6. CONCLUSIONS

1. The conclusions drawn from this study must be tempered by the fact that there were data limitations/gaps particularly for air transportation of hazardous materials.

2. Of the over 28 trillion pounds of hazardous materials shipped within the State of Alaska during this three year period, 99.86% was attributable to the natural gas production and transport within the State.

3. Of the remaining 302 billion pounds of hazardous materials shipped within the State of Alaska during this three-year period, 91% was attributable to HC 3 (Flammable Liquid Materials), specifically petroleum crude oil production and transport.

4. While the EHS Commodities transported within the State of Alaska varied slightly in from year to year volume for certain commodities, the ranking of the top six (6) commodities was very consistent. The top EHS Commodities by volume shipped were (1) Sodium Cyanide, (2) Chlorine, (3) Sulfuric Acid, (4) Anhydrous Ammonia, (5) Formaldehyde, and (6) Phosgene. The Subareas that experienced the greatest volumes of EHS shipments were (1) Cook Inlet, (2) Interior Alaska, (3) Kodiak Island, (4) Prince William Sound, (5) the Aleutians, (6) North Slope, and (7) Northwest Arctic. According to the data received and analyzed, the remaining Subareas (Southeast Alaska, Western Alaska, and Bristol Bay) saw little (less than 150 lbs) to no volume of EHS commodities shipped during the three-year time period evaluated.

5. The top three HS commodities transported within the State of Alaska were HC 2 (Gas Materials), HC 3 (Flammable Liquid Materials), and ORM-D (Other Regulated Materials). These commodities dominated the total volumes by several orders of magnitude due primarily to natural gas, crude oil, and produced water production and transport volumes within the State. After these commodities, HC 9 (Miscellaneous Materials), HC 5 (Oxidizer & Organic Peroxide Materials), and HC 8 (Corrosive Materials) consistently dominated the volumes of hazardous materials shipped from year to year. Following the trend noted above for the top three hazardous substances, the Subareas with the highest total volumes of hazardous materials shipped were (1) North Slope, (2) Cook Inlet, (3) Interior Alaska, and (4) Prince William Sound. These Subareas dominated the total volumes shipped over the three-year period by several orders of magnitude making up 99.99% of the total volume.

6. The top petroleum commodities transported within the State of Alaska remained very consistent in terms of product by volume from year to year. Crude oil shipments via the Trans-Alaska Pipeline and Cook Inlet Pipeline dominate the petroleum products shipped

within the state. The AFSC Pipeline provides significant volumes of jet fuel to the Ted Stevens International Airport day-to-day as well. As a direct result, the primary Subareas potentially impacted by these commodities are the North Slope, Cook Inlet, Interior Alaska and Prince William Sound. In general, the petroleum products most prevalent in Southeast Alaska, Kodiak Island, Aleutians, Bristol Bay, Western Alaska, and Northwest Arctic were primarily gasoline, diesel and heating oil type commodities.

7. By volume, commodities transported by pipeline dominate the total volume of hazardous materials shipped within the State specifically in the Hazard Class 2.0 and 3.0 categories (HC 2.1: Natural Gas, UN ID Number 1971, HC 3.0: Petroleum Crude Oil, UN ID Number 1267), and HC ORM-D (Other Regulated Materials): Produced Water, no UN ID Number).

8. The North Slope Subarea consistently maintains the highest volume of hazardous materials commodity shipments than any other Subarea in the State accounting for 63% of the total volume. The primary drivers for this conclusion are the presence of the North Slope Natural Gas, Produced Water, and Trans-Alaska pipeline systems. The annual production volumes from these pipelines are almost 50% higher than the Cook Inlet subarea. For Cook Inlet, the regional pipelines and the Alaska Railroad contribute greatly to the total volume for Cook Inlet that constitutes 36% of the total State volume. Both the North Slope and Cook Inlet Subareas are two orders of magnitude higher than the next highest volume subareas. Table 6-1 displays the total volume for each subarea.

Table 6-1. Subarea ranking based on total hazardous materials volume (3-Year total)[37]

Subarea	Total 3-Year HS Volume	Percent of Total Volume Shipped
North Slope	50,212,399,960,330	63.1589585%
Cook Inlet	28,721,315,976,165	36.1267019%
Interior Alaska	296,872,481,267	0.3734169%
Prince William Sound	270,960,131,488	0.3408234%
Western Alaska	19,515,026	0.0000245%
Northwest Arctic	15,851,238	0.0000199%
Southeast Alaska	14,460,255	0.0000182%
Aleutians	12,513,297	0.0000157%
Bristol Bay	11,447,867	0.0000144%
Kodiak Island	5,185,478	0.0000065%

[37] The volume/shipment for the North Slope, Cook Inlet, Interior and Prince William Sound are extremely high due to the shipment of HC 2.1 and 3.0 commodities via pipeline and/or railcar.

9. In general, the Cook Inlet Subarea experiences the highest number of hazardous materials shipments within the State, via all transportation modes, almost doubling the total for the Interior.

Table 6-2. Subarea ranking based on total number of hazardous materials Shipments (3-Year total)

Subarea	Total 3-Year HS Volume	Total 3-Year Shipments	Percent of Total Volume Shipped
Cook Inlet	28,721,315,976,165	5,479	36.1267019%
Interior Alaska	296,872,481,267	2,874	0.3734169%
North Slope	50,212,399,960,330	1,367	63.1589585%
Prince William Sound	270,960,131,488	719	0.3408234%
Aleutians	12,513,297	382	0.0000157%
Southeast Alaska	14,460,255	357	0.0000182%
Kodiak Island	5,185,478	245	0.0000065%
Western Alaska	19,515,026	207	0.0000245%
Northwest Arctic	15,851,238	192	0.0000199%
Bristol Bay	11,447,867	78	0.0000144%

10. The Subareas with the highest total volume of hazardous materials shipped were (1) North Slope, (2) Cook Inlet, (3) Interior Alaska, and (4) Prince William Sound. These Subareas dominated the total volumes shipped over the three-year period by several orders of magnitude making up 99.99% of the total volume. In order of total volume shipped, the remaining six subareas are ranked as follows: (5) Western Alaska, (6) Northwest Arctic, (7) Southeast Alaska, (8) Aleutians, (9) Bristol Bay and (10) Kodiak Island. Table 6-2 displays the ranking of subareas by total shipments. Table 6-2 lists the ranking of Subareas by total volume shipped.

11. In general, by volume, the commodities transported by pipeline dominate the total volume of hazardous materials shipped within the State by several orders of magnitude. Specifically, the primary commodities are natural gas, crude oil and produced water. Additionally, the volume of shipments by rail is significantly higher than all other remaining modes of transportation given the capacity of the various railcar options. The North Slope recognizes the highest volume of hazardous materials transported and is nearly 44% higher than the next highest Subarea (Cook Inlet). The Cook Inlet Subarea however, experiences the highest number of shipments of any other Subarea nearly doubling the number of shipments in Interior Alaska and more than tripling the number of shipments in the North Slope Subarea.

12. When only air, highway and marine transportation modes are evaluated, the Interior Alaska Subarea is the subarea with the highest volume of hazardous materials transported. Table 6-3 displays the subarea ranking when only evaluating air, highway and marine modes of transportation.

Table 6-3. Subarea ranking based on total hazardous materials Volume Shipped for Air, Highway and Marine (3-Year total)

Subarea	Total 3-Year HS Volume	Percent of Total Volume Shipped
Interior	380,563,478	34.6%
Cook Inlet	335,762,449	30.5%
North Slope	173,300,099	15.7%
Prince William Sound	132,024,143	12.0%
Western Alaska	19,515,026	1.8%
Northwest Arctic	15,851,238	1.4%
Southeast Alaska	14,460,255	1.3%
Aleutians	12,513,297	1.1%
Bristol Bay	11,447,867	1.0%
Kodiak Island	5,185,478	0.5%

13. The Pipeline mode of transportation accounts for 99% of the total volume of hazardous materials transported due to the volumes of Natural Gas, Crude Oil and other petroleum/HC 3.0 commodities (e.g. Jet Fuel, Diesel) carried within the North Slope pipelines, Trans-Alaska Pipeline, Cook Inlet Pipeline, AFSC Cross-town Pipeline, and the Kenai-Anchorage Pipeline.

14. Second to pipelines and after extracting the pipeline volumes, the railroad constitutes 97.7% of the volume of hazardous materials commodities shipped when compared to the other three transportation modes (air, highway and marine). The top rail corridors identified for the movement of hazardous materials are located within the Cook Inlet Subarea. Like pipeline shipments, commodities are consistent from year to year within the State.

15. The highway mode of transportation accounts for the majority of the total number of shipments within the State. Overall, by volume, the highway mode of transportation accounts for 0.0016% of the total volume shipped within the state. After extracting the pipeline data, the volume of hazardous materials commodities shipped makes up only 1.6% of the total volume, and after extracting the rail data the volume of hazardous materials shipped by highway constitutes 69% of the volume between highway, marine and air. The highway transportation mode moves hazardous materials that span the spectrum of commodities.

16. The top 5 highway corridors in terms of volumes of hazardous materials shipped are (1) Alaska Highway, (2) North Slope Haul Road, (3) Glenn Highway, (4) Richardson Highway, and

(5) Sterling Highway. In general, the primary highway corridors that are utilized to transport hazardous materials are located in and around, and in between the cities of Anchorage, Fairbanks, Valdez, and locations on the North Slope. Highway transportation is the dominant method for transportation of hazardous materials in terms of the total number of shipments in any given year.

17. It is suspected that transport of Chlorine is one of the highest EHS commodities shipped via the highway but the dataset did not support this. There were large marine shipments coming into Anchorage, but there was no equivalent trucking information for Chlorine beyond Anchorage.

18. Overall by volume the marine mode of transportation accounts for 0.0006% of the total volume shipped within the State. After extracting the pipeline data, the marine mode of transportation accounts for .6% of the total volume, and after also extracting the rail data the volume of hazardous materials shipped by marine constitutes 26% of the total volume between highway, marine and air. In general, the primary marine corridors for hazardous materials transportation are in and around Cook Inlet and associated ports, the Southeast Alaska Inside Passage and associated ports, and routes from Cook Inlet through the Aleutians and up to the North Slope. Marine Transportation of hazardous materials is second to highway in terms of the total number of shipments in any given year.

19. Air cargo transportation routes were analyzed by number of hazardous materials shipments from Ted Stevens International Airport in Anchorage to airports statewide, as reported by one air cargo carrier. The primary hazardous material commodities transported were HC 1 (Explosives), HC 3 (Flammable Liquid Materials), HC 8 (Corrosive Materials), and HC 9 (Miscellaneous Materials). In general, it is suspected that this combination of hazardous material commodities is fairly representative of what the other air cargo carriers would carry within the State. Based on the limited data received and analyzed, Bethel and Kotzebue consistently experienced the highest number of hazardous material shipments from year to year. As there are over 30 air carriers that could transport hazardous materials within the State of Alaska, this preliminary conclusion could change significantly if additional air cargo data were made available.

20. The 2008 Fixed Facility storage volumes represent 0.2% of the total volume shipped in 2008, via all transportation modes. After extracting the pipeline volume data, the Fixed Facility storage volume is five times larger than the total volume shipped in 2008. In several cases, the storage volume may go unchanged over extended periods of time, especially where substances are recycled and remain in the facility system. Examples include anhydrous

ammonia (used in refrigeration systems) and sulfuric acid (used for power generation and batteries).

21. The large majority of Tier Two Fixed Facilities are located in/around Cook Inlet and along the corridor between Anchorage and Fairbanks.

22. One of the primary limitations of this study was the reliance on disparate sources of data that varied tremendously from source to source in terms of detail, accuracy and coverage for the full spectrum of shippers. As a result, a significant amount of time was dedicated to data evaluation, refinement, interpretation and compilation to ensure systematic analyses could be conducted. While this result was not ideal and directly impacted the ultimate depth and detail of the analysis, very useful results were obtained.

23. The ability to QA/QC data received from multiple sources was sometimes problematic in that there was no foundation upon which to validate data entries. While in some cases errors were easy to identify, e.g. a misspelling, there was no way to determine if a specific volume entry was accurate or not. Consequently, there are some volume entries that are suspect. Assumptions can be made to correct those apparent input errors, but the assumptions were not able to be validated.

24. The Alaska Railroad Corporation prepares annual summaries of materials transported by rail. This list is based primarily on the broad hazardous materials categories (e.g. HC 1, 2, 3, 4, etc.), and not by specific HC divisions (e.g. 1.1, 2.1, 4.2, etc.). Discussions with the Alaska Railroad yielded key insight into some of the specific chemicals or substances shipped within each category.

25. A Hazardous Material Traffic Analysis for 2009 was received from Alaska West Express (AWE) that summarized percentages of 3,200 hazardous material shipments transported within the State during 2009. Although the nature in which the data was presented prevented it from being effectively integrated into the dataset that was evaluated, there were critical pieces of this report that were utilized to help facilitate development of this study.

26. As the conclusions drawn from a study of this nature are only as good as the data that is evaluated, it is critical that the dataset be as accurate and complete as possible to enable a more detailed capture of data (e.g. all by hazard class division and specific hazardous material description), and an assessment that yields greater granularity.

7. Recommendations for Future Hazmat Commodity Studies.

1. That additional data from all / more of the Air Cargo Carriers operating in the State be obtained to further delineate the transportation of hazardous materials via aircraft.

2. That on-site visits to air cargo carriers be conducted to facilitate capturing the hazardous materials air cargo data.

3. That for future studies a broader spectrum of shippers in the highway, marine and air transportation modes be accessed to further validate the conclusions/findings of this and follow-on reports.

4. That for future statewide studies, a longer time-line be identified and set aside (12 to 18 months) to conduct the Hazardous Material Commodity Flow Study.

5. That future Hazardous Materials Commodity Flow Studies should utilize field personnel at strategic shipping locations to identify and document shipments of hazardous materials via the various modes of transportation. This field-based approach, vice relying on shippers to provide the data would yield a more consistent and more accurate dataset across all modes of transportation to be utilized for an analysis of this nature.

6. That future studies consider focusing on a smaller regional or more localized on-site study to provide greater accuracy and granularity on the transportation corridors used to transport hazardous materials. The deeper level of detail will further enhance the information gleaned and used in the respective Subarea plans to increase awareness of first responders, and to develop community response preparedness.

7. That the methodology outlined in the PHMSA Guide to Conducting Hazardous Materials Commodity Flow Studies, although somewhat dated, be used as a guide for any subsequent studies.

8. That a database, similar to the Microsoft ACCESS Database generated for this report, be utilized to capture and maintain hazardous materials commodity flow data. A database of this structure enables simplified data entry, data analysis, report generation, and data maintenance.