-of-way.[7] The most common problems for elderly drivers at traditional intersections include left turns and entering busy thoroughfares from cross streets. The installation of a roundabout would eliminate some of these conflict points, and by forcing slower traffic speeds, provide elderly drivers more time to make decisions and navigate the road. In terms of perceived safety anc acceptability, a study in 2007 found that in 6 communities where modern roundabouts had recently replaced traditional intersections, two-thirds of drivers 65+ supported the change.[8]

Adjacent to the intersection of 53rd and West Hills is the West Hills Retirement and Assisted Living Residential Facility. Some residents of Benton County have expressed concern regarding the impact that installation of a roundabout would have on the elderly population in this

community. We discussed these concerns with staff of the facility and learned that only 1 resident drives. In addition, none of the residents walk in that direction along the road as they have on-property trails that are utilized for exercise and spending time outdoors. The staff did not think that a roundabout would affect the residents at the retirement home. However, in a short written survey administered to employees at a staff meeting, individual concerns included increased time and difficulty for emergency vehicles, difficulty in navigation of the roundabout by the Retirement Home's bus, and confusion and subsequent increase in accidents for new motorists.

Pedestrians

To assess the relative safety for pedestrians from a roundabout design, we evaluated data and information from the Oregon Bicycle and Pedestrian Design Guide, FHWA's Designing Sidewalks and Trails for Access, the NCHRP Report 672, and Roundabout USA. Our research was guided by concerns raised by community members at several Open House events.

Data on the safety effects of roundabouts on pedestrians suggest a positive impact when converting a traditional, signalized intersection or a 2-way stop to a modern roundabout. Similar to the factors making a roundabout safer for motorists, the slower speeds of vehicles and a reduced number of conflict points for pedestrians (from 24 at a signalized intersection to 8 at a single-lane roundabout) make roundabouts safer for those traveling by foot.[9] The slower speeds in which a vehicle is traveling decreases the likelihood of a pedestrian fatality should a vehicle-pedestrian conflict occur.

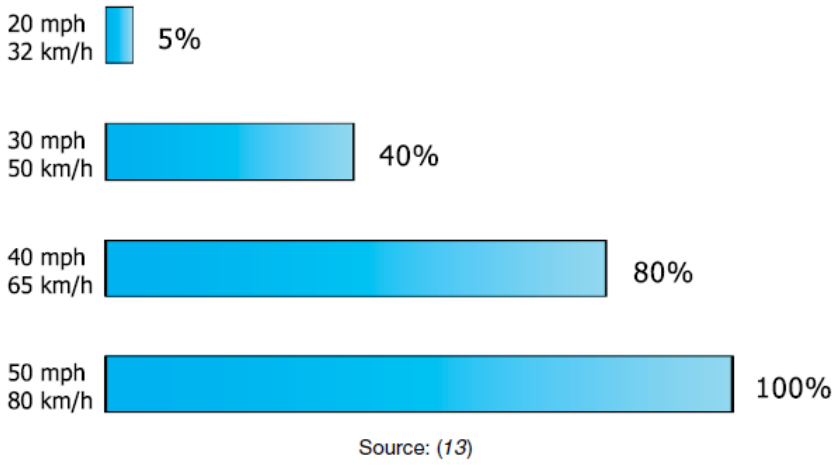


*Chart from NCHRP Report 672.[10]

Roundabouts with splitter islands and refuges halfway across the pedestrian crosswalk allow for a pedestrian to cross a single lane of traffic at a time, which enables them to focus on a one-way

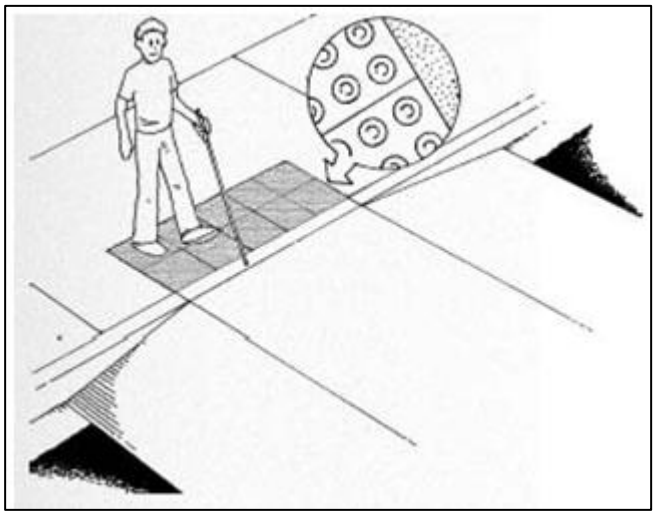
traffic stream.[11] Roundabouts also put pedestrians in a more visible location, especially when crosswalks are raised and located back from the circulatory roadway.

The combination of all of these features makes a roundabout safe for pedestrians; however, limitations can exist. Some pedestrians may be uncomfortable crossing lanes without a signal giving them the right of way. Populations that may be at risk include children, the elderly, and people with disabilities. These pedestrians may find it more difficult to cross unprotected road crossings since they may walk at slower speeds than other pedestrians and generally prefer larger gaps in the traffic stream.

Visually-impaired Pedestrians

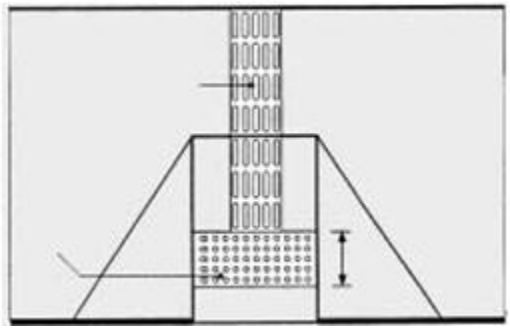
Roundabouts are significantly harder for visually-impaired pedestrians to navigate. Crosswalks are typically located outside the projection of approaching sidewalks, and the nature of the roundabout distorts the audible and tactile cues that visually-impaired pedestrians typically use to cross. In particular, the sound of circulating traffic masks the audible cues that these individuals use to identify a safe and appropriate time to enter the crosswalk and cross the street.[12] Although much research has been conducted in trying to determine the best way to mitigate the negative effects of roundabouts on these individuals, ADA and traffic engineers are still working to find the best solutions to these problems.

People with vision impairments stress the importance of consistency in design so that they can understand the detectable warnings used at intersections. Detectable warnings, also known as truncated domes, are identified by the visually-impaired through texture and are used to denote the boundary between the sidewalk and the street.[13] They are required by the Americans with Disabilities Act and are defined in the Americans with Disabilities Act Accessibility Guidelines (ADAAG) Section 3.5 as "a standardized surface feature built in or applied to walking surfaces or other elements to warn visually impaired people of hazards on a circulation path."[14] Design specifications are laid out in the ADAAG.



Detectable warnings placed at the entrance of a crosswalk to warn visually-impaired pedestrian of upcoming street.

Other surfaces that help visually-impaired pedestrians with wayfinding include directional surfaces. Raised directional tiles are similar to detectable warnings; however, rather than domes, long raised bars are laid out in parallel rows (see Figures below from the FHWA publication Designing Sidewalks and Trails for Access). Wayfinding information helps to orient those with vision impairments by delineating a path to crosswalks located in unexpected locations, such as those at roundabouts.[15] Other ways to assist in wayfinding is through landscaping strips located on the sides of sidewalks.



Directional warnings to assist in wayfinding followed by detectable warnings indicating pending crosswalk.

For this assessment, we contacted the Oregon Commission for the Blind (OCB) was contacted for their input on the safety of roundabouts for visually-impaired pedestrians. The OCB has orientation and mobility instructors who work with clients on all aspects of travel, including navigation through intersections. The OCB's feedback corroborated our findings in the literature regarding the barriers the visually-impaired encounter at roundabouts.

Limitations

Although there is general research on the safety of roundabouts to pedestrians, information regarding the safety features of roundabouts to vulnerable populations is inconclusive and sparse. The impact to visually-impaired pedestrians is of great concern and further assessment is needed to identify specific design features that will accommodate these users at the proposed roundabout at the intersection of 53rd and West Hills. We identified some features that could help mitigate potential negative effects on visually-impaired pedestrians in the recommendations section below.

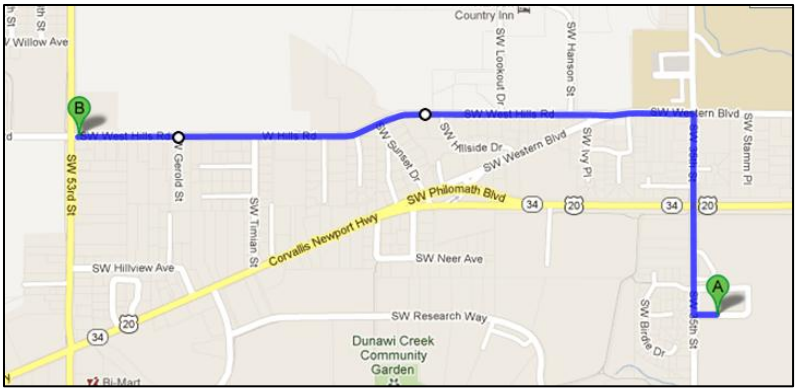
Bicyclists

To assess the relative safety for bicyclists from a roundabout design, we evaluated data and information from the Oregon Bicycle and Pedestrian Design Guide, the Journal of Accident Analysis and Prevention, presentations from the 2008 National Roundabout Conference, and the NCHRP Report 672. Our research was guided by concerns raised by community members at several Open House events.

The individual design of a roundabout greatly determines whether bicyclists will be impacted in a positive or negative way. When approaching a roundabout, a bicyclist has the option to either merge into the lane with motorists or travel as a pedestrian by way of an exit ramp up onto the multiuse path or sidewalk (see Figure below from the Oregon Bicycle and Pedestrian Design Guide). Because vehicles must travel at reduced speeds through a roundabout, bicyclists are generally better able to share the road. However, some studies show that accident rates for bicyclists, including severe injury accidents, are higher at roundabouts than signalized intersections.[16] This is typically the case when a roundabout is poorly designed and bike lanes are kept on the peripheral edges of the circulating lane(s), which causes cyclists to be in the motorists' blind spots throughout their time in the intersection. Because of these safety issues, most modern roundabouts are not designed in this way. Some bicyclists will choose the second option to travel as a pedestrian by way of the multiuse path and cross at the crosswalk with those traveling by foot. Typically these are people who are not comfortable riding in close proximity to motor vehicles.

Bicyclist using exit ramp to access sidewalk prior to entering a roundabout.

At the proposed 53rd and West Hills intersection, we identified parents and children riding their bikes to and from Adams Elementary School as potentially vulnerable populations (see map below – "A" indicates the location of the school, and "B" indicates the location of the intersection). Adams Elementary School is located 2 miles from the intersection. Without design features to accommodate these cyclists, a roundabout design could have negative effects on these users, since they may not be comfortable with riding in the circulating traffic lanes.



We attempted to contact the head of the Parent Teacher Organization and the school's office assistant for an opportunity to discuss the potential impacts of a roundabout with parents and teachers, and for data on the number of families that might travel through the intersection during their commute. No feedback or reply was received as of the writing of this document.

Limitations

There are very little data and research on the safety of roundabouts for bicyclists and the data available shows mixed results. Because so much of the safety impact for bicyclists relies on the design of the roundabout, research results vary depending on the design of the roundabout examined in each study. The available information on the proposed design for the intersection of 53rd and West Hills indicates that the roundabout should provide bicyclists with the necessary safety measures. Local bike and pedestrian committees have expressed support for the roundabout.

Design

To assess the safety of particular roundabout designs, we evaluated data and information from the NCHRP Report 672, presentations from the 2011 National Roundabout Conference, the US Department of Transportation's Roundabout: An Informational Guide, community members involved in bicycle and pedestrian affairs, and experts from Kittelson & Associates.

The design of the roundabout has important implications for its subsequent safety. Single-lane roundabouts are consistently identified as one of the safest traffic-calming measures for at-grade intersections.[17] Single-lane roundabouts require less decision-making from drivers than multi-lane roundabouts. In addition, pedestrians only have to cross one lane of traffic at a time, and vehicle speeds are slow enough to allow for comfortable mixed bicycle and motor vehicle traffic flow. In contrast to single-lane roundabouts, multi-lane roundabouts often cannot achieve the same levels of safety improvement as their single-lane counterparts.[18] Multi-lane roundabouts make driver decisions more complex, and increase conflicts for pedestrians who must cross more than one lane of traffic at a time. Crossing multiple lanes of traffic may pose particular difficulties for elderly individuals and children who move more slowly. For bicyclists traveling

on the roadway, multi-lane roundabouts can cause significant safety issues, especially if bike lanes are installed on the periphery of the circulating lanes.

Multi-lane roundabouts may be considered as an option in areas where there is high traffic flow; however, there are other ways to increase the capacity of a roundabout intersection without adding another circulating lane. One viable option is to add a right-turn bypass lane (shown below, picture from FHWA's Roundabouts: An Informational Guide), which acts in a similar way as those used at conventional intersections. This enables the right-turning traffic to bypass the roundabout, creating additional capacity for the through and left-turn movements. Despite the benefits of these lanes for motorists and their safety in areas with minimal non-motorized vehicle traffic, right-turn bypass lanes can pose significant safety problems for both pedestrians and bicyclists as the entries and exits of the lanes increase the number of conflicts. In general, right-turn bypass lanes should not be installed in urban roundabouts where there is bicycle and pedestrian activity, since they have a negative effect on the safety of non-motorized vehicle traffic.[19] During discussions with the chairman of the Benton County Bicycle Advisory Committee and the Corvallis Bicycle and Pedestrian Advisory Commission, there was support for the roundabout, but strong recommendations against building a right-turn bypass lane due to the negative safety implications for non-motorists, especially for cyclists.

Example of a right-turn bypass lane.

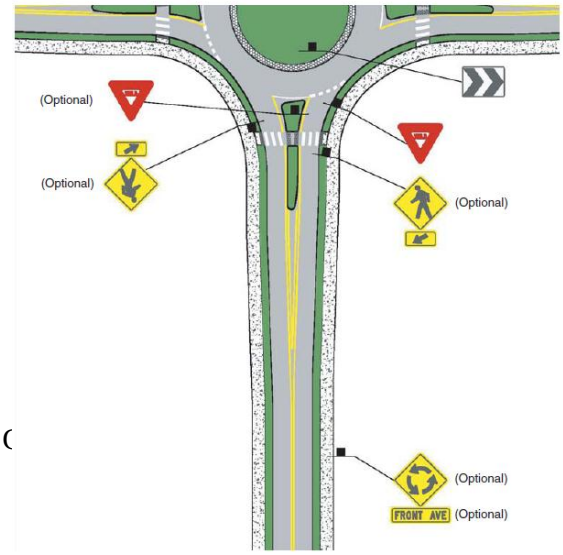
There are several design features involving signage and pavement markings which may improve the safety of the intersection as well. In general, a roundabout should be marked with appropriate signage to decrease the confusion among users. Upon approach to the intersection, a motorist should encounter a circular intersection sign to convey approach to a roundabout intersection. The sign is easily recognizable and gives advance notice of the proper direction in which to travel within the roundabout.[20]

Pedestrian signs should be located at entries and exits of roundabouts to indicate to drivers where a pedestrian crossing is located. The signs should not block the view of yield signs just ahead. Some roundabouts have installed advance pedestrian crossing signs to give the motorist notice of an upcoming crossing; however, these signs are generally not recommended because they may distract from the many other important signs in a roundabout.

Yield signs are required at each entrance of the roundabout to remind entering motorists that they do not have the right-of-way. Destination signs indicating how to proceed through the roundabout depending on desired location; these may not be necessary in single lane, local roundabouts but can be extremely beneficial in multi-lane roundabouts with higher out-of-area traffic volume. Exit signs are typically helpful; however, they may not be necessary at smaller intersections such as the one at 53rd and West Hills Road.

Signs that indicate the correct way to proceed through the roundabout for a left-hand turn are beneficial and encourage drivers to proceed in only one direction. Hook arrows have been shown to be the least confusing for motorists. Sharrows (markings placed in the center of a travel lane to indicate that a bicyclist may use the full lane) on the pavement can help to increase motorists' awareness of bicyclists on circulating lanes.

In order to increase the visibility of the roundabout, signage and prominent landscaping should be placed on the center island. In terms of signage, black-on-white chevron signs are designed to provide a regulatory message, which legally establishes the direction of circulation at roundabouts. These have replaced the black-on-yellow chevron warning signs used previously, which are intended for use on horizontal curves.[21] Landscaping not only helps to provide aesthetic quality to the intersection, but it can also contribute to the safety of the roundabout. Landscaping on the center island should be built up enough to make the intersection visible and to warn drivers that they cannot proceed straight through, but also should also be sized appropriately as to not block critical views. Landscaping can also serve to discourage pedestrian traffic through the center island and can be used to guide visually-impaired pedestrians to the crosswalks.



Source: 2009 MUTCD (1)

Example of regulatory signage at a single-lane roundabout.

Crosswalks should be properly designed to ensure the greatest safety to pedestrians. Crosswalks have been shown to be safest when located 1-2 car lengths back from the circulatory intersection. This improves pedestrian safety by reducing distractions for drivers, and directing drivers to focus on pedestrians in a crosswalk instead of on circulating traffic. Research studies have also shown that raised crosswalks are safer for those on foot since it puts them in a more visible and prominent location, and encourages motorists to slow down even more. In addition, zebra-striped crosswalks should enter into a pedestrian refuge at one angle and exit at a different angle; this encourages pedestrians to stop before proceeding across the second lane of traffic.

Pedestrian zebra-striped angled crosswalk with pedestrian refuge on splitter island.

Location: Bend, Oregon

In general, the design of roundabouts is substantially more difficult for visually-impaired individuals to navigate than traditional intersections. Due to the circulatory movement of the traffic, the auditory environment can be confusing for those relying on sound to determine their actions. In addition, crosswalks in roundabouts are typically located outside the normal trajectory of sidewalks at signalized intersections.

In order to mitigate the negative effects of roundabouts on visually-impaired pedestrians' accessibility, traffic engineers have proposed a number of strategies. Some promising strategies are vibrotactile cues and pedestrian walk signals. Tactile cues include detectable pavement markings that indicate that a pedestrian is nearing the edge of the sidewalk and approaching entry into a crosswalk. These mechanisms are already installed on many street corners in and around Benton County to aid visually-impaired pedestrians during road crossings. Another strategy is installing warning systems such as the Pedestrian Hybrid Beacon System (formerly known as the HAWK). This systems remains off until a pedestrian activates the system with a push button; when it is activated, the system flashes a sequence of warning beacons followed by a red "stop" beacon for motorists. It then signals to pedestrians when it is safe to cross.

Two factors may detract from the benefits of a roundabout at the 53rd and West Hills. One concern is the unequal contribution of cars from 53rd and West Hills. A roundabout is typically not recommended when a busy road crosses a quieter street, since people on the smaller

crossroad will have trouble navigating through the intersection due to being held up by traffic from the busier road. At the Community Meeting in May 2012, a gentleman also brought up his concern that the roundabout will be installed between two traffic lights. The stop and go traffic from these lights may also contribute to uneven traffic flow through the roundabout. To get around this problem, roundabouts are usually installed in multiples to create a uniform traffic corridor. Depending on the outcomes of this project, Benton County Public Works has long-term plans to install multiple roundabouts along the 53rd street corridor. However, we were not able to identify design options that could mitigate these two issues in the near term.

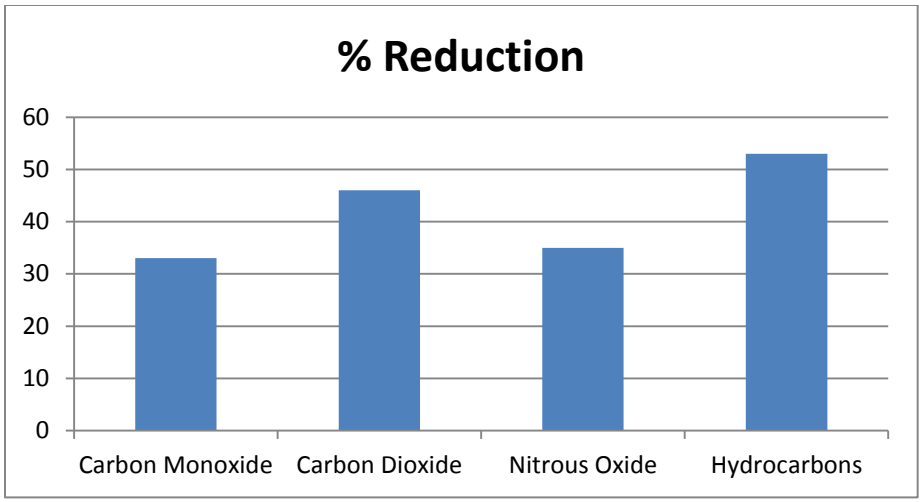
Design considerations are vital to the safety of roundabouts. There were few limitations in assessing the impact of design elements on the safety of most users; however, researchers are still determining best practices for accommodating visually impaired pedestrians at roundabouts.

Environment

In order to assess the effect a roundabout would have on environmental health, we evaluated data and information from presentations at the 2011 National Roundabout Conference, EPA research, the Journal of Environmental Health, and the 2003 Mid-Continent Transportation Research Symposium.

Overall, environmental quality improves when roundabouts are installed in place of traditional, signalized intersections. Roundabouts result in reduced vehicle emissions and improved air quality, which can have significant effects on health.

In general, research shows that there are 20-30% less toxic emissions and 20-30% less greenhouse gases at roundabouts compared to traditional signalized intersections.[22] The Environmental Protection Agency reported in March 2006 that 27% of U.S. greenhouse gas emissions between the years 1990-2003 were from the transportation sector alone.[23] In several national studies cited by the Insurance Institute for Highway Safety, roundabouts reduced carbon monoxide emissions by 29-32%, nitrous oxide by 21-34%, and carbon dioxide by 42% in comparison with emissions at a traditional, signalized intersection.[24] In general, roundabouts will result in fewer toxic emissions than signalized intersections, even if there are traffic delays due to small amounts of congestion. However, if roundabouts become very congested with large queues of vehicles, the emissions can equal those at traffic signals; however, it is uncommon for roundabouts to become backed up to this extent. In contrast to the intermittent stop-and-go traffic flow at roundabouts, stop signs and traffic signals always stop traffic and cause queuing even during off-peak hours, which results in higher vehicular emissions.[25]



*Data based off of *Impact of Modern Roundabouts on Vehicular Emissions* by Mandavilli, Russell, and Rys, a study looking at emissions from vehicles at 6 locations before and after conversion of a signalized intersection to a roundabout.

Reducing air pollution levels can reduce the burden of chronic diseases in a community. Chronic exposure to air-borne particles increases the risk of developing cardiovascular and respiratory diseases, and lung cancer. In a major review of 177 studies on particle pollution and other air pollutants, researchers at the American Lung Association found that many of these pollutants (including fine and coarse particle pollution, carbon monoxide, nitrogen oxides, and sulfur dioxides) increase the risk of heart attacks even when inhaled at elevated levels only once a week.[26] Even short-term exposures to particle pollution may increase risks for strokes. A study in Boston showed that breathing in traffic-related particles was linked to increased risk of stroke within 12 to 14 hours of exposure.[27] A study looking at 1.2 million volunteers found that levels of fine particles measured across the nation in the past few decades are linked to small but measurable increases in lung cancer in people who never smoked.[28]

In addition, short-term effects of air pollution on health include increased headaches, reduced mental alertness, difficulty in breathing, chest pain, eye and throat irritation, and respiratory tract problems including asthma and susceptibility to infection.[29] Exposure to these noxious pollutants is largely beyond the control of individuals and requires action by public authorities at all levels. The Harvard Center for Risk Analysis conducted a study in which they estimated nationwide emissions attributable to congested traffic for 2005 as being 1.2 million tons of nitrous oxide, 34,000 tons of sulfur dioxide, and 23,000 tons of fine particulate matter. These emissions were associated with approximately 3,000 premature deaths and a social cost of $24 billion.[30]

The burden of air pollution is often not equitably shared. Poorer individuals and some racial and ethnic groups tend to carry more of the burden by facing higher exposure to pollutants. Exposure to air pollution is generally out of the individual's control, and it is the responsibility of community leaders and policymakers to ensure all residents have clean air to breathe. Researchers believe there are three overarching reasons why disparities in exposure to air pollution exist. First, some groups face greater exposure because of factors related to racism or class bias or housing market dynamics and land costs. Second, low social position may increase

susceptibility to health threats because of related factors such as lack of access to health care or higher traffic exposures. Third, existing health conditions, traits, and/or behaviors have the potential to predispose some groups to greater risk, as has been found to be the case among the elderly, African-Americans, Mexican-Americans, city dwellers, and diabetics.[31] In addition, when children are exposed to air pollution, serious ill health effects can ensue including decreased lung capacity and function and frequent reports of respiratory illness.[32]

One environmental drawback to the installation of roundabouts is that they typically take up more space than a traditional signalized intersection. The county needs to assess the potential impacts of developing a roundabout at 53rd and West Hills since there may be some disruption of wetlands. In addition, the additional space needed for the roundabout is of particular concern to the adjacent property owners at each corner. Ultimately, however, a roundabout should reduce stress and increase usability by increasing ease of access to housing developments on West Hills Road. To the west of 53rd lies a new housing development and to the east lies several residential plots. Likewise, there are several small neighborhoods to the north of the intersection and several residences to the south.

There was relatively limited information and data on the environmental effects of roundabouts and the impact that those would have on health. However, the general research findings suggest that roundabouts will reduce air emissions at the proposed intersection, and have corresponding health benefits to users and nearby residents.

Quality of Life and Livability

In order to assess the effect a roundabout would have on overall quality of life of residents and those passing through the intersection we evaluated data and information from the AARP, the US Department of Transportation, the Landscape and Human Health Laboratory, BMC Public Health, Web MD, and the WHO.

Roundabouts may improve quality of life by decreasing stress associated with human fatalities and economic costs from accidents and fuel consumption. In addition, installation of a roundabout can improve the walkability of an area and ultimately result in lower rates of disease and health care costs. Roundabouts can also improve the livability of an area by increasing the aesthetics of an intersection and reducing noise pollution, congestion, and traffic delays.

Roundabouts have many proponents, including the Complete Streets and Walkable and Livable Communities Institute, and the "street doctor" Dan Burden, who has helped more than 3,500 communities become places that support active living.[33] In an article titled *America Needs Complete Streets*, Dan Burden and Todd Litman outline some of the major livability problems in the U.S. Over the past twenty years, the United States has averaged 43,000 fatal accidents and 2.5 million injured individuals on roadways per year. Motor vehicle crashes are the leading cause

of death for U.S. teenagers. In 2009, approximately 3,000 teens in the U.S. were killed and more than 350,000 were treated in an emergency room for injuries following a motor-vehicle accident.[34] In addition to the cost of life lost, which has been estimated to be $2.6 million per fatality, traffic crashes cost about $164 billion annually in property damage and injuries.[35]

Below is a summary of the existing crash data for the West Hills/53rd intersection.

	Existing Crashes (2004-2011)			
	Total	**PDO**	**Injury**	**Fatal**
Total	10	7	3	0
Crashes/Yr	1.25	0.875	0.375	0.00

Based on this data and intersection traffic volumes, crash prediction models were applied to estimate the number of crashes at this location by the type of traffic control at the intersection. Because of uncertainty with the models, high and low estimates are provided for each traffic control to provide context to the estimates. All of the future estimates listed below were provided by Kittelson & Associates.

	Expected Crashes Through Horizon Year (2012-2030)				Expected Crashes Per Year			
	Total		**Injury & Fatal**		**Total**		**Injury & Fatal**	
Intersection Control	**Low Estimate**	**High Estimate**	**Low Estimate**	**High Estimate**	**Low Estimate**	**High Estimate**	**Low Estimate**	**High Estimate**
Side-street Stop-controlled	*23*		*7*		*1.30*		*0.38*	
Signalized	18	26	2	9	1.00	1.47	0.09	0.49
Roundabout	10	19	0	3	0.53	1.05	0.01	0.16

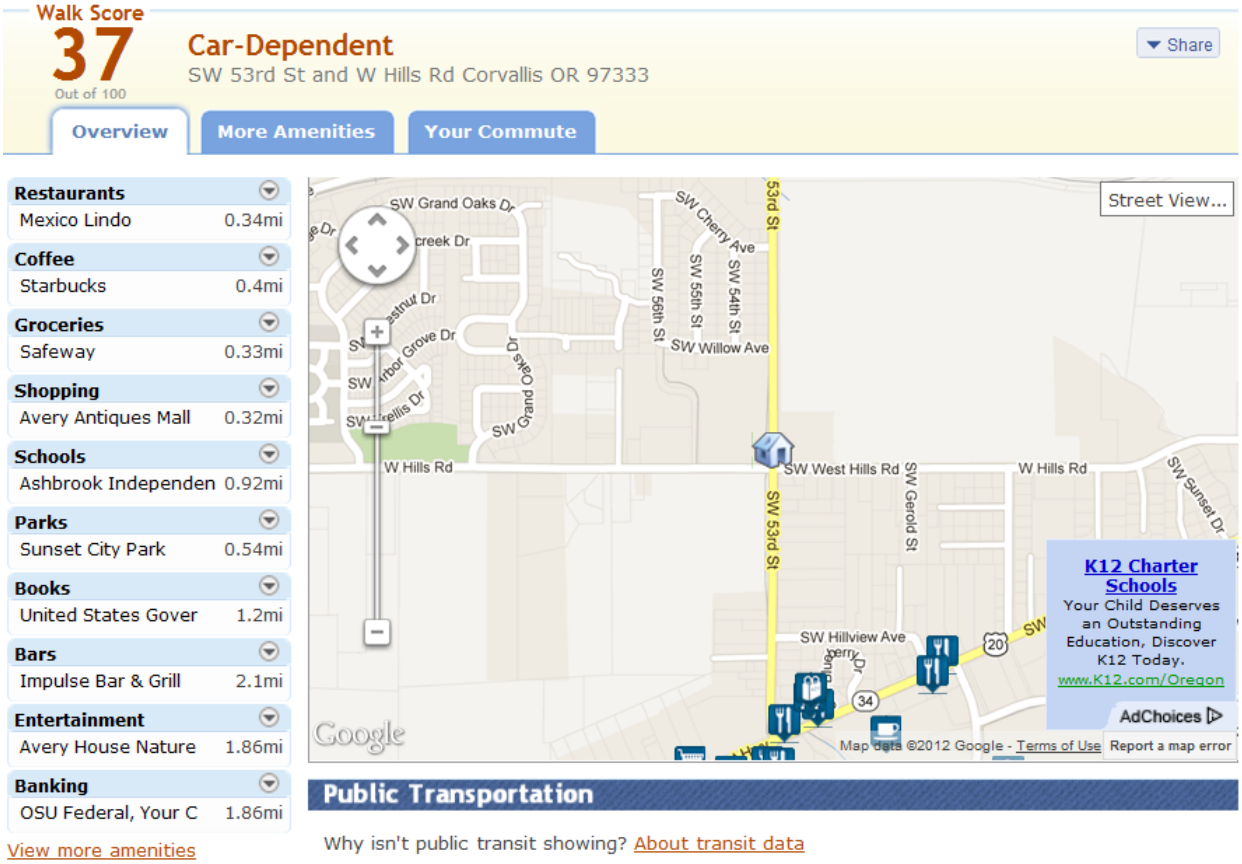
Finally, using ODOT crash cost estimates, high and low estimates for the cost of crashes at the intersection based on traffic control through the horizon year (2012-2030) were developed. These results are shown below.

	Cost of Crashes	
	Low Estimate	**High Estimate**
Side-street Stop-controlled	*$3,390,000*	
Signalized	$1,140,000	$4,305,000
Roundabout	$150,000	$1,590,000

In addition to the economic benefits from decreased fatalities and injuries, vehicles traveling through roundabouts use less fuel due to the decrease in stop and go movements. In many cases, 20-30% less fuel is consumed in roundabouts than at traditional intersections.[36] A study in Virginia found that at 10 roundabout intersections there was a reduced consumption of more than 200,000 gallons of fuel per year.[37] At current gas prices, the installation of a roundabout intersection at the corner of West Hill and 53rd could save Benton County residents an estimated $100,000 per year in fuel costs. These savings can be fed back into the local economy, enhancing the quality of life within the community.

Not only do "incomplete streets" have a large economic impact on our nation as described above, the Burden and Litman article also describe the impact of incomplete streets on individual and community health, fitness, and well-being. Complete streets encourage walkability and may contribute to decreasing the burden of obesity in America. A decrease in obesity due to increased activity, as well as a decrease in health complications related to pollution, can have enormous economic benefits to society resulting from decreased expenditures in health care costs.

According to Walk Score®, the intersection of SW 53rd St and West Hills Rd as currently designed received a score of 37 out of 100 and is categorized as car-dependent. 79% of Corvallis residents have a higher Walk Score than those at this intersection, and the top 10% in Corvallis have a score of 92. The average score for Corvallis is 61.[38]



Roundabouts can provide an enhanced community environment through increased aesthetics. As urbanization increases, more people face the prospect of living in residential environments with fewer trees and green areas. This is especially true for people of lower socioeconomic status who often cannot afford to relocate to the greener areas of a community. This can ultimately lead to environmental injustices related to the distribution of and access to public green spaces. Studies show that residential common areas containing trees and other greenery help to build strong neighborhoods. A Chicago public housing development study showed that residents of buildings with more trees and grass nearby reported that they knew their neighbors better, socialized more often, had a stronger sense of community, and felt safer and better adjusted than did residents of more barren buildings and areas.[39] Experimental research in environmental psychology has shown that a natural environment has a positive effect on well-being through restoration from stress and fatigue. In addition, descriptive epidemiological research has shown a positive relationship between the amount of green space in the living environment and physical and mental health and longevity.[40] Another study that examined the impact of green areas on mental and physical health found that people living in green areas were a third less likely to have anxiety disorders that required treatment and one-fifth less likely to seek treatment for depression than those living in areas devoid of green spaces. In terms of physical health, the study found that green environments had the strongest correlation with decreased respiratory diseases such as asthma, chronic obstructive pulmonary disease, and upper respiratory infections. In addition, a

slight positive association was shown between green spaces and reductions in cardiovascular disease, diabetes, and cancer.[41]

Another aspect of roundabouts that has the potential to increase quality of life is the reduction in noise pollution. In 2011, the World Health Organization conducted a study on environmental noise pollution and the burden of disease in Western Europe. From their research, they found that noise pollution can affect rates of cardiovascular disease, cognitive impairment, sleep disturbance, tinnitus, and annoyance. The evidence for the association between exposure to road traffic noise and hypertension and ischemic heart disease has increased over the past several years. Based on exposure data, it was estimated that the burden of disease from environmental noise was approximately 61,000 DALYs (disability-adjusted life years) for ischemic heart disease in high-income European countries. In assessing the relationship between noise pollution and cognitive impairment, the WHO estimated it at 45,000 DALY lost for children aged 7-19. For sleep disturbance, a total of 903,000 DALYs were lost, and for tinnitus, DALYs lost were estimated at 22,000. Tinnitus (internal perception of sound in the absence of an external source) can lead to sleep disturbance, cognitive problems, anxiety, psychological distress, depression, communication problems, frustration, irritability, tension, inability to work, reduced efficiency, and restricted participation in social life. Finally, the WHO considered a high level of annoyance caused by environmental noise as one of the environmental health burdens. Estimates suggest a total of 654,000 DALYs lost. From their study, the WHO concludes that there is sufficient evidence that environmental noise can be linked to adverse health effects.[42] Roundabouts have been shown to reduce noise pollution as they decrease start and go traffic patterns; and therefore, it can be postulated that they can also have long term positive effects on health.

Unfortunately, very little data or evidence is provided regarding quality of life as it specifically relates to roundabouts, and much of the evidence is anecdotal. However, research on complete streets indicate a positive impact on quality of life, and roundabouts may have similar impacts if they improve walkability, increase green space, and reduce noise and air pollution. .

Chapter 4: Recommendations

In considering the installation of a roundabout at the intersection of West Hills and 53rd, the results of the HIA suggest that a single-lane roundabout will be the most beneficial intersection at this junction. Research findings indicate that single-lane roundabouts have lower numbers of total vehicle collisions and severe crashes than signalized intersections and multi-lane roundabouts. In addition, single-lane roundabouts provide safer pedestrian crossings since they only need to cross one lane of traffic at a time. They also provide benefits to bicyclists who can either cross safely with pedestrians or merge into the circulating traffic lane. See the Table of Recommendations at the end of this section for a full list of recommended modifications and considerations for the installation of a roundabout at West Hills and 53rd.

The roundabout design that Kittelson & Associates and Benton County Public Works are currently planning is for a single-lane roundabout. Given the research on the effects of a multi-lane roundabout on safety, we do not recommend that a multi-lane roundabout or right-turn bypass lane be installed at this intersection without further research on the consequent health effects. Reports show that these designs are less beneficial to both pedestrians and bicyclists and can introduce some serious threats to their safety. If the carrying capacity is reached on this intersection and re-design and expansion are deemed necessary, we recommend a second review of the potential health impacts prior to implementing any changes.

In addition, we recommend that speeds be kept at 15-20 miles per hour through the intersection, since the main reason for improved safety in a roundabout is the slower speed that motorists are forced to travel. In order to prepare motorists for this reduction in speed, we recommend that a lower speed limit be implemented prior to reaching the roundabout. The speed limit is currently set at 45 mph on 53rd and 35 mph on West Hills, and residents have raised concerns about motorists approaching the roundabout at that speed. Public Works should consider slowing traffic down prior to the intersection. In addition to signs lowering speeds, Public Works should closely follow the recommended signage in roundabout literature. This includes roundabout intersection signs prior to reaching the intersection, pedestrian crosswalk signs, yield signs at each entrance of the roundabout, and signs showing proper navigation throughout. Black and white chevron signs should be placed on the center island to indicate the one-way direction of travel.

The design of the pedestrian crosswalk should also be given careful consideration. The crosswalk should be located no closer than 1-2 car lengths from the roundabout entrance point. Evidence suggests that a zebra-striped, diagonal crosswalk is most effective design for pedestrian safety. This design is highly-visible and the angle of the crosswalk encourages pedestrians to stop at the refuge before continuing to cross the second lane of traffic. A raised crosswalk should be considered, since this design increases the visibility of the pedestrian and the crosswalk, and may improve the safety of the pedestrian.. In order to accommodate for pedestrians needing extra assistance or time in crossing the intersection, installation of visual, audible, and tactile devices

should be considered.

Because roundabouts are particularly difficult for visually-impaired pedestrians to navigate, certain features should be included in the proposed roundabout to mitigate these negative effects. Detectable and directional surfaces should be installed at the proposed roundabout to help pedestrians navigate their way to the crosswalk and to assist in crossing. In addition, landscaping strips or other detectable edge treatments should be placed between sidewalks and the roadway in order to lead visually-impaired pedestrians to the crosswalk. The installation of pedestrian crosswalk signals should also be considered to help increase visibility and alert motorists to pedestrians wanting to cross.

The safety of roundabouts for cyclists depends on roundabout design features. Installing a bicycle lane at the outer edge of the roadway is not recommended as this places the bicyclist in the motorist's blind spot for exiting the roundabout. Bicycle lanes should be dropped on approaches to the intersection as this will encourage cyclists to enter the roundabout with traffic and ride in the circulating roadway or use a bicycle exit ramp to access the sidewalk. The bike lane should be dropped 30-50 feet prior to the pedestrian crosswalk and dashed for approximately 30 feet before being dropped to allow cyclists the time to either merge with traffic or use the sidewalks and crosswalks. The bicyclist exit ramp should be located where the dashed line begins. Allowing cyclists access to the crosswalk will keep them in a safe area, which is especially important when considering parents and children riding to and from Adams Elementary School, located south of the proposed intersection. In contrast, allowing individuals to merge into the motorist lanes and act as a vehicle within the roundabout is favorable depending on the skill and comfort level of the individual. A roundabout design should typically accommodate both methods.

As it currently stands, the intersection is unsafe and results in many users making risky decisions. Although community members are divided on the issue, many recognize the unfitness of the intersection as it currently stands and desire that something be done to mitigate the negative effects that the poor design has on health and safety. A study by the U.S. Department of Transportation shows that community attitudes regarding roundabouts changed from very negative (23%) and negative (45%) before construction to positive (41%) and very positive (32%) after construction. Given the data found throughout the course of the HIA, it is our recommendation that a roundabout be installed at the intersection of 53rd and West Hills Road assuming that its design incorporates the recommendations above. Benton County Public Works should also be responsible for public outreach and education regarding proper use of and navigation through a roundabout for all users.

Table of Recommendations

	Recommendation	Health Impact
Overall Design	Single-lane; if capacity of intersection is reached, reassess for health impacts of right-turn bypass lanes or multi-lane roundabout before implementing any changes	Shown to be the safest at-grade intersection; provides a significant decrease in overall crashes
Speed limit	15-20 mph through the intersection and decreased on roadways prior to reaching the roundabout entrances	Decrease in fatal and injurious crashes
Signage	Signage should be installed in accordance with current recommendations made by the US Department of Transportation Federal Highway Administration	Improved safety for all users
Pedestrian Crosswalk	Angled, zebra-striped; raised; located 1-2 car lengths back from roundabout entrance	Increase in pedestrian safety by improving visibility; encourages pedestrians to stop at refuge before continuing across second lane of traffic; decreases the focus points for a driver
Features for the visually-impaired	Installation of proper detectable and directional surfaces; use of landscaping to help guide pedestrians toward crosswalks; installation of a pedestrian-activated crosswalk signal	Enhances safety and mitigates some of the negative effects of a roundabout for those with visual impairments
Features for Bicyclists	Bike lanes should end 30-50 ft. prior to roundabout and should have dashed lines their last 30 feet to encourage a bicyclist to either use the exit ramp (located at the beginning of the dashed line) and proceed as a pedestrian or merge into the circulating lane with motorists	Offers cyclists the option to either proceed as a pedestrian or merge with motorists which increases their overall safety

Chapter 5: Conclusion

Reporting Plan

Benton County Health Department staff will meet with the County Commissioners in early-Summer to present this HIA's findings and recommendations. We will meet with them in a Board-work session format in which they have an opportunity to ask questions and receive answers about the specifics of the HIA recommendations.

In addition, Health Department staff will contact the public and host a public forum specifically to present the recommendations of the HIA, and outline how the recommendations were formulated based on their opinions and from literature regarding roundabouts. We will also communicate our findings to the Benton County Roads Advisory, City of Corvallis Public Works Transportation staff, Benton County Bicycle Advisory, Corvallis Bicycle and Pedestrian Advisory and CAMPO Advisory commissions. Health Department staff will also seek to present the results of the HIA at local, State, and National conferences, and consult with other jurisdictions on the potential health impacts from installing roundabouts in their communities.

Monitoring and Evaluation of Plan

The Benton County Health Department chronic disease prevention team will allocate staff time to monitoring the results and impact of this HIA. Our monitoring activities will collect information to determine if:

1. The HIA is well received by county staff and elected officials.

2. The HIA has an impact on decision-making.

3. The HIA increases interest in incorporating new HIAs into future work.

4. Policy changes do occur and if so, how accurate the HIA's findings on potential health impacts were.

Health Department staff will present this report to Benton County staff and the Benton County Board of Commissioners for review. Health Department staff will also follow up with each of these entities with the results of monitoring and with plans for future work. In addition, the Health Department will ensure that this HIA and Project Summaries are developed and made available for all stakeholders.

Next Steps

Should the Board of Commissioners approve the installation of a roundabout at the intersection of 53rd and West Hills, staff from the Health Department will work with staff from Public

Works to ensure that certain essential design features of a roundabout are incorporated in order to provide the community with the greatest positive effects on health.

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