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Hazardous Materials Commodity Flow Study: Marion County, Oregon

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List of entities involved in HMCFS Project

Marion County Emergency Management Office

- Edwin Flick, County Emergency Manager
- Kathleen Silva, Emergency Preparedness Coordinator
- Erik Anderson, Emergency Management Coordinator
- Krista Rowland, Emergency Management Program Coordinator
- Caitlin Esping, AmeriCorps VISTA Member

Center for Public Service, Mark O. Hatfield School of Government, Portland State University

- Stephanie Hawke, Senior Research Assistant, PhD Candidate
- Aaron Kaufman, MPA Candidate
- Robert Cheney, MPA Candidate

Volunteers

- Tim Sing
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- Roger Williamson
- Paul Guthrie
- Joe Favata
- Chuck Roberts
- Kevin Hassen
- Andrew Johnson
- Dan Bathurst
- Peter Allen
- Donald Rhoads
- Roseann Kendal
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- Larry Konick
- Jill Ogden
- Kyle Moore
- Scott Hittner
- Tim Beaver
- Mark Dodge
- Cynthia Achinbach
- Lee Achinbach
- Mari Worley
- Daviann Otto
- Burnie Pearson
- Beth Tanner

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A number of private companies and public agencies helped with this project. Marion County Emergency Management office and the Center for Public Service would like to extend a special thank you to the following organizations (listed alphabetically):

- Marion County Public Works
- Marion County Sheriff's Office
- NW Natural
- Oregon Department of Transportation
- Oregon State Fire Marshal's Office
- Portland and Western Railroad
- Union Pacific
- Williams

I. Purpose

Hazardous materials are prevalent in all communities in the United States. They are stored and they are transported. Regardless of the method of transport, (for this study defined as: pipeline, rail, roadway, air, or water) hazardous materials are generally transported without incident. However, consequences of a hazmat transportation incident can be extreme with serious repercussions to public safety, life and wellbeing, the environment, and infrastructure1. To plan for and mitigate these consequences, communities may choose to examine the transportation of hazardous materials through high risk areas – areas with sensitive ecosystems or high population – to better develop strategies.

Therefore, in February 2016 the Marion County Emergency Management Office commissioned a Hazardous Materials Commodity Flow Study (HMCFS), to be carried out by the Center for Public Service (CPS) research team. This study was to be conducted in accordance with recommendations from the US Department of Transportation (USDOT).

The purpose of a HMCFS is to identify the types and amounts of hazardous materials transported through a specified geographic area[2]. It provides a methodological approach to understanding the unique hazards that may be present in Marion County. The intent of this study is to complete a HMCFS that will provide the data necessary to estimate risks facing the County and provide grounding for an emergency response plan.

This Commodity Flow Study was funded by the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Hazardous Materials Emergency Preparedness grant program through the Oregon State Police, Office of State Fire Marshal and Marion Co. Emergency Management.

The opinions, findings, and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect views of the U.S. Department of Transportation or Oregon State Police, Office of State Fire Marshal.

About the Center for Public Service

The Center for Public Service (CPS) is housed within the Hatfield School of Government at Portland State University. It consists of a team of academic professionals, practitioners, consultants, trainers, and students with expertise in consulting, research, and professional development, with a shared focus on public service leadership and capacity building.

With decades of experience delivering high quality consulting, research and professional development to public and nonprofit organizations located in the Pacific Northwest as well as in international settings such as Vietnam, Japan, and China, CPS offers the cost competitiveness of a not-for-profit organization, the intellectual content of a leading academic center, and the client-driven flexibility of a traditional consulting firm.

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[1] Transportation Research Board of the National Academies, "*Hazardous Materials Cooperative Research Program Report 3: Guidebook for Conducting Local Hazardous Materials Commodity Flow Studies".* 2013 (1).
[2] Ibid., (10).

Project Overview

The CPS Research team devised the following plan to meet the HMCFS guidelines. The project plan consisted of five distinct steps, as outlined in the project proposal and summarized here:

- The collection, review and assessment of baseline information pertaining to hazardous material flow including: transportation networks, commodity movements, traffic levels, critical and sensitive facilities, and historical incident information;
- An analysis of data gaps, developed based on the baseline information, in order to prioritize data collection for this project and future projects the county may be interested in pursuing;
- The planning and collection of data based on the gaps and priorities identified;
- Analysis of baseline data together with additional data collected throughout the course of the study to identify the flow of hazardous materials through the county;
- The preparation of a project written report and an oral presentation containing extensive documentation and evidence-based recommendations for next steps.

Three additional elements were added to the project. These additions were identified during the implementation of the project and though technically outside of the initial scope, they added important and rich data.

The first addition was the use of GIS mapping as an analysis tool. The initial framing of analysis in the project was to present a summary overview of the data by transportation method. This technique is presented below, and highlights specific details about hazardous materials such as: which companies are transporting the most; how the bulk is being transported; what is being transported; and so forth.

However, after a number of meetings with the Marion County research team, it became clear that they were interested in something more. That is, they wanted to know how hazardous materials interplay with elements already in the community. They wanted to be able to identify the hazardous materials risks present in a community, and speak to how these risks uniquely affect the community as a whole. For this, the project required a geo-spatial element. They needed to be able to see the relative proximity of hazardous materials risks and community fixtures like schools, hospitals, etc. Mapping is, by far, the best approach for answering questions like this. And so the CPS research team added another approach to the analysis – the creation of an Arc GIS map and the identification of hotspots in the community.

The second addition to the project was the stakeholders' feedback meeting. In the project proposal, the CPS research team proposed to present the findings of the project, ostensibly to the Marion County research team. During the course of project implementation, however, this idea grew. Instead of a small presentation to the Marion County research team, a large-scale presentation was given to all of the relevant stakeholders on September 21, 2016. This session served as an additional data-collecting tool; eliciting feedback from those most familiar with the local context. The information gathered from the session is interwoven in this report.

Finally, the third addition to the project was the bolstering of data on social vulnerability. Encouraged, in part, by feedback from the stakeholders' meeting the Marion County

research team asked that we augment our proxy variables for social vulnerability in the hotspot analysis. That is, they asked that we include a discussion of the Social Vulnerability Index in our description of each hotspot identified. Corresponding language is included in the results section.

A note: all methods and approaches for this project were based on the guidebook, *Hazardous Materials Cooperative Research Program Report 3: Guidebook for Conducting Local Hazardous Materials Commodity Flow Studies* (referred to as "HMCFS guidebook").

The Co-Production Model

At its simplest level, our strategy involves joint planning and joint delivery of leadership programs with our organizational partners and with the students we teach. We call this process co-production.

Over the past 20 years of doing leadership development in a variety of organizations and countries and through a process of trial and error we have developed an approach that addresses current leadership challenges: developing capabilities to deal with "wicked problems", filling the leadership vacuum, increasing the public performance of leaders and organizations and motivating public servants with leadership potential to prepare themselves for leadership positions.

Principle #1: Co-production and Co-delivery

The Center for Public Service (CPS) gives priority to clients who are prepared to participate as an equal partner in the design and delivery of our leadership development programs. This usually takes the form of having 1-2 senior leaders in the organization designated to work with our Center faculty to design the curriculum as well as deliver it to participants.

Principle #2: "Active Learning Pedagogy"

Our Co-Production model not only includes the active participation of agency leaders in the design and delivery of the curriculum. It also includes the active participation of trainees throughout the duration of the program. What "active learning" means is that participants are asked at every stage of the program to apply what they are learning to their organizational work setting. This requirement is based on well-tested studies of what and how adults learn.

Principle #3: Multi-level Leadership Focus

It is important that leadership development be multi-level in its focus, giving appropriate attention to 1) individual leadership strengths/styles, 2) leading groups and teams, 3) leading organizations (i.e., managing budgeting, personnel, MIS and other systems) with a focus on "change management" and 4) leading in the larger community setting which shapes the environment of the organization. It is common knowledge that some leaders can easily inspire followers but cannot run organizations or facilitate group and team-oriented activities. Others are good at interacting in large community settings while others become nearly incapacitated when facing hostile groups, the media or any kind of larger public limelight. In short, it is important for participants to understand that leadership at all levels of the organization plays a critical, but slightly different role in promoting the public good, starting with street level leaders who deliver the service to those at the other end of the leadership spectrum who are responsible for the strategic direction of the organization.

Principle #4: Public Service Leadership Requires Balancing Competing Moral Values

Co-Production is not only an effective curricular design and delivery strategy for quickly teaching applied leadership principles to emergent leaders, it also models the real-life practicalities of public service leadership. One of the major differences between public and private sector leaders is that the former lead in an environment of murky, grey and often contested values. There is not a financial "bottom line" profit & loss target that serves as a common denominator for measuring success. For public officials, success is in the "eye of the beholder" – the party, the business community, the environmentalists, the religious/ethnic community, the press, the internet, leaders of other nations, etc. As the eyes of the beholders expand in number and increase in diversity, public sector officials have the problem of mediating competing values or competing interpretations of the values at the center of the political system.
Given this unique challenge faced by public sector leaders, CPS's programs explicitly promote the view that public sector leadership carries with it unique moral obligations that are distinctive to a particular political/legal setting.

Principle #5: Adaptability Over Time

It is important that leadership programs have the capacity to quickly adapt to the changing context of the organization. For example, if an organization suddenly finds itself facing a major challenge as a result of a natural catastrophe, a sudden economic reversal, an unexpected court mandate, or a political change in direction, the program needs to have the flexibility to incorporate these "surprises" into the design and delivery of the training. The Co-Production Leadership Model we have outlined facilitates this adaptability extremely well. Agency co-instructors can make suggested change in the design of the curriculum or last minute changes in each session to incorporate the latest "surprise of day" that may require organizational changes by the top leadership to accommodate the new contextual forces at play in the external environment.

One technique we have found especially useful to accommodate this need for flexibility is a final "Capstone case" at the end of the program. This case is used both as an integrative group project to further hone the leadership principles learned in the program as well as an organizationally relevant problem-solving exercise that can add additional information to the decision-making process of senior managers. These cases are generated by the agency co-instructors who team-teach with our Center faculty.

This figure provides a pictorial representation of the Leadership Co-Production Model we have developed, with the specific content being shaped by the needs of our clients. It is still a "work in progress", but through testing over time and in different cultural settings, we believe it captures some of the essential elements for successfully and quickly preparing the next generation of public service leaders to meet the daunting challenges of globalization and the expectations for ever-higher levels of performance.

The Marion County Emergency Management team provided considerable background information for this project. They provided the subject area expertise, whereas the CPS research team provided the research and analysis experience. We met a number of times between the January 2016 and the culmination of the project, in September 2016. These meetings provided the background and clarifying information that significantly expedited the process.

Throughout this report, we refer to the "CPS research team", which is defined as the principle researchers, faculty and students from CPS. We refer, also, to the "Marion County research team", defined as the core researchers at the Marion County Emergency Management office.

Marion County Local Emergency Planning Committee

Local Emergency Planning Committees (LEPCs) are responsible for local emergency planning for chemical hazards under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA). Emergency plans can be developed as standalone documents, or as part of the community's larger comprehensive emergency management plan. Generally, LEPCs will commission a HMCFS. HMCFS are not a plan in themselves, but they do provide critical information for the emergency planning process. These can be conducted with internal resources, but can also be contracted out, as in the case of this study.

In some counties, LEPC's are independent organizations. They operate in conjunction with the local emergency management agencies, but they are non-governmental groups. In other counties, such as Marion, the local emergency management office is charged with performing the duties of a LEPC. It is the stated goal of the Marion County Emergency Management office to develop a LEPC. The development of a LEPC depends, in part, on the buy-in of community stakeholders. One large-scale goal of the HMCFS project, and following Phases of the work, is to convey the importance of a LEPC and bolster relationships with stakeholders so that a LEPC can be developed in the future.

II. Scope and Background

Description of Marion County

Marion County is the fifth largest County in Oregon with a population of approximately 315,900. There are twenty incorporated cities and thirty-seven unincorporated communities in the county. The largest city and the county seat is Salem. Marion County stretches from the Willamette River to the Cascade Mountains encompassing nearly 1,200 square miles.

The principal industries are government, food processing, lumber, manufacturing, education, tourism, and agriculture[3].

Marion County is landlocked, without significant waterways. It is located south of Clackamas County, north of Linn County, east of Yamhill and Polk Counties, and west of Wasco and Jefferson Counties.

Tracking the flow of hazardous materials is made more complicated by the use of different modes of transport. Hazardous material can be transported by roadways, rail, pipelines, air and water. While transport of hazardous material is present in nearly every community, not every mode appears. In Marion County, the transport of hazardous material by water and air is either not possible or not utilized. Therefore, for the purposes of this study only roadways, rail, and pipelines are analyzed.

Pipelines in Marion County consist of three major distribution pipelines. Two of these are natural gas distribution pipes and traverse the county – both north to south and east to west. The third major pipeline is noted as "Hazardous Material Pipeline" by the National Pipeline Mapping Service. Further data collection revealed that this pipeline is owned by Kinder Morgan, and that it carries a variety of hazardous materials. Stakeholders identified the pipeline as generally transporting natural gas, but that it is regularly cleaned out, inspected using a "pig" method (pipeline inspection tool), and then used to transport other hazardous materials. The majority of pipeline discussion in this report references the natural gas pipeline.

There are three main railway lines in the county. They traverse the county north to south. The railroads are present in every city and major town in Marion. The major tracks are owned by Union Pacific, Portland and Western Railroad, and (to a lesser extent) BNSF. The scope of this project focuses on Union Pacific and Portland and Western Railroad, as they are the major companies in Marion County. When possible, the CPS research team focused on each line segment.

The roadways in Marion County are numerous. Interstate 5 bisects the county, and is the most important thoroughfare and hazardous materials transportation line. There are additional, smaller highways, including: 22, 99, 164, 211, 213, 214, 219, and 551.

Based on interviews with the Marion County Public Works Department (detailed below) the following highways were included in the study. They are: I-5, 22, 99, 214, and 219. Information on these roads was collected by placard survey and by informational interviews with transportation experts.

Why focus on the transportation of hazardous materials?

Emergency managers require plans for a host of contingencies including mitigating the threat of hazardous materials in emergency situations. And hazardous materials present different threats, depending on whether they are stationary or in transit. This study focuses only on the transportation of hazardous materials for two reasons.

[3] Marion County, "About". Available at: www.co.marion.or.us/Pages/about.aspx

First, there is more information collected and made available about stationary hazardous material. Information is collected about fixed facilities, vulnerable population, possible disaster situations and other natural hazards. There is substantial policy that requires the reporting of all hazardous materials (in sufficient quantities) being stored in the county.

However, there is little information captured about hazardous materials while they are in transit, or "flowing". Part of the reason for this is the sheer complexity of data collection. Information is required from both private and public industry and crosses many jurisdictional boundaries. Additionally, the existing regulation on reporting is less clear.

Second, the funding stream for HMCFS studies is, in part, provided by the US Department of Transportation. The Department of Transportation recognizes the unique hazards presented by the transportation of hazardous materials within a jurisdiction. Further, the Department of Transportation recognizes that a catalog of the hazardous materials stored in a county rarely matches a catalog of hazardous materials present in a county at any moment. That is, the movement of hazardous materials in a county presents a significant portion of the hazardous materials in a county at any time. Focusing on these in-transit materials allows for a much more complete picture of the emergency management scenario and potential risk.

Which transportation networks?

The HMCFS Guidebook addresses five transportation networks, any (or all) of which may be present in a county. These networks are: road, rail, pipeline, air and water. These are the five main ways that, according to the HMCFS Guidebook, hazardous materials are moved through all regions.

A preliminary interview with the Marion County research team indicated that some of these networks were more important in this context than others. They identified that road, rail and pipeline all were significant hazardous material transportation networks in Marion County. They were highlighted in this study.

The preliminary interview also indicated which transportation networks were not important in the regional context. Airways, for one, are not a significant mode of hazardous materials transportation in Marion County. There are three airports in the county – all of which are small and serve only the immediate area. Their traffic did not justify inclusion of the airports as a transportation mode. However, because these facilities *store* significant amounts of hazardous materials, they were included as fixed facilities storing hazardous materials.

Waterways do not serve as transportation networks in Marion County. The preliminary interview with the Marion County research team confirmed this and waterways were excluded from the study.

III. Methodology and Description of Data

Approach to Data Collection – Baseline and Additional

Based on the project proposal and recommendations in the HMCFS guidebook, the data collection consisted of two phases. The first phase was the collection of baseline information.

This is the information that was accessible to the Marion County research team. Data was already held by the Emergency Management office, or easily gathered from related agencies.

After the baseline data was collected and summarized, the research teams identified gaps in the data and devised a strategy for filling said gaps. In terms of methods, we relied in large part on leveraging the contacts and expertise of the Marion County research team. Our data collection strategy consisted of a series of steps and methods. We conducted in-person and email interviews with key contacts in the public and private sectors. We requested records from companies transporting hazardous materials. We gathered related public record from secondary sources. We collected primary data with a placard survey of key roads in the county. Throughout this process, the CPS research team was in contact with the Marion County research team. In the spirit of co-production, the approach to data collection, and indeed the actual specification of the data points collected, were borne of collaboration.

Description of the data collected

Baseline Data

As assumed by the HMCFS guidebook, a considerable amount of the data used in this study was already held by Marion County government agencies and departments. The trick was to coordinate with the departments to gather the relevant data and make sense of it for the analysis. Kathleen Silva, Emergency Preparedness Coordinator at Marion County Emergency Management office, headed these efforts. She coordinated with various agency contacts to gather the following data points: vulnerable populations locations and facilities that store hazardous materials in reportable quantities; dangerous intersections; and previous incidents involving hazardous materials.

All sensitive data collected for this project was protected. It was stored on an encrypted drive – hosted by Portland State University - and was password protected with a limited number of administrators. All collected information that is not protected under the SARA Title III was treated as classified, and protected using similar methods.

The State Fire Marshal provided data on fixed facilities including facilities that store a threshold planning quantity (TPQ) of an extremely hazardous substance. These facilities are subject to the Emergency Planning and Community Right to Know Act, and are thus required to report the status of the materials to the federal government. There are 78 of these facilities in Marion County. The exact placement of the hazardous material storage within each facility was not required for the analysis.

The Fire Marshal also provided information that was used to identify critical facilities, population centers, and vulnerable populations. The office provided extensive data. We used the following types of facilities as indicators of critical facilities and vulnerable populations: state government facilities and airports, schools, hospitals, and other health facilities.

In all, 186 schools are included in the analysis – spanning elementary, middle/junior high, and high schools. Both public and private schools are included.

There are three major hospitals in Marion County. They are: Salem Hospital, Silverton Hospital, and Santiam Memorial Hospital in Stayton. Additionally, 100 other health facilities were included in this study. Of these facilities, 24 are senior living facilities. Other facilities include hospice and wound care. These facilities were included because they (a) represent

particularly vulnerable populations, and (b) present a different risk if damaged in a hazardous materials incident.

There are three low-traffic airports in Marion County. Analysis of their traffic patterns indicated that air did not pose a significant hazardous materials transportation risk. However, these airports *store* hazardous materials and are therefore important to include in the analysis. Further, in the case of a large-scale hazardous materials incident, airports become an important hub of emergency management. They were therefore included in the analysis as separate and distinct from the other fixed facilities that store hazardous materials in the county.

A preliminary draft of analysis failed to include the state capitol and other critical state buildings. This is not a data point that is addressed in the HMCFS guidebook, but it is clearly an essential component in the Marion County context. The CPS research team therefore referred to the Oregon Blue Book's list of state buildings[4]. The CPS research team identified 29 state-owned buildings in Marion County. The majority of these are capitol buildings or located in the immediate vicinity of the state capitol. However, others (e.g. the State Fairgrounds) provide an interesting layer to the analysis.

Data on the dangerous intersections in the County were provided by the Public Works Department. Kathleen Silva contacted representatives from that office and collected a narrative account of the most dangerous intersections in the area. This list is included in Appendix A. The majority of these intersections are located at crossroads between busy rural roads and railroad.

Finally, data was provided on previous hazardous materials incidents. Though the data was very rich – chronicling many – only data from 2015 and 2016 was used in the study. There were enough data points in the recent past to get an accurate picture of the recent hazards in the county. This data was collected by Silva, from the Public Works Department.

Table 1. Baseline data collected

Data	Source
Fixed facilities storing hazardous materials	State Fire Marshal's Office
Critical facilities and population data	State Fire Marshal's Office, Marion County airports, Oregon Blue Book
Dangerous Intersections	Marion County Public Works
Hazardous materials incidents	Marion County Public Works

Additional Data

After compiling the above information, the research team identified gaps in the data – we needed more information. The gaps identified include: information about the companies that

[4] Which can be found here: http://bluebook.state.or.us/facts/statebuildings/build.htm

operate, and a catalog of the hazardous materials transported by (1) freight, (2) road, and (3) pipeline in the county; and the location of distribution pipeline in the county.

Rail
There are two Class I rail companies that run freight in Oregon: BNSF and Union Pacific. There are many more (approximately 20) short-line railroads companies that run freight in the state. To identify what companies were important for this study, the CPS research team first conducted an exploration of secondary information about the companies.

The CPS research team learned that BNSF owns rail in Marion County, but does not use it currently. Instead, it is leased out to Amtrak and Portland and Western Rail. Union Pacific is the main freight operator in the county.

Of the secondary rail companies, two operate in Marion County. They are Portland and Western, and Willamette Valley. However, upon further examination, Willamette Valley Railroad was excluded from the study because, according to a representative from ODOT, the company does not currently transport hazardous materials. The CPS research team therefore identified that there are two freight companies in the county that needed to provide data for the analysis.

The research team requested records on all hazardous materials freight from UP and Portland and Western. Both companies complied. The raw data, included in Appendices B and C respectively, varies between companies. Both provide the UN/NA code for the hazardous material, and the amount being moved. Portland and Western provided line segment information, as well as totals by month for 2015 and the first quarter of 2016. UP provided only data from Quarter 3 (beginning in July) in 2015.

Because of the different reporting systems, the information was not directly comparable. However, there was enough critical information included to complete analysis.

Table 2. Rail data collected

Data point	Source	Use in analysis
Exact location	Secondary sources (ESRI)	Hotspot analysis
Hazardous materials transported over time	Private company data	Hotspot analysis
Network segment data	Portland and Western Railroad	Summary information

Road
The HMCFS guidebook suggested a couple of different approaches to collecting roadway data. One suggestion was to contact the companies that manage freight and request records. The CPS research team attempted to contact and make these requests, but were rebuffed.

Another suggested approach was to conduct a placard survey. By placard survey, the guidebook described a methodology that included observing a critical roadway, noting the number, type, and configuration of trucks, as well as the hazardous materials placards. The placard survey conducted in this study was designed and co-created by the CPS and Marion County research teams.

The placard survey was the most intensive primary data collection process that was conducted for the project. The survey was designed in partnership between the Marion County research team and the CPS research team. Together, along with advice from the Public Works department, we decided on five key sites. These sites were informed by expected traffic flow patterns. See Table X below for a detailed account of the target population, location, and direction of each survey site.

Table 3. Placard survey sites

Site location	Direction
Hwy 22 – Lancaster Dr.	Westbound
Hwy 214 – Silverton	Northbound and Southbound
Hwy 219 – St. Paul	Southbound
Hwy 99 – Aurora	Northbound and Southbound
I-5 - Jefferson	Northbound
I-5 - Woodburn Weigh Station	Southbound

A point of clarification may be needed about the target population choices. It is clear why, for example, I-5 was included in this study; it is the major transportation artery in Marion County. Highway 99 might be a little opaquer. Marion County Public Works Department advised this decision. In an informal conversation, they reflected that it is possible that some of the long haul truck drivers are pulling off of I-5 before the Woodburn weigh station. The hypothesized rationale for this decision would be to avoid the weigh station and thus avoid a conversation/record of the number of hours that the driver has been behind the wheel. This was speculation on the part of the Public Works Department but it did inform a need to survey some less conventional transportation routes. To that end, Highways 22, 99, 214, and 219 were included in the study.

The survey instrument was provided by the HMCFS guidebook. In fact, the guidebook provides a variety of survey instruments to choose from. The choice made by this research team can be found in Appendix D. The instrument chosen was the most detailed option. Though this did present a steeper learning curve for those administering the survey, it provided the richest data possible. Some HMCFS studies conduct many placard studies over a year-long period. Because our approach to the placard survey was a concentrated collection effort, the research team collected as much information as possible during the three survey dates.

The placard survey was conducted by Marion County staff and volunteers, recruited by the Marion County Emergency Management team. The volunteers learned about the opportunity through outreach efforts of the Marion County research, and their participation was coordinated by Kathleen Silva and Erik Anderson. In all, 25 individuals participated in administering the survey tool. Some volunteers and staff participated in one survey day; others participated in two or three days.

Each survey site was manned by a three-person team. One Marion County staff member and two volunteers – generally – made up the teams. There were some constraints on the number of volunteers, so some teams consisted of two people – one staff and one volunteer. The choice to work in teams was made to ensure everyone's safety in the process. The

multiple person teams also helped in the information gathering. That is, each person had a different role in the data collection process.

In response to the HMCFS guidebook, as well as our requirements for internal validity, every survey participant went through a training session. On August 2, 2016 – one day before the first training – members of the CPS research team travelled to Marion County to deliver the training to the Marion County staff members who were participating in the survey. This training consisted of a project description, an introduction to the survey tool, and a presentation of the different types of trucks and placards that would be present during the survey days.

After completing the training, some staff indicated that they would benefit from more real-life examples of trucks, trailers, and placards. The training slides were updated to include more examples before it was delivered to the volunteers.

The survey was conducted at five sites, over three days. Placard survey volunteers manned the sites on August 3rd, 5th, and 8th. These days were chosen purposefully, as they represented different days of the week (Wednesday, Friday and Monday). The HMCFS guidebook suggested that different days of the week may have different truck traffic patterns.

The surveys were conducted in three hour blocks; different times of day were chosen for each survey. The HMCFS guidebook suggests that truck traffic varies significantly by time. The varying times were 1:00pm – 4:00pm, 5:00pm – 8:00pm, and 6:00am – 9:00am. All sites were surveyed at each time.

Table 4. Survey dates and times

Survey Date	Survey Day	Survey Time
August 3, 2016	Wednesday	1:00 – 4:00pm
August 5, 2016	Friday	5:00 – 8:00pm
August 8, 2016	Monday	6:00 – 9:00am

The survey administration teams met an hour before their slated survey time at the Marion County Emergency Management office. During this hour, they received the truck and placard identification training (for a second time, for some). They were given updated team and location assignments, and safety directions. The teams were also provided with reflective/high visibility vests, traffic cones, and survey instruments.

Immediately following each survey period, the survey administration teams reconvened at the Marion County Emergency Management office for a "hot wash". In other words, the convened at the main office to debrief the events of the day, discussing what went well, what went poorly and what could be learned for future survey days. Some changes were made between survey days, in response to these debriefing discussions. The notes from these discussions are included in Appendix E.

Data from the placard survey was reported using either the paper tool provided, or the Arc Collector application. The app was designed by Burnie Pearson, GIS Specialist at Marion County. The app collected the same data as the paper tool, but had the added functionality of capturing the location in latitude and longitude. This data was incorporated into the road results.

Pipeline

Pipeline is a significant and important transportation mode for hazardous materials in Marion County. There are three main companies that serve the county: NW Natural Gas, Williams, and Kinder Morgan. Williams is the largest of the companies, and supplies NW Natural with its product. Williams runs the major pipeline in the county. The second major pipeline in the area is owned and operated by Kinder Morgan. As noted above, this pipeline is used to transport natural gas, but is also regularly used to transport other hazardous materials.

To gather data on the pipelines in Marion County, we conducted informational interviews, requested records from private companies, and collected secondary data from public record sources.

Williams Pipeline provided tabular and map data. NW Natural agreed to an hour-long information-sharing meeting. Kinder Morgan was not contacted during the primary phase of data collection for the project.

Additionally, the CPS research team was able to locate an approximate map of the main pipelines in Marion County. NW Natural confirmed the location of the main Williams pipeline – as did Williams - and we were therefore able to include this in the final analysis. Further, Kinder Morgan was contacted at the final stages of the project; they, too, confirmed the location of their pipeline.

Table 5. Pipeline data collected

Data point	Source	Use in analysis
Approximate location	National Pipeline Mapping Service (public record), confirmation by companies	Hotspot analysis
Safety precautions, communication networks, critical infrastructure nodes	Informational interview	Summary information

Sampling

The HMCFS Guidebook made explicit suggestions about sampling for this study. The Research Team chose to let the sampling be driven by the availability of data. For all requested data, we asked for the most current data. We tended to receive data from 2014-2016. There were some clear outliers, e.g. the hazardous materials incident data provided by the Public Works Department, which provided data from 1986 – 2016[5]. However, in the main, the data provided for the study was from 2015 and 2016.

The placard survey was conducted with purposeful sampling. We chose to conduct the survey over different days and different times. We did not, however, conduct the survey

[5] Data was provided for 1986-2016. The analysis only included from January 2015 – March 2016.

over different months or seasons. The HMCFS Guidebook indicated that this extended study may provide richer results. However, the method that was chosen was both the most feasible in terms of our research project, and one of the options suggested by the HMCFS Guidebook.

Analysis approach

This study uses two approaches to analysis: data compilation and summarization, and hotspot analysis. Using two approaches to analysis allows for a more complete understanding of the context. The summary information gives the reader the information by transportation method, whereas the hotspot analysis shows the transportation methods in relation other elements of the community. Both methods use qualitative analysis to draw conclusions.

The data compilation and narrative provides information about each transportation method. The CPS research team considered the most prevalent hazardous material for each transportation method. Note that this approach does not account for a "black swan" scenario – that is, very small amounts of very dangerous materials. Though it was a conscious choice to focus on the most likely situation, this is a limitation to the study. Analysis of a very unlikely, but very dangerous hazardous materials incident would doubtlessly add color and richness to the findings. In terms of pre-planning, however, black swan scenarios are

Hotspot analysis is one approach suggested by the HMCFS Guidebook. Hotspot analysis focuses on where the different elements of the data overlap. It is a geo-spatial orientation towards the data. Hotspot analysis identifies locations where seemingly unrelated elements are nearby, creating a threat that could be much more dangerous than expected.

In terms of methods, the CPS research team took the following tact. We created an Arc GIS template of Marion County. We then plotted all geo-located data that had been collected. First mapped were the fixed county parameters, including the county borders, and other natural elements.

Next the CPS research team mapped the fixed transportation routes. This includes the interstate, highways, and railways. The study identified which of these routes present particular hazards. Those routes and network components that were identified as important in the transportation of hazardous materials were highlighted on the map. Additionally, we placed the approximate location of the distribution pipeline on the map.

Third, the fixed facilities that store hazardous materials in the county were placed on the map. The facilities were treated as all the same. That is, there was no distinction between facilities in terms of what types of hazardous materials are stored. Phase II of this project – described in the Recommendations section below – we propose using an additional approach: distinguishing between what types of chemical are present, and the appropriate mandated response. A buffer would be added to recreate the potential impact of an accident.

Fourth, we mapped previous events. This includes the hazardous materials incidents from January 2015- May 2016, and the accident prone intersections in the county.

Finally, we mapped the vulnerable populations. We mapped all of the K-12 schools, which included a large number of churches that double as schools. We included the hospitals, other health facilities (like assisted living facilities, etc.), and state owned buildings. Details about this inclusion can be found above.

After all of these data points were placed on the map, the CPS research team visually inspected the map. We were looking for the interplay between the hazardous sites and transportation routes, and the community at large. We added and removed buffers, to model the impact of a potential hazardous situation. We ran different models and used qualitative methods to assess four components. They are: (1) the hazard, a potential source of injury, death, or damage; (2) community vulnerability, susceptibility to injury, death or damage; (3) exposure, people and property within the potentially affected area; and (4) risk, the likelihood of a hazard resulting in injury, death, or damage.

The most effective method of analysis operationalized the above tenets to the following data points, valuing (1) vulnerable populations, (2) hazardous materials transportation networks, (3) fixed facilities and (4) all other components of the data. We looked for relatively small areas (under 5 square miles) within which there appeared a major hazard.

After the hotspot analysis was completed, the CPS research team overlaid data on the Social Vulnerability Index (SVI). The SVI, developed by the Center for Disease Control, is one way to conceptualize a "community's capacity to prepare for and respond to the stress of hazardous events ranging from natural disasters… to human-caused threats"[6]. The CDC conceives of social vulnerability as having four themes: socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. These four elements are rolled together to create a composite variable, SVI.

The Marion County research team provided the CPS research team with heat maps of Marion County. These maps, included in Appendix F, indicate the breakdown of social vulnerability in the county by quartile. A heat map was provided for the composite variable, SVI, as well as for each element of vulnerability.

The CPS research team undertook a visual inspection of these maps in conjunction with the already-identified hotspots in the county. The results are included in the hotspot analysis write up below.

Stakeholders' Feedback Meeting

After the initial round of analysis was conducted, the results were presented to stakeholders on September 21, 2016. A list of stakeholders in attendance is included in Appendix H. The meeting presented the initial results, and then opened the discussion to any and all related feedback. The research team was alerted to missing data, information that seemed at-odds with expectations, and general feedback about how to best present the information clearly. The information gathered in this meeting informed the content of the final project.

One additional theme that came out of the stakeholders' meeting was the implications of this analysis and the application of the findings to other data. For example, the importance of social vulnerability, and the utility of the SVI tool, was one of the suggestions of stakeholders. The CPS research team was able to incorporate this feedback into the final project. Some suggestions, however, we were not able to include in this phase. For example, distinguishing between different chemicals housed at fixed facilities was a notable suggestion. Additionally, suggestions to include environmental factors such as wind patterns and topography of the land were of interest, but not feasible in this phase of the study.

[6]Center for Disease Control, "A Social Vulnerability Index". 2014 (1).

IV. HMCFS outcomes

The results of the CPS research team's analysis are detailed below. First, the results are detailed by transportation method. This section of the results serves as a narration and compilation of the data; it will allow for decision makers to hone in on the most important issues pertaining to pipelines, roadways, and railways respectively.

The second section of the results details the findings of the hotspot analysis. Five main hotspots were identified, based on the geo-spatial analysis. These hotpots are: Woodburn, Silverton, north of Salem city center, Capitol Buildings and Downtown Salem, and Stayton.

Results by transportation method

Pipeline

The in-person and email interviews with natural gas providers in the county were informative. We learned about the safety precautions in place, as well as the communication networks to best use in case of emergency. Additionally, we confirmed the relative location of the pipeline that runs under Marion County.

There are two major natural gas pipelines in the county. There is also a "hazardous materials" pipeline in the county, as designated by the National Pipeline Mapping System. Though there is no further explanation given by the National Pipeline Mapping System, further research showed that this pipeline was owned and operated by Kinder Morgan. This company runs primarily natural gas, but also other hazardous materials.

There are two types of natural gas pipelines present in Marion County: distribution lines and delivery lines. Distribution lines are the large, main lines that traverse the county. Delivery lines travel from the distribution lines to each customer.

The map of delivery lines in Marion County looks very nearly like the county road map. That is, it is safe to assume that there is a delivery line present under every paved street in the county. All emergency plans should include a consideration of limited natural gas problems.

The distribution lines, however, are not omnipresent. There are two main distribution pipeline in Marion County, which bisect the county. Williams operates the two main natural gas pipes, and NW Natural receives its supply from Williams. There is the large Kinder Morgan hazardous materials pipeline as well, which runs north-south.

The main north-south natural gas pipeline travels under Highway 99, and then makes its way into Salem via the west side. The second pipeline travels east-west in the north of the county, and then travels south west through the county. The Kinder Morgan pipeline runs close to I-5 throughout the county. See map for illustration.

The map, provided by National Pipeline Mapping System, is included in Appendix G.

Rail

Table 6. Rail Results Summary

Rail Company	Line Segment	Hazardous Materials	UN/NA	Monthly Average (by car load)
Union Pacific	n/a	Petroleum – Crude Oil	UN1267	420.33
Union Pacific	n/a	Propane	UN1978	109.67
Union Pacific	n/a	Liquefied Petroleum Gas	UN1075	56.00
Portland & Western	Salem to Tigard Yard (CP Bonita)	Ethanol/Gasoline Mix	UN3475	114.66
Portland & Western	Albany Yard to Salem	Carbolic Acid	UN2312	10

Overall, Union Pacific transported the majority of hazardous materials in the period studied. Of the materials that UP transported, the majority was petroleum/crude oil (placard 1267) in the time studied.

The second most common hazardous material transported by UP in the timeframe considered was propane (placard 1978). By month and on average, UP transported about four times the amount of petroleum-crude oil as propane.

As noted above, the analysis of hazardous materials carried by rail does not focus on the very dangerous, very rare hazardous materials that pass through the county. Instead, the CPS research team outlines the most common materials, presenting the most likely hazardous materials situation.

Portland & Western Railroad

Portland & Western Railroad provided data from January 2015 to March 2016. The data was grouped by rail line segment. Hazardous material names, UN/NA ID numbers, hazard class, and amounts per month were included with each line segment. Raw data can be found in Appendix C. The figures below highlight how the quantities of materials shift over time and by line.

Figure 1 below shows the difference between the amount of hazardous materials transported on Portland and Western Lines in Marion County. Across all hazardous materials, there is more traffic on the Salem – Tigard Yard (CP Bonita) line than the Albany Yard – Salem line. This is particularly pronounced in 2015 when, across all months, the difference between the lines is stark. However, beginning in 2016, the difference between lines in terms of hazardous materials traffic is much less. Indeed, in the first quarter of 2016, the lines reach almost parity in terms of traffic of hazardous materials.

This distinct uptick presents a number of questions. Was 2015 an anomaly, with unusually low traffic on the Albany Yard-Salem line, and therefore the 2016 values are simply a return to normal? Was the first quarter of 2016 the anomaly, with unusually high levels of hazardous materials on the Albany-Salem line and traffic has since returned to normal? Or, was there some external or policy change that explains the change? The data that we have cannot answer these questions. Further data collection would be needed to speak to the larger trend.

Figure 1. Line segment comparison

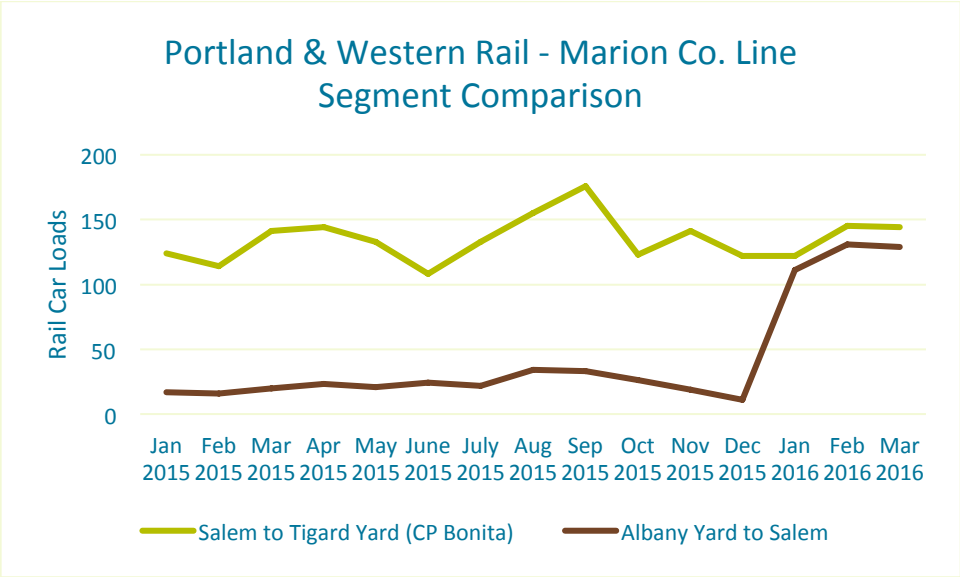
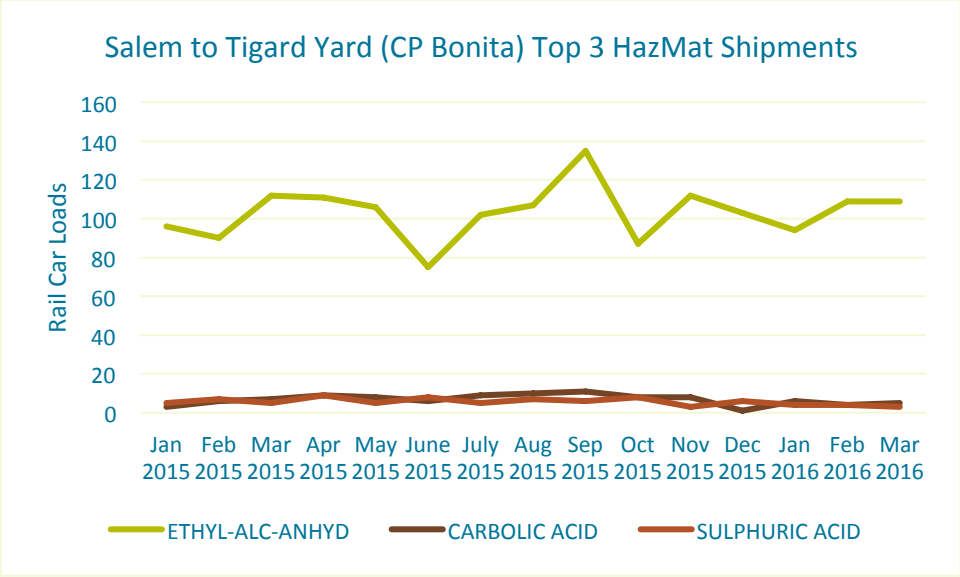


Figure 2, below, shows which hazardous materials are being transported in highest quantities on the Salem to Tigard Yard line. Ethanol/gasoline mix is, by far, the most prevalent hazardous material on the line. This is true across the time frame considered. Though there are peaks and valleys in terms of the amount of ethanol/gasoline mix on the line, it is always significantly higher than any other material. The two next highest hazardous materials are carbolic acid and sulfuric acid. Over the time frame, both materials are transported in relatively low quantities.

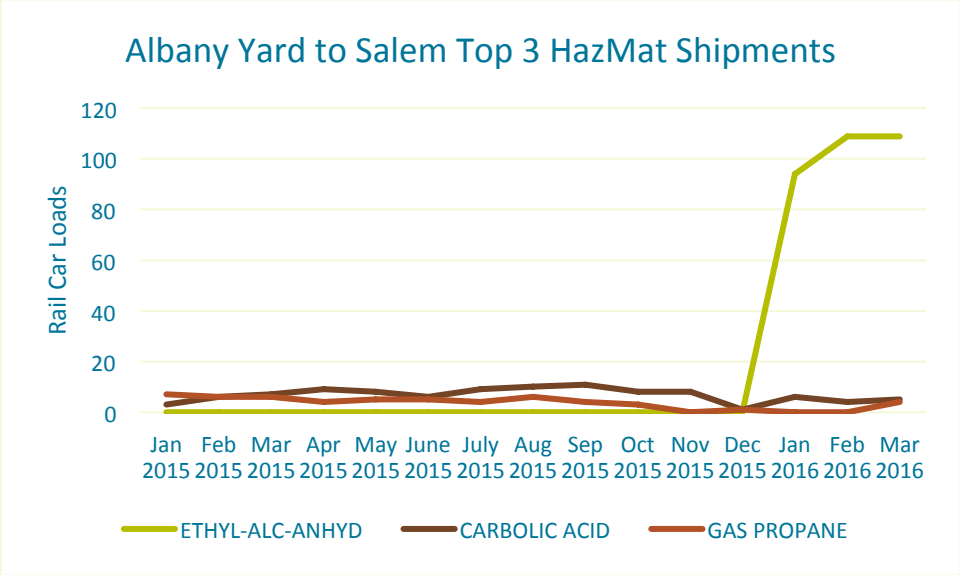
Figure 2. Hazardous materials by line: Salem-Tigard Yard



As discussed above, Figure 1 highlighted the change in traffic patterns on the Albany Yard-Salem lime between 2015 and 2016. The by-material analysis therefore follows a similar

pattern. What is surprising is where the gains are made. In 2015, the Albany Yard-Salem line transports relatively equal amounts of ethanol/gasoline mix, carbolic acid and (unlike the Salem-Tigard Yard line) gas propane. Beginning in January 2016, however, the story changes. The gains observed in the overall hazardous materials traffic in Figure 1 can be explained, wholly, by the increase in ethanol/gasoline mix. That is, carbolic acid and gas propane maintain a relatively constant amount from 2015 to 2016. Ethanol/gasoline was not transported at all in 2015, whereas in 2016 it constituted the vast majority of hazardous material traffic on the line. As noted above, further research would certainly point to why this change occurred and, more to the point for this study, if these amounts of ethanol/gasoline mix continue to be transported on the line.

Figure 3. Hazardous materials by line: Albany Yard – Salem



Trucks

Table 7. Summary of truck data

Site Name	Total Trucks	Total Hazardous Materials Truck
Hwy 22 - Lancaster Dr. (WB)	239	3
Hwy 214 - Silverton (NB)	155	3
Hwy 214 - Silverton (SB)	134	1
Hwy 219 - St. Paul (SB)	308	7
Hwy 99 - Aurora (NB)	165	2
Hwy 99 - Aurora (SB)	183	2
I-5 - Jefferson (NB)	2072	44
I-5 - Woodburn Weigh Station (SB)	2180	68

The placard survey provided rich detail for the HMCFS. The CPS research team determined: which routes were most used by trucks, which routes were most used by trucks carrying hazardous materials; and which routes were most popular given different time and days.

Interstate 5 overall had the most truck traffic, across all days and times. I-5 south bound had more truck traffic than I-5 northbound. Over the three time periods in the placard survey, I-5 northbound had 2072 trucks observed, whereas I-5 southbound had 2180 trucks observed.

Of these observed trucks, 44 of the trucks traveling northbound on I-5 had placards indicating hazardous materials on board. 68 of the trucks traveling southbound had placards. This translates to approximately 2% of northbound traffic, and approximately 3% of southbound traffic. Both in terms of raw numbers and percentages, I-5 southbound had the most truck traffic and placard observations.

The highways studied were identified by the Marion County research team and Marion County Public Works. Significant truck traffic was suspected on these roads. The results from the placard survey, however, indicates that these worries were perhaps unfounded.

The route with the most truck traffic – aside from I-5 – was Highway 219 at St. Paul. Across the three survey dates, a total of 308 trucks were observed traveling southbound. Of these trucks, seven had placards indicating hazardous materials. This translates to approximately 2.3% of all truck traffic.

239 trucks were observed at Highway 22 at Lancaster Drive, 3 (or 1.3%) of trucks had a hazardous materials placard. Highway 99 at Aurora was observed both north and southbound. 165 trucks were observed traveling northbound, and 183 were observed traveling southbound. Two trucks had placards travelling northbound (1.2%) and two trucks had placards travelling southbound (1.1%).

Highway 214 at Silverton was observed both north and southbound. It had the least amount of truck traffic. 155 trucks were traveling northbound; 134 trucks were traveling southbound. Of those, three trucks had placards traveling northbound (1.9%) and one truck had a placard traveling southbound (.7%).

Table 8. Truck data by survey site

Site Name	Total Trucks	Total Hazardous Materials Truck	Most Frequent Placard	Most Frequent Hazardous Material
Hwy 22 - Lancaster Dr. (WB)	239	3	1203 x 3	Gasoline
Hwy 214 - Silverton (NB)	155	3	1075; 1977	Butane/Propane; Nitrogen
Hwy 214 - Silverton (SB)	134	1	1075	Butane/Propane
Hwy 219 - St. Paul (SB)	308	7	2187; 1203	Carbon Dioxide; Gasoline
Hwy 99 - Aurora (NB)	165	2	1993	Diesel

Hwy 99 - Aurora (SB)	183	2	1075	Butane/Propane
I-5 - Jefferson (NB)	2072	44	1203 x 15	Gasoline
I-5 - Woodburn Weigh Station	2180	68	1203 x 29	Gasoline

Across all sites, gasoline (placard 1203) was -- by far -- the most common placard observed. Gasoline placards were observed on I-5 (both directions) and on Highway 22 at Lancaster Drive (westbound). On Highway 214 (both directions), butane/propane was the most common placard observed (placard 1075). ON Highway 219 at St Paul (southbound) the most common placards observed were carbon dioxide (placard 2187) and gasoline (placard 1203). On Highway 99 northbound, the most common placard was for diesel (placard 1993); on Highway 99 southbound, the most common placard was butane/propane (placard 1075).

Overall results from the hotspot analysis

Nine hotspots were identified as a result of our analysis. They are indicated in the Results Map, included in Appendix I. The top five hotspots are described below. They are listed in geographic (north-to-south) order; not in the order of associated risk.

Hotspot 1: Woodburn, OR

The city of Woodburn is located in the northern region of the county. In a five square mile area in and around Woodburn, there are the following transportation networks: I-5, Highway 211, Highway 214, two rail lines, one natural gas distribution pipeline, and one hazardous material (Kinder Morgan) pipeline.

All of these transportation networks have significant amounts of hazardous materials running on and/or through them. The placard survey was conducted just north of this region and indicated that there was considerable hazardous materials traffic on this route.

The proximity of these hazardous materials transportation networks to one another poses significant risk. In this area, there were seven incidents that involved hazardous materials in 2015-2016. There are ten fixed facilities with hazardous materials in this five square mile area. These facilities and incidents highlight the nature of the risk; the close proximity of the transportation networks and fixed facilities present a problem. This problem is highlighted by the number of incidents in the study year.

There are significant vulnerable populations in the area. These vulnerable populations are represented by schools, hospitals and other health facilities. There are 11 schools in the five square mile area. There are no major hospitals, but there is one other health facility.

The biggest risk posed in this area is the sheer number of transportation networks carrying hazardous materials. A major incident on any one of these lines would pose significant problems for the surrounding railways, highways, and pipelines. That is, because the proximity of one transportation network to the next, any incident that affects one network

could likely affect another physically (in that a hazardous materials incident could affect more than one method).

According to the CDC's heat map of social vulnerability, Woodburn is in the top quartile in the county in terms of SVI (the composite variable that considers the four elements of social vulnerability: socioeconomic status, household composition, race/ethnicity/language, and housing/transportation). More specifically, Woodburn is in the top quartile for vulnerability in terms of socioeconomic status. It is in the second quartile for vulnerability in terms of household composition. It is in the top quartiles for vulnerability in terms of race/ethnicity/language. And finally, it is in the third quartile for vulnerability in terms of housing/transportation. Interpreted, this means that socioeconomic status and race/ethnicity/language vulnerabilities are important elements to consider when dealing with hazards in Hotspot 1, whereas household composition and housing/transportation vulnerabilities are of less concern.

Hotspot 2: Silverton

The second hotspot identified is in Silverton. There are a number of factors that, together, make this area risky. This hotspot is relatively small – the entire area of the hotspot is approximately one square mile.

Silverton is home to Highway 214, which was included in the placard survey. Results of our study indicate that hazardous materials travel on Highway 214 with regularity. Highway 213 is also in this hotspot; data on Highway 213 was not collected for this project.

There is railroad in this hotspot – however, it is not in use. Initially, the CPS research team identified that Willamette Valley Railroad, owned by Union Pacific, railroad operated in the town. Feedback from Christopher Kuezni of ODOT indicated that Willamette Valley Railroad is not currently using these tracks.

There are only two fixed facilities that store hazardous materials in this area. However, there were six hazardous materials incidents in 2015-2016. This is a relatively large number for a very small, rural area. Further information is needed to understand why there were so many incidents in such a short time.

In terms of vulnerable populations, there are nine schools in the hotspot area. One (of the three) main hospitals in the county is located in the hotspot, as are six other health facilities.

According to the CDC heat map of social vulnerability, Silverton is in the second quartile for overall SVI in the county. More specifically, Silverton is in the second quartile for vulnerability in terms of socioeconomic status. It is in the third quartile for vulnerability in terms of household composition. It is in the fourth quartile for vulnerability in terms of race/ethnicity/language. And finally, it is in the fourth quartile for vulnerability in terms of housing/transportation. Interpreted for the situation at hand, this means that socioeconomic status vulnerability is an important element in Silverton. Household composition vulnerability may be a slight factor in Silverton, whereas there is relatively low vulnerability in terms of race/ethnicity/language and housing/transportation.

Hotspot 3: I-5 and Highway 213 intersection, South of Hayesville

Located in the middle of the county, this 5.3 square mile are presents a series of challenges. First, the present transportation networks are of concern. The area is bisected by I-5. There are three segments of railroad in the area – two owned by BNSF (freight run by Portland

and Western), one owned and operated by Union Pacific. These are major transportation networks for hazardous materials. Highway 213 is also in this area. Though not included in the scope of this project, it is possible that there are additional hazardous materials travelling on this stretch of road.

In terms of fixed facilities, there are 10 that store hazardous materials. These are located primarily in the corridor between the two main rail lines in the area. There was one incident involving hazardous materials in 2015-2016.

There are vulnerable populations in the area, including 15 schools. There are four other health facilities and two state buildings in the hotspot.

Hotspot 3 is in the top quartile in terms of SVI, according to the CDC. More specifically, it is in the top quartile for vulnerability in terms of socioeconomic status. It is in the top quartile for vulnerability in terms of household composition. It is in the top quartile for vulnerability in terms of race/ethnicity/language. And finally, it is in the top quartile for vulnerability in terms of housing/transportation. Interpreted for the situation at hand, this means that all elements of social vulnerability are at-play in Hotspot 3; pre-planning should pay considerable attention to these vulnerabilities.

Hotspot 4 description: Capitol Buildings

The inclusion of state owned buildings highlighted the importance of central Salem as a hotspot in this analysis. Hotspot 4 is small. Yet there are 22 state buildings. This presents a significant vulnerability. Additionally, there are nine schools in the area. Further, Willamette College is located in this vicinity which functions as both a population hub and housing for students. One of the three major hospitals in the county (Salem Health Hospital) is located within the hotspot, as are five other health facilities.

There are three rail lines in the hotspot. Additionally, there are two facilities that store hazardous materials. Finally, there is one of the county's main bridges in this hotspot. Though critical infrastructure, like bridges, was not included in the scope of this study, it was a factor in identifying this hotspot. That is, this hotspot was identified not because it has particularly high risk for a hazardous materials incident, but because an emergency effecting this area would cause extensive damage.

The capitol buildings and surrounding area are in the second quartile in terms of SVI, according to the CDC. More specifically, it is in the second quartile for vulnerability in terms of socioeconomic status. The area is in both the first and second quartiles for housing composition vulnerability (the hotspot encompasses two areas on the heat map). It is in the second quartile for vulnerability in terms of race/ethnicity/language. And finally, it is in the third quartile for vulnerability in terms of housing/transportation. Interpreted for the situation, this means that housing composition is the most significantly vulnerability for the area. However, vulnerabilities in terms of socioeconomic status and race/ethnicity/language are also significant. Housing/transportation vulnerability is not a major issue in Hotspot 4.

Hotspot 5 description: Stayton

Stayton was identified as the fifth hotspot. This area presents risk of a hazardous materials incident, as well as considerable vulnerable population.

In three square miles, there is a major highway (22) and rail line. There are five fixed facilities storing hazardous materials, at least three of which are major industrial outfits.

One of the county's three major hospitals is located in this hotspot. This county presumably serves a wide area, and its loss in an emergency situation would be very problematic for swaths of the county. Additionally, there are two other health facilities and seven schools. In the 2015-2016 time period, there were eight hazardous materials incidents in the area.

According to the heat map provided by the CDC, Stayton is in the top quartile for SVI in the county. More specifically, it is in the top quartile for vulnerability in terms of socioeconomic status. It is in the top quartile for vulnerability in terms of household composition. It is in the second quartile for vulnerability in terms of race/ethnicity/language. And finally, it is in the second quartile for vulnerability in terms of housing/transportation. Interpreted for the situation at hand, this means that though all elements of social vulnerability require attention in Stayton, socioeconomic status and housing composition vulnerabilities require the greatest attention.

V. Recommendations

Phase II

Overall, we recommend that a second phase of this project is conducted. Phase II should focus on the real-life planning needs of the hotspots identified in this study. That is, the most concrete recommendation that we can give now is this: now that you have this information, now that you know where the danger zones are, how are you going to inform the people and what are they going to do with it?

To that end, we recommend a three-step project for Phase II. This project has already been developed by the research team, and FEMA funding for the project is expected beginning in October 2016. The CPS research team is excited to work with the Marion County research team on another project of this caliber and scope.

Phase II is in its design phase; we expect that some modifications will be made after planning meetings, and as the project begins. However, here is the project as we understand it now.

Step 1: Creating a heuristic tool for emergency planning

One of the main takeaways of the HMCFS is that there are many elements at-play in any emergency management scenario. In terms of Phase II, this means that there is no one-size-fits-all answer for creating an emergency plan. To some extent, every organization that is creating an emergency plan will have a unique slate of variables to consider.

To that end, Step 1 of Phase II is to create a heuristic tool to guide emergency planning. Practically, this means creating a highly detailed survey tool. The research team will develop a series of questions to determine the types of risk and vulnerable populations in a location. This information will then be used to determine what the appropriate emergency plan looks like.

Step 2: Creating a data collection tool

To stay in step with already-established data collection methods in the county, Phase II will use a GIS Collector App to collect and store data. The app will pose the questions, formed in Step 1, and provide the tool for collecting responses.

The CPS research team will aid in the theoretical formation of the application. We will guide the substance and phrasing of the questions. The application development, however, will be undertaken by the Marion County Emergency Management team. The CPS research team will help as needed.

Step 3: Five sample plans -- using the heuristic and data collection tools

The final step of the project will be testing the heuristic tool and data collection tool developed in Steps 1 and 2. Step 3 will focus on writing five sample emergency plans. The CPS research team recommends that the five sample emergency plans be based in the five hotspots identified in this study.

The CPS Research team will use the heuristic tool, and the GIS Collector Application to write the sample plans. After test-driving the tools, the CPS research team will make any and all appropriate alternations to the tools. This will inform the final product that is submitted.

Researcher Biographies

Stephanie Hawke, Senior Research Assistant, PhD candidate

Stephanie Hawke is the Senior Research Assistant for the Center for Public Service. She is a doctoral student in Public Affairs and Policy program at Portland State University (estimated completion in June 2017), and holds a BA in International Relations from University of California, Davis (completed in 2009). Her applied research focuses on local government and issues of civic engagement and inclusion. Her academic research focuses on comparative urban politics, the politics of representation, and policy analysis. She is currently writing on her dissertation, "The Dynamic Returns of Representation: Descriptive Representation and Policy Outcomes in Urban Government."

Aaron Kaufman, Graduate Researcher, MPA candidate

Aaron Kaufman is a second year Master of Public Administration candidate specializing in Local Government at Portland State University's Hatfield School of Government. His passions include environmental and socio-economic equality policy and innovative public management.

Robert Cheney, Graduate Researcher, MPA candidate

Robert Cheney is a MPA candidate with an emphasis in local government at the Hatfield School of Government at PSU. His interests include city/county management and public policy implementation.