Nevada Hazardous Commodity Flow Study

Final Report

prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.

NEVADA DOT SAFE AND CONNECTED

August 16, 2019

www.camsys.com

final report

Nevada Hazardous Commodity Flow Study

Final Report

prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, CA 94607

date

August 16, 2019

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Avgas	Aviation gasoline
BTS	Bureau of Transportation Statistics
CAMEO	Computer-Aided Management of Emergency Operations
CAPP	Chemical Accident Prevention Program
CFATS	Chemical Anti-Terrorism Facility Security
CS	Cambridge Systematics
DBE	Disadvantaged Business Enterprise
DEP	Department of Environmental Protections
DHS	Department of Homeland Security
DOT	Department of Transportation
EHS	Extremely Hazardous Substances
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FAA	Federal Aviation Administration
FAC	Freight Advisory Committee
GIS	Geographic Information System
Hazmat	Hazardous materials
HF	Hydrogen Fluoride
HHS	Highly Hazardous Substances
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICMI	International Cyanide Management Institute
IEM	Innovative Emergency Management
KCN	Potassium Cyanide
LAS	McCarran International Airport
LEPCs	Local Emergency Planning Committees
LFL	Lower Flammable Limit
LTL	Less-than-Truckload
MPO	Metropolitan Planning Organization
NA	North America
NCNN	Northern California Northern Nevada
NDEP	Nevada Division of Environmental Protections
NDOT	Nevada Department of Transportation

NOAA	National Oceanic and Atmospheric Administration
ORM-D	Other Regulated Materials
OSHA	Occupational Safety and Health Administration
PADD 5	Petroleum Administration for Defense District 5
PETN	Pentaerythritol tetranitrate
PG	Packing Group
PHMSA	Pipeline and Hazardous Materials Safety Administration
PMT	Program Management Team
PVC	Polyvinyl Chloride
RMP	Risk Management Plan
RNO	Reno-Tahoe International Airport
RQ	Reportable Quantity
SCSN	Southern California Southern Nevada
SDS	Safety Data Sheets
SERC	State Emergency Response Commission
SFMO	State Fire Marshal's Office
SFPP	Santa Fe Pacific Pipeline
TPQ	Threshold Planning Quantity
TRI	Toxic Release Inventory
UNEP	United Nations Environment Program
UN	United Nations
UP	Union Pacific Railroad
USDOT	United States Department of Transportation
USGS	United States Geological Survey

Executive Summary

The Nevada Department of Transportation (NDOT) contracted Cambridge Systematics (CS) assisted by Silver State Traffic to conduct a Hazardous Commodity Flow Study that documents hazardous material (hazmat) transportation routes and modes in Nevada to help local, regional, State, and Federal officials and first responders better understand the volumes and nature of hazmat movement in the State.

Methodology

The study team employed a three-part approach to documenting hazmat transportation in Nevada. These parts included a (1) priority hazmat identification process; (2) petroleum supply chain analysis; and (3) hazmat roadside surveys at 18 locations around the State. This information will help transportation officials prioritize infrastructure investments and emergency managers prepare for the hazmats carried in the largest volumes and those that pose the greatest hazard to health and safety; it will also help officials position hazmat response resources in locations with the highest risks.

Stakeholder Outreach

The team held meetings and briefings with the groups noted below to facilitate coordination and receive necessary guidance throughout the project.

Nevada State Emergency Response Commission

The Nevada State Emergency Response Commission (SERC) reviewed study progress and provided the information to the Local Emergency Planning Committees (LEPC) and Tribal Nations for review and input.

Nevada State Freight Advisory Committee

The Freight Advisory Committee (FAC), a single advisory committee for all NDOT freight-related studies and actions, received progress reports and opportunities to comment at each quarterly meeting.

Industry Outreach

Since many companies and industries are involved in the transport of hazardous commodities, outreach is a critical component to this project. The study team conducted extensive telephone interviews and multiple in-person meetings with 60 representatives from industrial manufacturers, mines, fuel terminals, and other industries that store hazmat, large shippers/receivers, trucking companies, railroads, pipelines, and chemical companies.

Roadside Hazmat Surveys

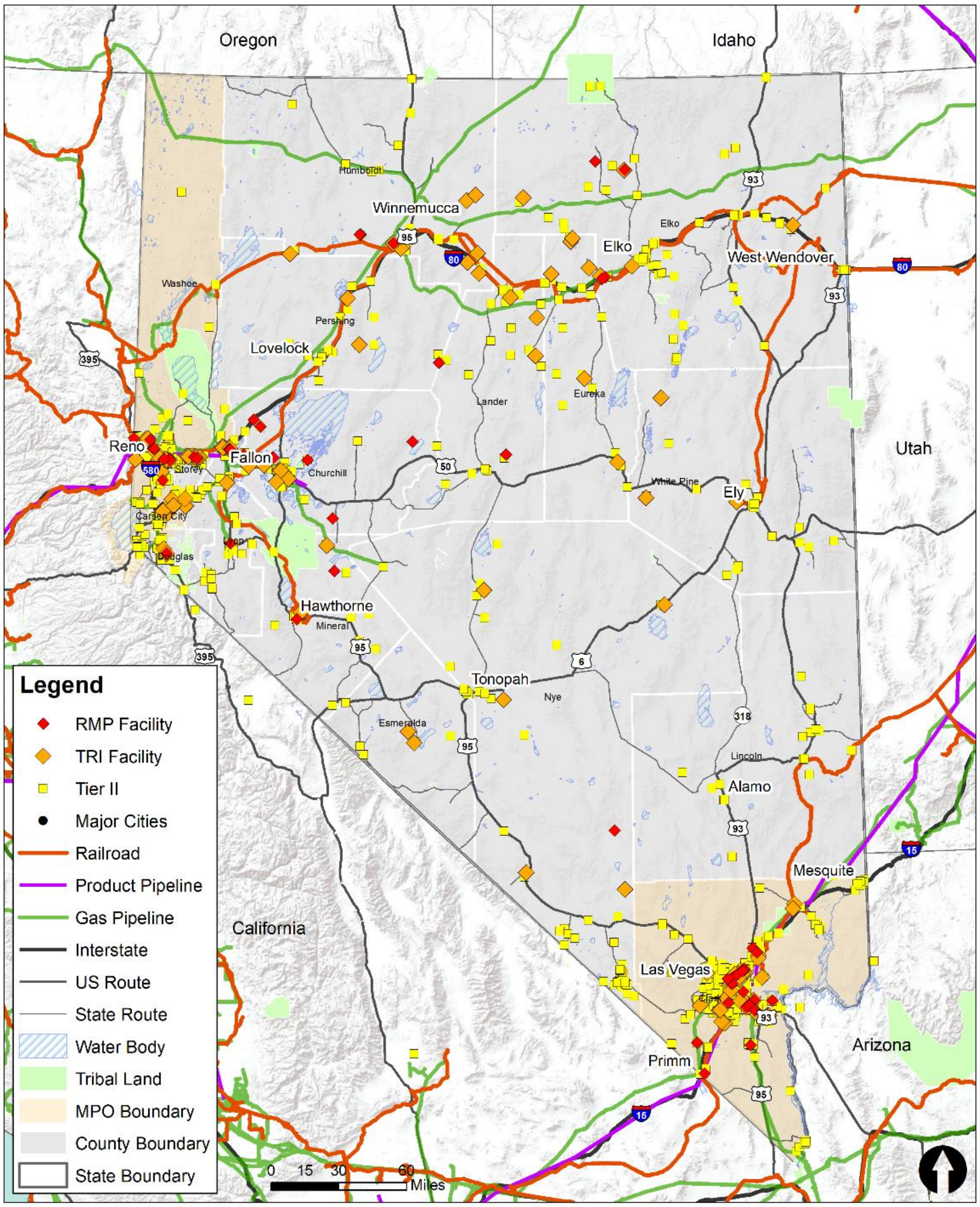
Silver State Traffic, a registered Disadvantaged Business Enterprise (DBE) with NDOT, collected hazmat information by identifying truck volumes, types, and hazmat placards on specific roadways throughout the State.

Data Collection

Hazmat Facility Data

The study team collected data from Federal, State, and local sources to determine the location of hazmat facilities and the distribution methods for hazmats throughout the State. This included geographic information system (GIS) shapefiles, and hazmat facility data from NDOT, the Nevada Division of Environmental Protections (NDEP), the Chemical Accident Prevention Program (CAPP), and the State Fire Marshal's Office (SFMO).

Figure ES.1 Hazmat Facilities Map



Source: EPA, NDEP CAPP, SFMO, Cambridge Systematics.

Chemical Selection Process

Using the data collected from EPA reports, the study team focused on toxic and high-volume flammable chemicals and applied selection criteria to organize the chemicals into a list of priority chemicals for analysis. EPA requires industries to file certain reports depending on stored hazmat quantities on site. They include: (1) Tier II reports if industries handle chemicals greater than a "reportable quantity" (RQ); (2) Toxics Release Inventory (TRI) reports if stored hazmats are released into the air, ground, or water and/or (3) Risk Management Plans RMP reports if they store hazmats exceeding the threshold planning quantity (TPQ) for extremely hazardous substances (EHS).

The study team identified four selection criteria to "rank" the priority chemicals:

- Isolation Distance.
- Threshold Planning Quantity.
- Lower Flammability Limit.
- Flash Point.

Using the list of hazmats stored at Nevada facilities, the team conducted a hazmat analysis using the criteria above to sort and rank the hazmats in order of impact to health and safety. For each criterion, a cumulative score was established to help with the ranking process. For example, the larger the isolation distances for large spills, the higher the score and therefore the higher the ranking for that chemical. The hazmat analysis provides justification for which companies storing or transporting priority chemicals to contact for determining the transport routing, frequencies, and volumes of priority chemicals.

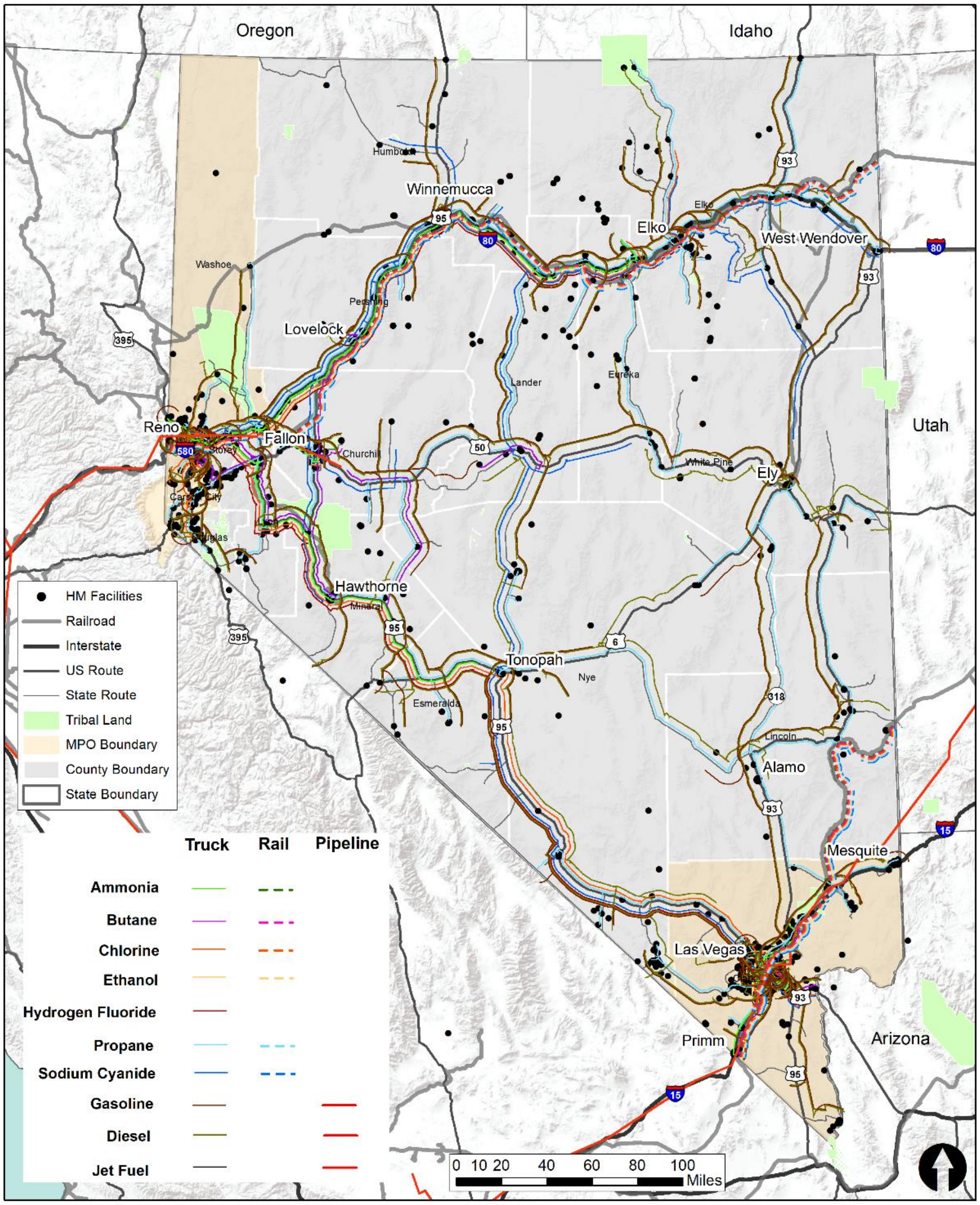
Table ES.1 Priority Chemicals for Study

#	Chemical Name	Score	Chemical Uses	Facilities	EHS
1	Anhydrous Ammonia	4	Refrigerant, fertilizer	18	Yes
2	Butane	5	Fuel and blending	6	No
3	Chlorine	7	Water treatment	6	Yes
4	Ethanol	3	Biofuel	5	No
5	Hydrogen Fluoride	4	Manufacturing	8	Yes
6	Nitrogen Dioxide	6	Catalyst, oxidizing agent	3	Yes
7	Potassium Cyanide	4	Mining and electroplating	2	Yes
8	Propane	5	Fuel and heating	7	No
9	Sodium Cyanide	4	Mining operations	18	Yes
10	Titanium Tetrachloride	4	Titanium, whitening	4	Yes

Once the priority chemicals were selected, the information provided a baseline to determine which industries store the priority chemicals in the State. From this list of priority chemical industries, the study team conducted outreach calls and interviews to collect additional hazmat transportation information, including origin-destination, frequency, volume, and mode of transport. Some interviews were conducted in person, most interviews were conducted by conference calls between October 2018 and March 2019.

Mapping priority chemicals involves a combination of techniques previously described in this report. The Statewide Hazmat Facilities Map served as a starting point for chemical transport destinations. Industry outreach and supply chain analysis techniques helped to determine chemical supply sources from in-State and out-of-State refineries, distributors, and manufacturers. Interviews with stakeholders and industry contacts helped to determine hazmat demand, transport frequencies, and volumes. Using the results of the priority chemicals, the CS Team added the three petroleum flows from the Petroleum Supply Chain Analysis to create a “composite” map of 10 hazmat routes. The resulting Hazmat Composite Map in Figure ES.2 depicts 10 flows across Nevada highways, railroads and pipeline by route but not volume.

Figure ES.2 Statewide Hazmat Composite Map



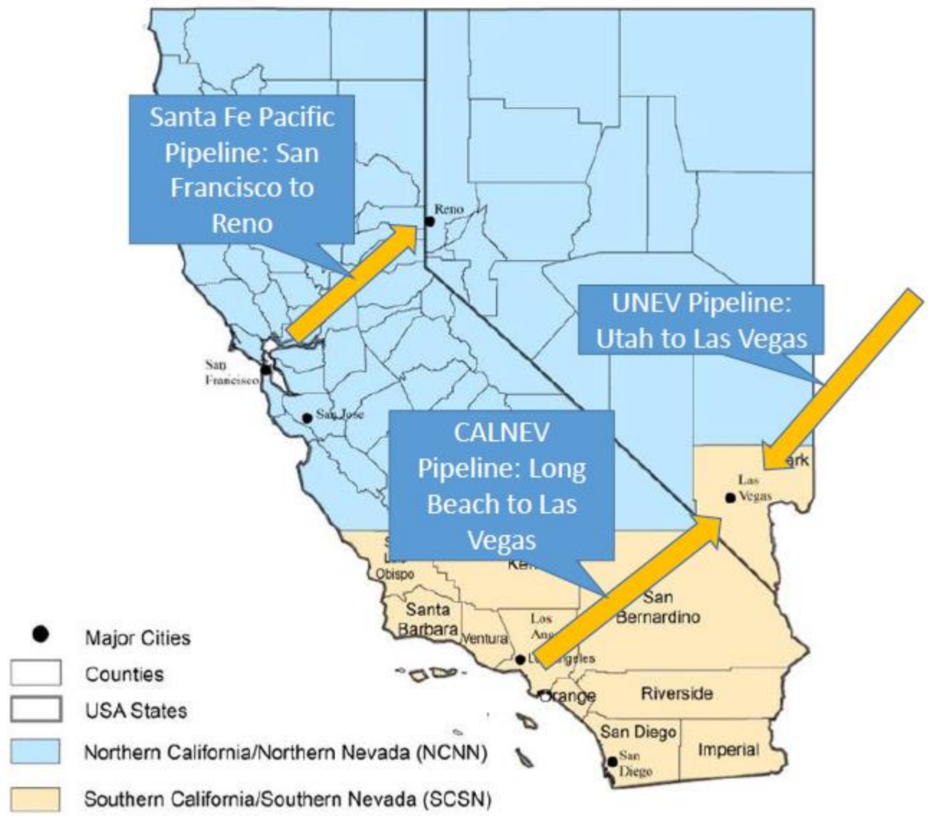
Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

Petroleum Supply Chain Analysis

To supplement the priority hazmat analysis, the study team also conducted a petroleum supply chain analysis. Refined petroleum products represent 86.4 percent of all hazmat shipments transported in the United States, including the required transportation fuels for automobiles, trucks, trains, and airplanes throughout Nevada. Though the volume of petroleum products on the roads is greater than any other hazmat, emergency responders have experience with handling petroleum-related incidents. The primary fuels evaluated in this effort included gasoline, diesel, and aviation fuel.

Nevada relies on neighboring States for its petroleum supply; Southern California and Utah refineries supply Southern Nevada and Northern California refineries supply Northern Nevada.

Figure ES.3 PADD 5 Regional Markets in California/Nevada, with SCSN Counties



Source: Cambridge Systematics. Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

From California and Utah Refineries to Nevada Petroleum Terminals

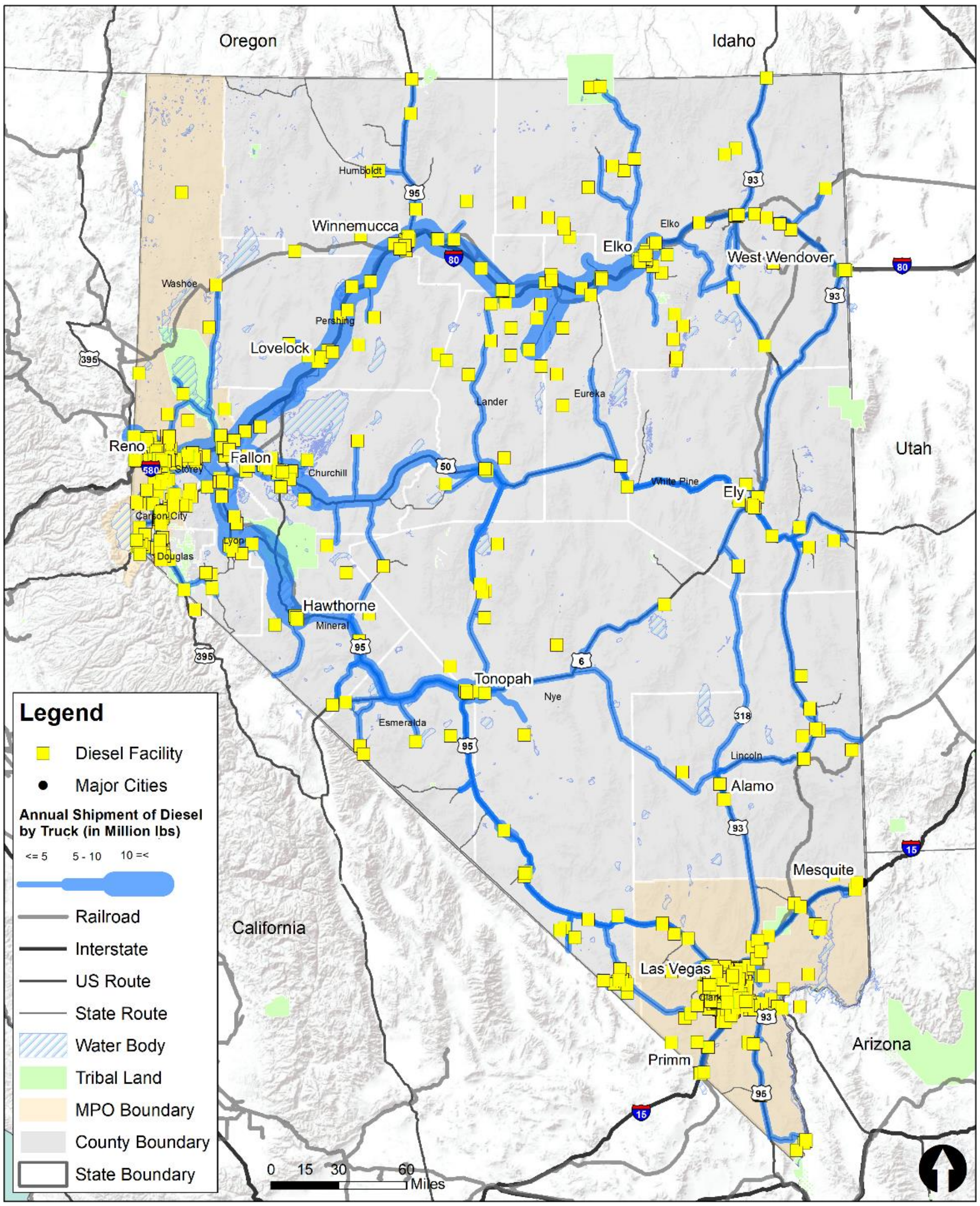
In Southern California, the CALNEV pipeline transports gasoline, jet fuel, and diesel fuel from Colton Terminal to Kinder Morgan's Las Vegas Terminal, which is adjacent to Nellis Air Force Base in Southern Nevada. From Utah, the UNEV pipeline transports petroleum products into Las Vegas from Woods Cross, Utah to Holly Energy's Terminal at Apex Industrial Park. In Northern California, Kinder Morgan's Santa Fe Pacific Pipeline (SFPP) North Line transports gasoline, jet fuel, and diesel fuel from Concord Station to the Sparks Terminal in Northern Nevada.

Petroleum Distribution by Truck

Petroleum products are transported from storage facilities to retail petroleum facilities throughout the State. The team used the Nevada Statewide Hazmat Database to identify refined petroleum facilities by type and develop estimates for refined petroleum distribution across the State. Applying a 250-mile radius around Las Vegas for petroleum distribution, the study team used a shortest path algorithm to determine likely routing options, with the assumption that truck drivers will primarily stay on Interstates and U.S. highways as much as possible.

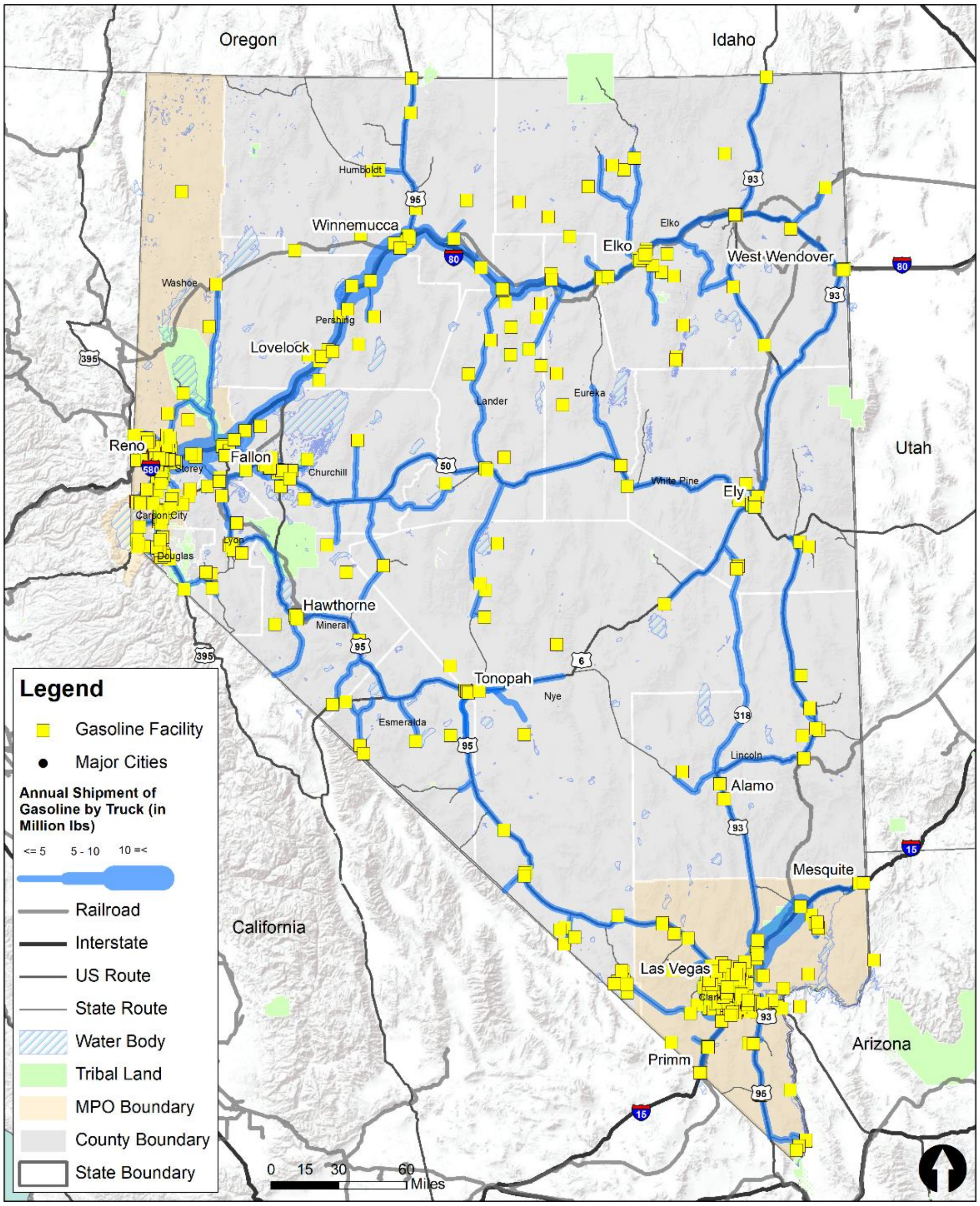
The petroleum distribution maps below demonstrate that the volume of diesel on the roadways is greatest in Northern Nevada, while Southern Nevada is dominated by gasoline. These results are consistent with the large urban population around Las Vegas in the south and the increased prevalence of industrial facilities and mining operations in Northern Nevada. Figure ES.4 and Figure ES.4 illustrate the likely distribution of diesel and gasoline by truck in Nevada.

Figure ES.4 Statewide Diesel Fuel Distribution by Truck



Source: SFMO, Kinder Morgan, Cambridge Systematics.

Figure ES.5 Statewide Gasoline Fuel Distribution by Truck



Source: SFMO, Kinder Morgan, Cambridge Systematics.

Hazardous Materials Classification

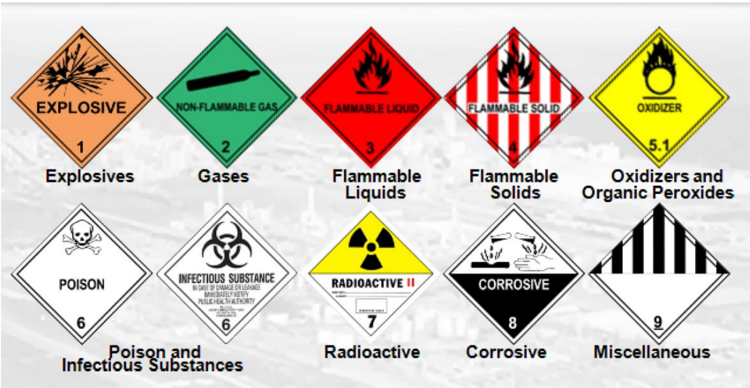
Hazmats are classified according to the risks that they pose. The U.S. Department of Transportation (U.S. DOT) established nine hazmat classifications in order to provide consistency across all agencies that regulate commercial shipping. There are multiple sources for identifying the defined hazards of a material, including shipping papers, safety data sheets (SDS), container labels, and markings. Hazmat placards or labels found on packaging reference the U.S. DOT hazard class of the material. Some classes include multiple hazards denoted by the division number.

Table ES.2 Hazardous Material Classes

Class	Description
Class 1	Explosives
Class 2	Gases
Class 3	Flammable and Combustible Liquids[1]
Class 4	Flammable Solids
Class 5	Oxidizing Substances, Organic Peroxides
Class 6	Poisonous (Toxic) Materials and Infectious Substances
Class 7	Radioactive Materials
Class 8	Corrosive Materials
Class 9	Miscellaneous Hazardous Materials

[1] Includes materials whose flash point is not more than 141°F.

Figure ES.6 Hazmat Classification Placards



Source: U.S. DOT, et al. Emergency Response Guidebook, 2016.

In Nevada, the study team identified hazmat flows for 5 of the 9 hazard classifications. Not all hazmat classifications were identified as part of the chemical selection process and not all hazmat classes were identified during the Hazmat Roadside Surveys conducted at 18 locations around the State. Radioactive materials were not part of the study scope of work. Table ES.3 illustrates the 5 hazmat classifications identified as part of this study.

Table ES.3 Nevada Hazardous Commodity Flow Study Classifications

Class	Description	Study Hazardous Materials
Class 2	Gases	Butane, Chlorine, Propane, Ammonia, Nitrogen Dioxide
Class 3	Flammable and Combustible Liquids	Gasoline, Diesel, Jet Fuel, Ethanol
Class 5	Oxidizing Substances, Organic Peroxides	Ammonia, Chlorine
Class 6	Poisonous (Toxic) Materials and Infectious Substances	Potassium Cyanide, Sodium Cyanide, Titanium Tetrachloride
Class 8	Corrosive Materials	Hydrogen Fluoride, Chlorine, Hydrofluoric Acid, Titanium Tetrachloride

Source: Industry interviews, Cambridge Systematics.

Conclusion

Hazmats are essential to Nevada's industries that manufacture chemicals, protect public water, and sewer systems, fuel transportation services and mine precious minerals. Because of Nevada's location between National east-west freight flows, approximately one third of U.S. hazmats pass through the State.[1] Nearly all of Nevada's refined petroleum is transported from California and Utah by pipeline and distributed to mining operations and retail petroleum facilities by truck; this includes gasoline, diesel, and jet fuel. Nevada industries use more diesel than gasoline, which is the opposite of most States, and likely the result of the extensive mining operations in Northern Nevada counties.

Nevada's top hazmats of concern are similar to those in other States, including the truck and rail transportation of anhydrous ammonia, butane, chlorine, ethanol, and propane. However, Nevada specializes in mining precious minerals and specialty manufacturing facilities, resulting in the transportation of sodium cyanide and potassium cyanide, which is not typically used in significant volumes in other States. Several large-scale green energy utilities use butane and propane to transfer energy using specialty turbines. Butane is also used to increase octane levels in gasoline mixtures. Most of the ethanol transported through the State by rail is destined for West Coast ports for export, and only 10 percent of ethanol is used in Nevada for biofuel blending purposes. However, Nevada and California are using proportionately higher volumes of ethanol than other states, and this is the reason for increasing amounts of ethanol in retail gas stations.

Air cargo transportation of hazmats represents a small fraction of all air cargo, estimated by several air cargo carriers as less than one percent. Air cargo hazmat shipments are restricted by regulation that limits the types and amounts of hazmat that may be shipped. Dry ice and lithium batteries are shipped by air but are not the only hazmats shipped by air. Medical aerosols, small amounts of radioactive materials, and high value epoxies can be shipped by air.

By identifying top hazmat volumes, routes, and frequencies, transportation officials will have more information on which transportation facilities transport high volumes of hazmats. This will help officials prioritize transportation infrastructure investments for highway, rail, and pipeline facilities, first responders train for chemicals and fuels likely to be transported in their counties, and emergency managers locate hazmat response assets and resources in appropriate locations. At the local level, LEPCs will be able to use this information to conduct training and exercise programs that match up with the likely hazards in their jurisdictions.

[1] ICF International, John A. Volpe National Transportation Systems Center (U.S.) "Guidance for Conducting Hazardous Materials Flow Surveys." Cambridge: U.S. Department of Transportation, 1995.

1.0 Introduction

The Nevada Department of Transportation (NDOT) contracted Cambridge Systematics (CS) assisted by Silver State Traffic to conduct a Hazardous Commodity Flow Study that documents hazardous material (hazmat) transportation routes and modes in Nevada to help local, regional, State, and Federal officials and first responders better understand the volumes and nature of hazmat movement in the State.

This report is organized into 12 sections with three appendices. Section 1.0 introduces hazardous materials (hazmats) in the context of freight transportation. Section 2.0 describes the three-part approach to documenting hazmat transportation in Nevada. Section 3.0 summarizes the stakeholder outreach process. Section 4.0 describes the data collection techniques to identify hazmat facilities which served as the basis for identifying commodity flows. Section 5.0 summarizes the chemical selection process used to identify priority hazmats. Section 6.0 describes the priority hazmats and maps showing volumes and flows. Section 7.0 presents the petroleum supply chain analysis used to describe how refined petroleum products are transported in the state. Section 8.0 describes the limited hazmats transported via air cargo. Section 9.0 provides an overview of the nine hazard classes used to identify hazmats for surface transport with maps. Section 10.0 summarizes the results of the roadside surveys used to corroborate hazmat data collection. Section 11.0 describes the 21 maps developed for the study by section. Section 12.0 presents report conclusions. The three appendices reflect technical memoranda developed for the Literature Review, Chemical Selection Process and Petroleum Supply Chain Analysis.

Hazardous materials (hazmats) help sustain our modern society in many direct and indirect ways. For example, industries use chemicals every day to ensure the safety of our water and food supply.[2] From chlorine to crude oil, America's freight railroads transport essential hazmats, 99.999 percent of which reach their destination without a release caused by an incident.[3] This includes fertilizers, coal, fuels, and industrial chemicals that are essential to U.S. manufacturing, agriculture, food production, and energy production. Petroleum products fuel the growing economy and they are transported primarily by pipelines across the U.S. and by truck to their final destinations at the gas pump. Each day 43.3 million barrels of crude oil, refined petroleum products and natural gas liquids move through the transportation system.[4] Ethanol has become the largest biofuel transported by rail and an important U.S. export. Due in part to the recent shale oil and gas revolution, the U.S. now exports more natural gas than it imports, making the U.S. the leading exporter of refined petroleum products in the world.[5]

According to the Pipeline and Hazardous Materials Safety Administration (PHMSA), hazmats are substances or materials that, when transported in commerce, are capable of posing a risk to health, safety, property, and the environment.[6] Also known worldwide as "Dangerous Goods," such products are inherently dangerous whether or not they are in transport.[7] Up to one million daily hazmat shipments transit the United States

---

2 American Chemical Council (ACC) Website, accessed December 2018.

3 Association of American Railroads (AAR) Website, accessed November 2018.

4 American Petroleum Fuel and Manufacturers (AFPM) Website, accessed November 2018.

5 U.S. Energy Information Administration (EIA) Website, accessed August 2018.

6 49 CFR §171.8

7 Transport Canada, "Transportation of Dangerous Goods – A Primer." August 2017. https://www.tc.gc.ca/media/documents/tdg-eng/Transportation_of_Dangerous_Goods_-_A_Primer.pdf

(Footnote continued on next page...)

every day, or more than 2.2 billion tons by all modes of transportation. This represents 12 percent of all freight tonnage shipped annually in the U.S.[8]

Due to the inherent hazards in transport and risk to the public, hazmats face regulations from multiple Federal and State agencies. More information about regulations can be found in the Literature Review, Appendix A.

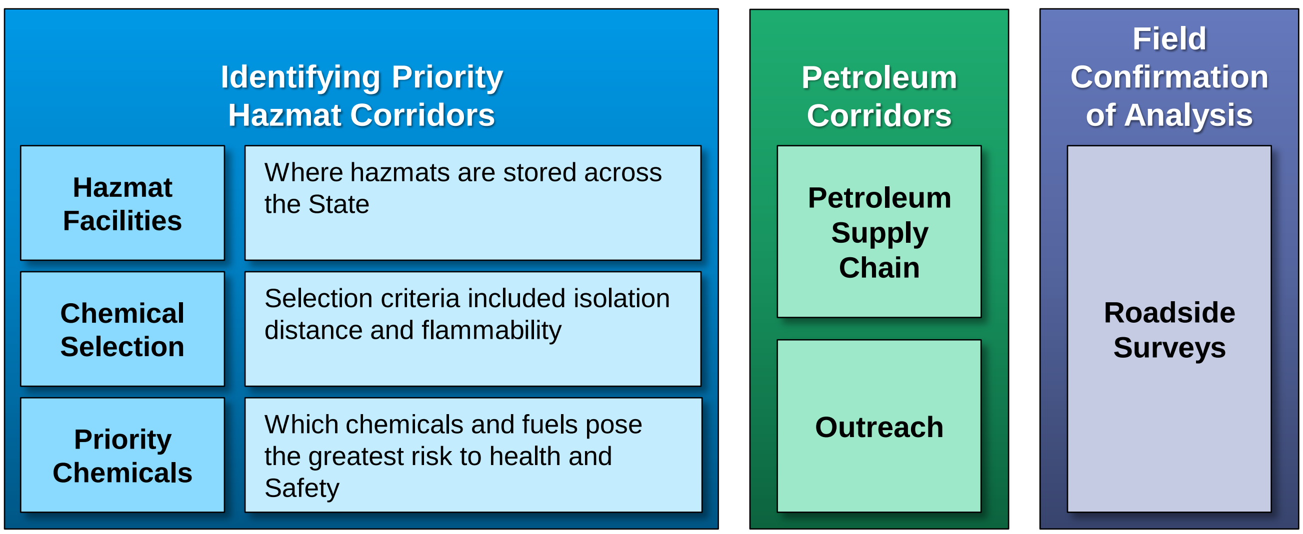
While much is known about hazmat storage at facilities, less is known about how hazmat is transported to and from those facilities. Study staff collected hazmat data from facilities, railroads, motor carrier, pipeline, and airline companies. Roadside hazmat inspections were conducted at certain times of the day and week along key highway corridors. Staff used a chemical selection process to identify priority hazmats and an "industry approach" to document hazmat routes and volumes by mapping highway, railroad, and pipeline networks to and from each facility. This report documents the study process, results, findings, and recommendations.

8 U.S. DOT Bureau of Transportation Statistics (BTS) Website, accessed November 2018.

2.0 Study Methodology

The study team employed a three-part approach to documenting hazmat transportation in Nevada. First, the team documented hazmats that posed the greatest danger to the public if released in transit or from storage facilities. The EPA and NDEP classify these chemicals and fuels as extremely hazardous substances (EHS) and highly hazardous substances (HHS), respectively. The team identified EHS routes and conveyances, known in the study as the priority hazmat identification process. Second, 85 percent of hazmat transported in Nevada by volume is refined petroleum shipments conveyed by pipelines and trucks, and refined petroleum products are not classified as EHS. Therefore, the study team conducted a petroleum supply chain analysis to document Statewide refined petroleum flows, including gasoline, diesel, and aviation fuels. Finally, to corroborate the information from the first two parts, the study team conducted a hazmat roadside survey to identify hazmats transported by truck during two-hour weekday surveys over a period of 3 months at 18 locations around the State. This three-part approach helped tell the hazmat transportation story in Nevada, and the results will prepare public officials for what they can expect to see transported in the State by motor carrier, rail, pipeline, and air. Figure 2.1 summarizes this three-part approach. This information will help transportation officials prioritize infrastructure investments and emergency managers prepare for the hazmats carried in the largest volumes and those that pose the greatest hazard to health and safety; it will also help officials position hazmat response resources in locations with the highest risks.

Figure 2.1 Three-Part Approach to Study



3.0 Stakeholder Outreach

The team held meetings and briefings with the groups noted below to facilitate coordination and receive necessary guidance throughout the project.

Nevada State Emergency Response Commission. The Nevada SERC reviewed study progress and provided the information to the LEPCs and Tribal Nations for review and input.

Nevada State Freight Advisory Committee. The Nevada FAC, a single advisory committee for all NDOT freight-related studies and actions, received progress reports and opportunities to comment at each quarterly meeting.

Industry Outreach. Since many companies and industries are involved in the storage, manufacturing, and transport of hazardous commodities, outreach is a critical component to this project. The study team conducted extensive telephone interviews and multiple in-person meetings with 60 representatives from industrial manufacturers, mines, fuel terminals, and other industries that store hazmat, large shippers/receivers, trucking companies, railroads, pipelines, and chemical companies. Outreach to these organizations was facilitated by a letter of introduction from the NDOT Project Manager.

Roadside Hazmat Surveys. Silver State Traffic, a registered DBE with NDOT, collected hazmat information by identifying truck volumes, types, and hazmat placards on specific roadways throughout the State. This process is further explained in Section 10.0.

Stakeholder Interviews. The study team conducted in-person meetings with the NDEP, including the Chemical Accident Prevention Program (CAPP), and the Nevada State Fire Marshal's Office to collect hazmat data and other pertinent information. This study required significant outreach efforts to industries that store hazmat and carriers that transport hazmat, including chemical manufacturers, fuel terminals, mines, universities, utility companies, and fuel distributors. Transportation carriers included trucking companies, railroads, pipeline companies, and air cargo carriers. Private-sector stakeholders interviews included large shippers/receivers, trucking companies, railroads, pipelines, and chemical companies. The team used this information to determine hazmat storage and transportation patterns by multiple modes in the State.

4.0 Data Collection

4.1 GIS Shape Files

The geographic distribution of transportation facilities and hazmat flows is best illustrated by the use of maps to depict chemical and fuel distribution networks. As a result, the data collected for this project included numerous GIS shape files from the NDOT State Freight Plan and other sources. Table 4.1 lists the selected GIS shape files.

Table 4.1 GIS Shape Files

Transportation	Facilities	Land Use
Railroads	Tier II[1]	Indian Land
Pipelines	TRI[2]	Metropolitan Areas
Highways	RMP[3]	Mining
Intermodal Facilities	Fuel Stations	Hydrology
Airports	Utilities	County Boundaries

1 EPA requires annual “Tier II Reports” for facilities storing reportable hazmat quantities.
2 EPA requires Toxics Release Inventory Reports for certain facilities.
3 EPA requires Risk Management Plans for facilities storing hazmat in certain threshold planning quantities.

Source: Cambridge Systematics, NDOT, SFMO, CAPP, EPA.

4.2 Hazmat Facilities

The study team collected facility data from Federal and State agencies to identify hazmat facilities. The facility identification process is the basis for understanding where hazmats are transported. Federal agencies have developed hazmats storage regulations since 1986; as a result of several industrial accidents at that time, Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA) that year. As part of this act, Federal, State, and local Governments, Indian Tribes, and industries are required to report hazardous and toxic chemicals in individual facilities, their uses, and releases into the environment to the public. Hazardous materials are regulated based on reportable quantities at facilities.

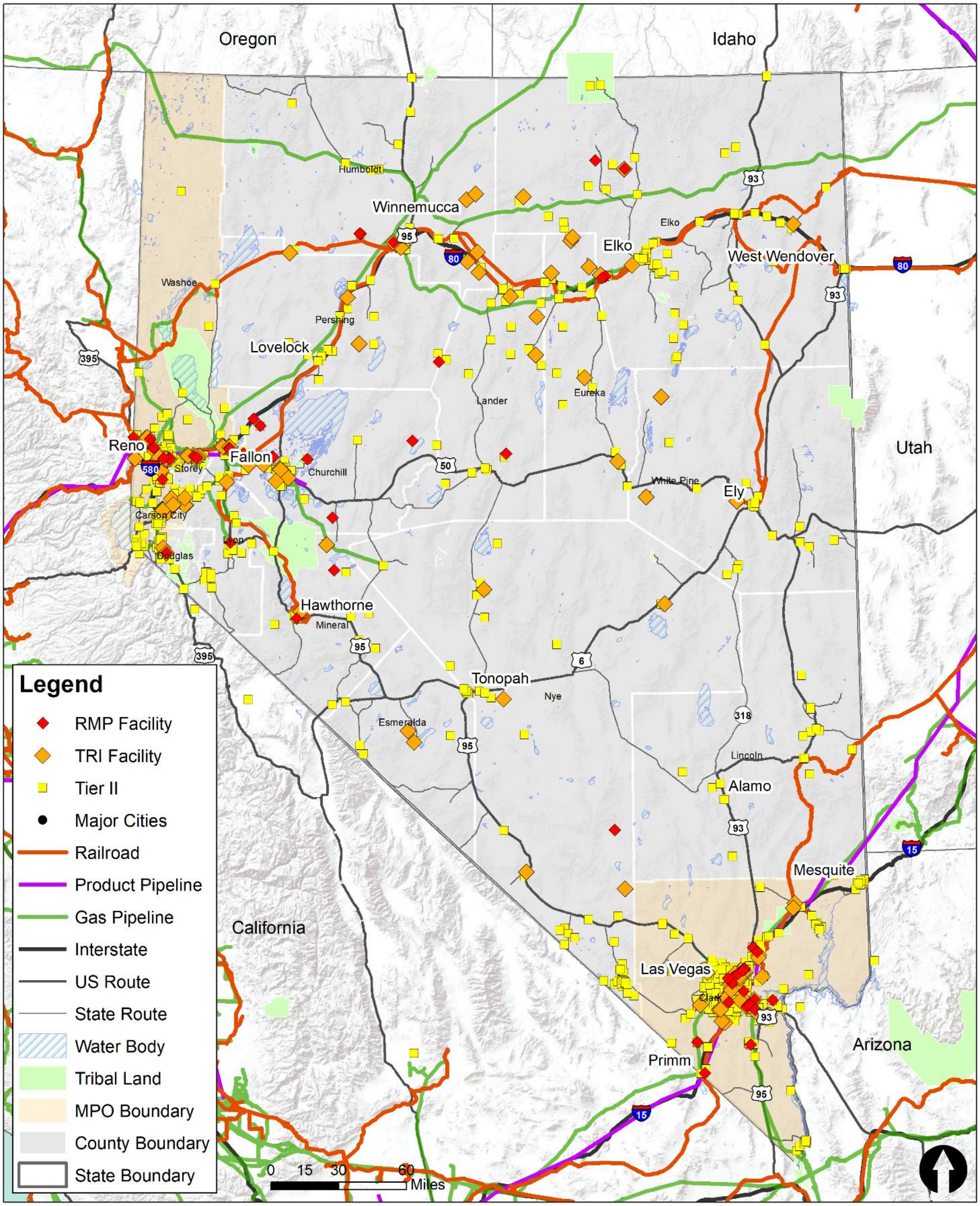
The Environmental Protection Agency (EPA) is the Federal agency that regulates hazmat storage at facilities to reduce or eliminate the release of pollutants and wastes, both on and off site. EPCRA provisions cover different types of hazmat management depending on stored quantities on site or in process at hazmat facilities. Industries that handle chemicals are required to report to the EPA if the chemical quantity is greater than a “reportable quantity” (RQ) for filing annual Tier II reports. The Nevada SFMO maintains a Statewide hazmat database for Tier II reporting, and the study team requested access to this database as part of the data collection process. The EPA requires industries to file TRI reports if hazmats stored at such facilities are released into the air, ground, or water. Finally, the EPA also requires industries that store hazmats exceeding the threshold planning quantity (TPQ) for extremely hazardous substances (EHS) to file a Risk Management Plan (RMP).

In 1991, the Nevada Legislature passed Senate Bill 641, the Chemical Catastrophe Prevention Act, primarily in response to a large chlorine release in Southern Nevada and a devastating ammonium perchlorate explosion in 1988. Subsequently, the CAPP was created, requiring industries storing or handling HHS to meet certain regulations, similar to how the EPA Risk Management Program regulates EHS. Details of these programs are described below:

- **Risk Management Program.** Filing an RMP is required by facilities that contain EHS and flammable substances above a certain TPQ. EPA currently lists 355 chemicals under EHS in the "List of Lists."
- **Chemical Accident Prevention Program.** In Nevada, there are approximately 60 industries storing HHS at facilities and 219 different chemicals and fuels defined by the CAPP program. Later legislation authorized CAPP to regulate explosives manufacturing, issue permits, and coordinate inspections in explosives manufacturing facilities. There are 59 CAPP facilities in Nevada.
- **Toxics Release Inventory Program.** This program tracks the management of certain toxic chemicals that, if released into the air, ground, or water, pose a threat to human health and the environment. As part of the TRI program, industries must report onsite release, recycling, offsite transfers, and treatment of toxic chemicals. EPA's TRI list includes approximately 650 toxic chemicals and categories. In Nevada, there are 150 facilities required to file annual TRI Reports. This information can be found on the EPA website.
- **Tier II Reports.** The EPA requires organizations and businesses in the U.S. with hazardous chemicals above the required RQ to fill out annual Tier II reports. There are approximately 500,000 chemicals that require Tier II reporting, including gasoline, diesel, and other chemicals. In Nevada, there are over 2,600 facilities required to file annual Tier II reports. This information was accessed with permission from the SFMO.

The study team collected data from these sources to develop a Statewide Hazmat Facilities Map. Figure 4.1 displays hazmat facilities in the State.

Figure 4.1 Hazmat Facilities Map



Source: EPA, NDEP CAPP, SFMO, Cambridge Systematics.

5.0 Chemical Selection Process

While there is ample data regarding hazmat facility locations, hazmat transportation corridors are not well documented because of the complexities of hazmat transport and the need to collect proprietary information from industries. The study team recognized that it was important to explain to industry officials that the collected data would be aggregated by chemical from all hazmat facilities. By combining this information, the resulting hazmat flows are no longer specific to any one industry, but rather display aggregated hazmat flows by commodity and by mode. With this in mind, identifying priority hazmat corridors involved a multistep process that includes chemical selection, priority facility identification, industry outreach, and hazmat analysis. This section describes each process in detail.

There are thousands of chemicals and fuels transported in Nevada every day. Chemicals are used by industries to ensure the safety of our water and food supply. Railroads transport fertilizers, fuels, and industrial chemicals that are essential to U.S. manufacturing, agriculture, mining, food production, and energy production. Every day, petroleum products are transported primarily by pipelines across the U.S. and by truck to their final destinations at the gas pump.[9] In order to identify which of these hazmats pose the greatest risk to health and safety, the study team employed a chemical selection process.

5.1 Methodology

Using the data collected from CAPP, TRI, and Tier II, the study team focused on toxic and high-volume flammable chemicals, then applied selection criteria to organize the chemicals into a list of priority chemicals for analysis. The criteria used to rank the hazmats included isolation protection distance, threshold planning quantity, lower flammable limit, and flash point. Additional professional judgment was applied to determine the final hazmat priority. Table 5.1 describes each criterion, description, and source.

Table 5.1 Chemical Selection Criteria

Criterion	Description	Source
Isolation Distance	Recommended distance from a spill source within which first responders should position emergency assets.	U.S. DOT Emergency Response Guidebook
Threshold Planning Quantity	Minimum amount of chemical that if present at a facility poses a hazard.	EPA/CAMEO[1]
Lower Flammable Limit (LFL)	Lower limit of a concentration range of a gas or vapor that will burn if exposed to an ignition source.	Engineering Toolbox
Flash Point	Temperature at which vapor from gas ignites	National Fire Protection Association

1 Computer-Aided Management of Emergency Operations (CAMEO) developed by National Oceanic and Atmospheric Administration (NOAA).

Using the list of hazmats stored at Nevada facilities, the study team conducted a hazmat analysis, applying the criteria above to sort and rank the hazmats in order of impact to health and safety. For example, the larger the isolation distances for large spills, the higher the ranking. The hazmat analysis provides

9 American Petroleum Institute (API) Website, accessed April 2019. https://www.api.org/oil-and-natural-gas/wells-to-consumer/transporting-oil-natural-gas

justification for contacting companies that store or transport priority chemicals to determine transport routing, frequencies, and volumes.

The study team used the results of this analysis to generate a list consisting the chemical final score, stored amount, number of corresponding facilities, and EHS designation. The higher the score, the more hazardous the toxic or flammable chemical.

5.2 Priority Chemical Selection

From the list of 34 preliminary chemicals identified, the study team examined the stored volumes at facilities and the number of facilities storing chemicals and used professional judgment from previous studies to determine a proposed list of priority chemicals for study. Several "non-EHS" chemicals were included as part of the final list. These include ethanol and butane since these fuels are transported in larger volumes and have been subject to new Federal and State regulations pertaining to transport by "High-Hazard Flammable Trains." Ethanol is transported by rail in large volumes from the Midwest to urban areas for fuel blending and to ports for export. Butane is used to supplement gasoline stocks and increase fuel octane levels. Table 5.2 displays the proposed priority chemicals for study. The study team conducted additional outreach to the facilities storing these chemicals to determine routing, frequencies, and volumes.

Table 5.2 Priority Chemicals for Study

#	Chemical Name	Score	Chemical Uses	Facilities	EHS
1	Anhydrous Ammonia	4	Refrigerant, fertilizer	18	Yes
2	Butane	5	Fuel, blending, refrigerant	6	No
3	Chlorine	7	Water treatment	6	Yes
4	Ethanol	3	Biofuel	5	No
5	Hydrogen Fluoride	4	Manufacturing	8	Yes
6	Nitrogen Dioxide	6	Catalyst, oxidizing agent	3	Yes
7	Potassium Cyanide	4	Mining and electroplating	2	Yes
8	Propane	5	Fuel and heating	7	No
9	Sodium Cyanide	4	Mining operations	18	Yes
10	Titanium tetrachloride	4	Titanium, whitening	4	Yes

5.3 Outreach to Priority Hazmat Companies

Once the 10 chemicals were selected, the study team presented the results to the NDOT Freight Advisory Committee (FAC), and the SERC. This information provided a baseline to determine which industries store the priority chemicals in the State. From this list of priority chemicals, the study team conducted outreach calls and interviews to industry to further determine hazmat transportation information, including origin-destination, frequency, volume, and mode of transport. Some interviews were conducted in person, most interviews were conducted by conference calls between October 2018 and March 2019.

Obtaining sensitive chemical information is a difficult and time-consuming process for two reasons. First, industry officials responsible for hazmat regulations and protocols are not usually familiar with hazmat transportation destinations, customers, and hazmat shipment frequencies. As a result, multiple emails and phone calls were required to locate the persons with the knowledge of hazmat transport and sales. These persons in turn needed permission from management; often corporate officers became involved in the interview process, creating additional delays. Second, sharing chemical information has come under increased Federal scrutiny since 9/11 due to concerns with terrorism and security. Recent Department of Homeland Security (DHS) regulations for the Chemical Antiterrorism Facility Security (CFATS) Program has further delayed the industry's willingness to share sensitive chemical shipment information out of security concerns. Officials must confirm the identity of persons requesting data with a "need to know" before releasing any information pertaining to EHS Chemicals defined under CFATS as "Chemicals of Interest."

As a result of this increased concern for sharing chemical information, some companies chose not to participate in the outreach effort. However, most industries cooperated with the study since they realized that (1) the information would be aggregated by chemical to mask shipments from any one facility; and (2) public reports would only display high-level Statewide hazmat flows. Detailed county-level maps would only be available to first responders through a secure database managed with strict access controls and protocols.

5.4 Hazmat Corridor Identification

The study team used the outreach information obtained from industry representatives, carriers, and fuel terminal managers to conduct a detailed hazmat corridor identification sorted by each priority chemical or fuel. In some cases, staff contacted distributors to determine distribution patterns; in other cases, staff identified refineries or manufacturers from which certain chemicals were transported and employed GIS tools such as "shortest path" algorithms to determine likely routes. Other cases showed that industrial gases processed in Gulf Coast States are transported to Nevada by rail and by truck over long distances.

Industry representatives helped to confirm shipment frequencies based on overall demand, seasonality, and availability. Chemicals used for water treatment, such as chlorine and ammonium hydroxide, are shipped in higher quantities during the summer months. Other chemicals used in manufacturing are used year-round and have no seasonal transport patterns. In some cases, staff developed transport and frequency assumptions based on feedback from stakeholders and industry representatives. For example, some industrial gases are used as a refrigerant for energy generation utilities; this is an example of closed systems where infrequent shipments to replenish system components are only required once or twice a year. Using this information, the study team developed detailed maps for each of the priority chemicals for study described in the following section.

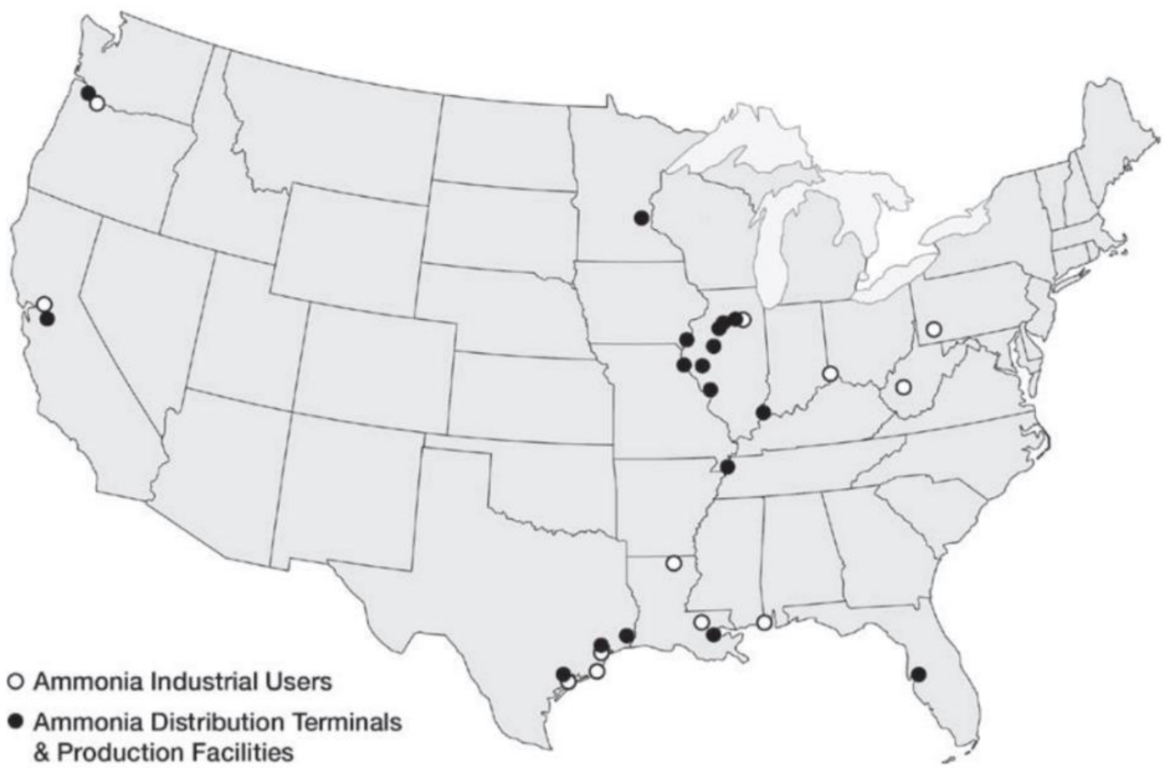
6.0 Priority Hazardous Materials and Maps

Mapping priority chemicals involves a combination of the techniques previously described in this report. The Statewide Hazmat Facilities Map (see Fig. 4.1) served as a starting point for chemical transport destinations. Industry outreach and supply chain analysis techniques helped to determine chemical supply sources from in-State and out-of-State refineries, distributors, and manufacturers. Interviews with stakeholders and industry contacts helped to determine hazmat demand, transport frequencies, and volumes. GIS tools and further industry guidance helped to determine routing, orientation, and mode choice, using pipelines, trucks, railroads, and air carriers. Finally, the maps in this section were scaled by volumes and mode to best illustrate shipment volumes by segments, depending on facility densities along each hazmat corridor. The following sections describe each of the priority hazmats and the corresponding maps for each hazmat analyzed as a part of this study effort.

6.1 Anhydrous Ammonia

Used for refrigeration and as a fertilizer, anhydrous ammonia is the most common industrial toxic inhalation hazard stored and transported in the United States. Manufactured primarily in the Midwest, ammonia is transported by rail and truck to final destinations (Figure 6.1).

Figure 6.1 Major U.S. Ammonia Production Facilities, Distribution Terminals, and Industrial Users

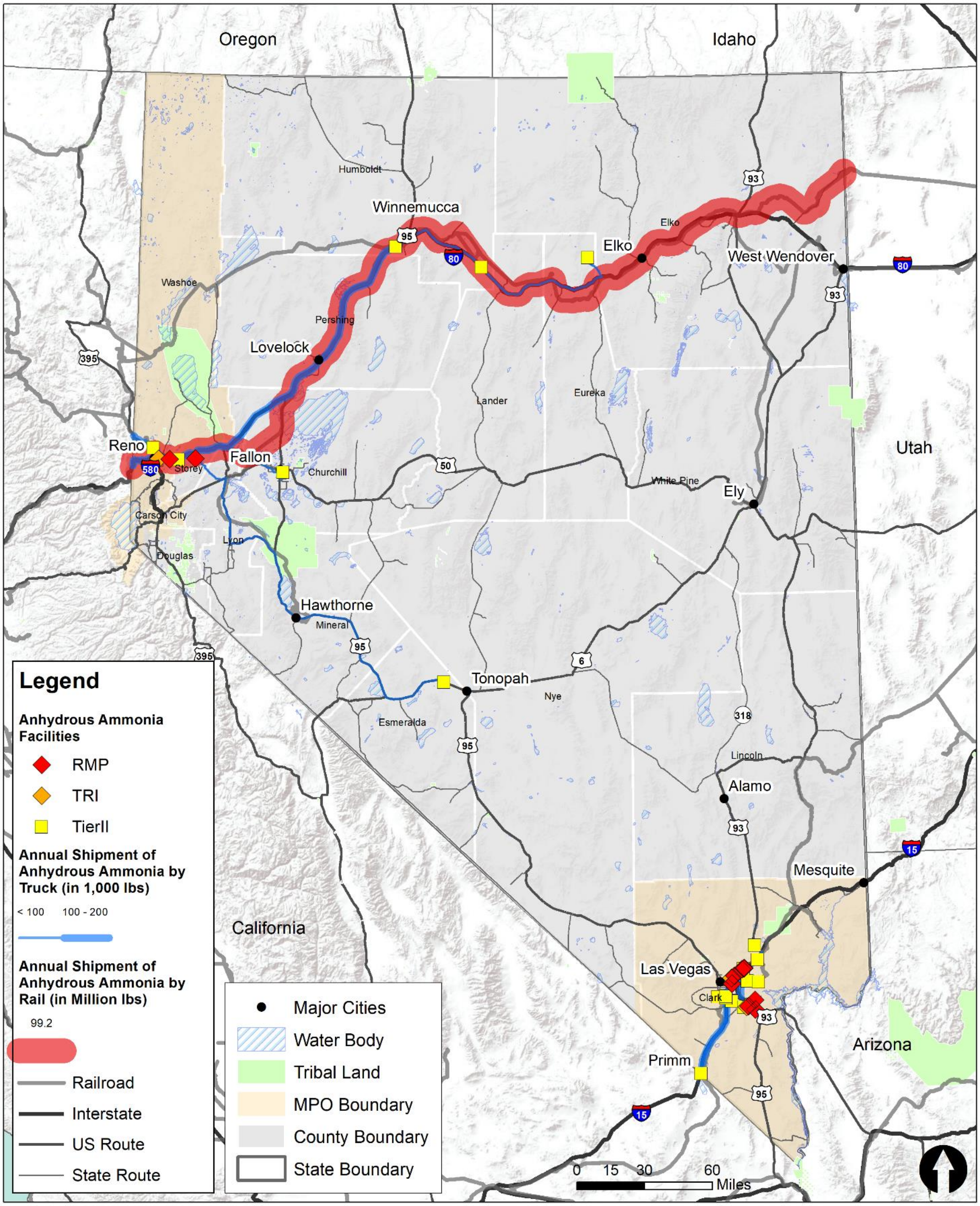


Source: Kruse, J., A. Protopapas, L. Olson, M. Donelan, N. Hutson. “Figure 6 Major Ammonia Production Facilities, Distribution Terminals, and Industrial Users.” *NCFRP Report 18: Marine Highway Transport of Toxic Inhalation Hazard Materials (2012).*

Ammonia is transported in pressure containers, either a MC-331 cargo tank trailer or DOT 112 rail tank car. The chemical properties include toxic gas (Class 2.3), inhalation hazard, and a corrosive (Class 8), resulting in multiple hazard placards for surface transport. The gas is generally regarded as nonflammable, but it does burn within certain vapor concentration limits. Fire hazard increases in the presence of oil or other combustible materials. Although ammonia is lighter than air, vapors from a leak initially stay close to the ground.

In Nevada, anhydrous ammonia is transported by rail and truck to utility companies for pollution control, refrigeration facilities, water treatment plants, chemical companies, and mining operations. Facility locations and chemical flows are illustrated in Figure 6.2.

Figure 6.2 Anhydrous Ammonia Facilities and Flows

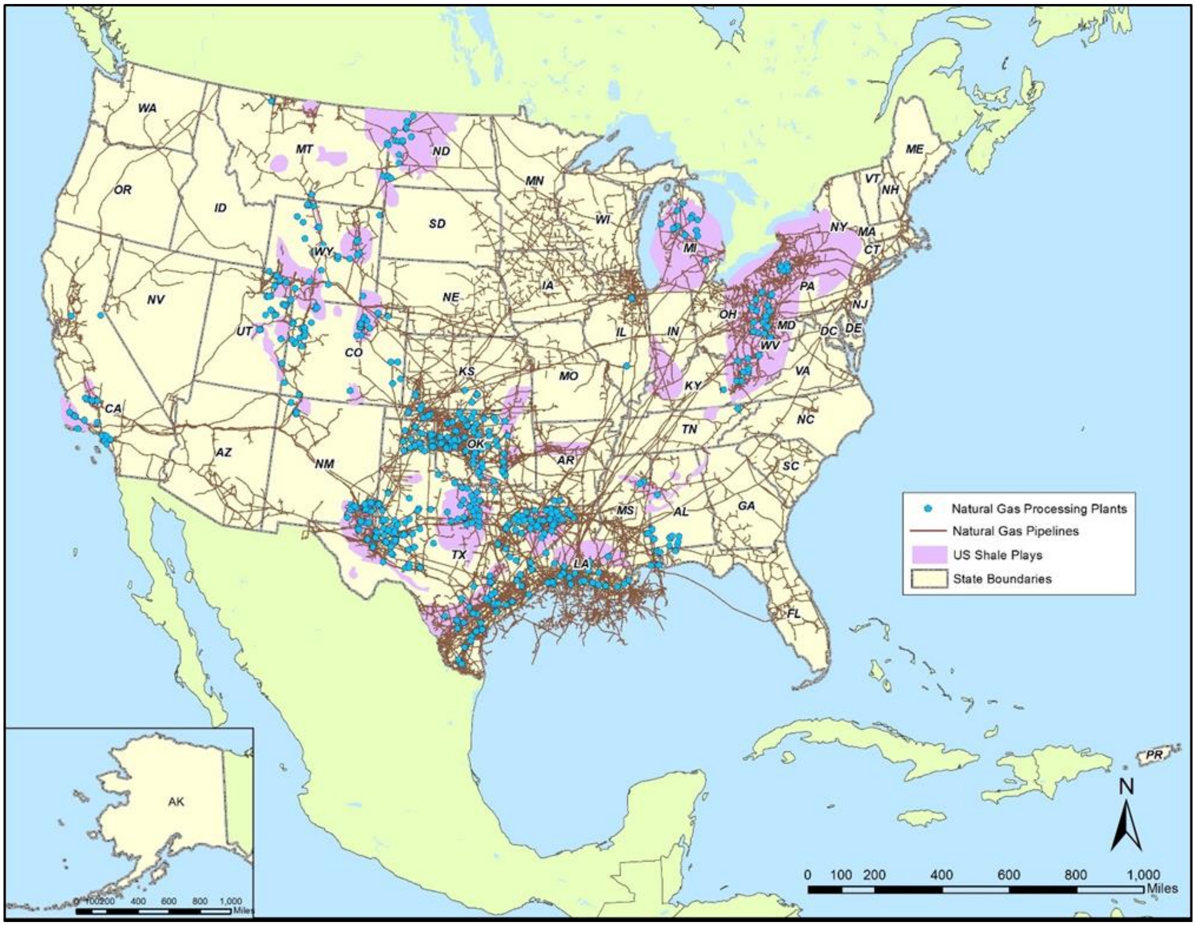


Source: UP Railroad, CAPP, SFMO, Industry Outreach, Cambridge Systematics.

6.2 Butane

Butane is a natural gas liquid used for fuel blending and refrigeration. Extracted from natural gas during processing, butane is generally transported by rail and truck from processing plants and refineries to fuel terminals and power generation facilities; it is used in other refrigeration applications, such as natural gas and ethylene liquefaction processes. Figure 6.3 displays U.S. natural gas processing facilities, located primarily in the gulf coast.

Figure 6.3 U.S. Natural Gas Processing Plants and Shale Plays

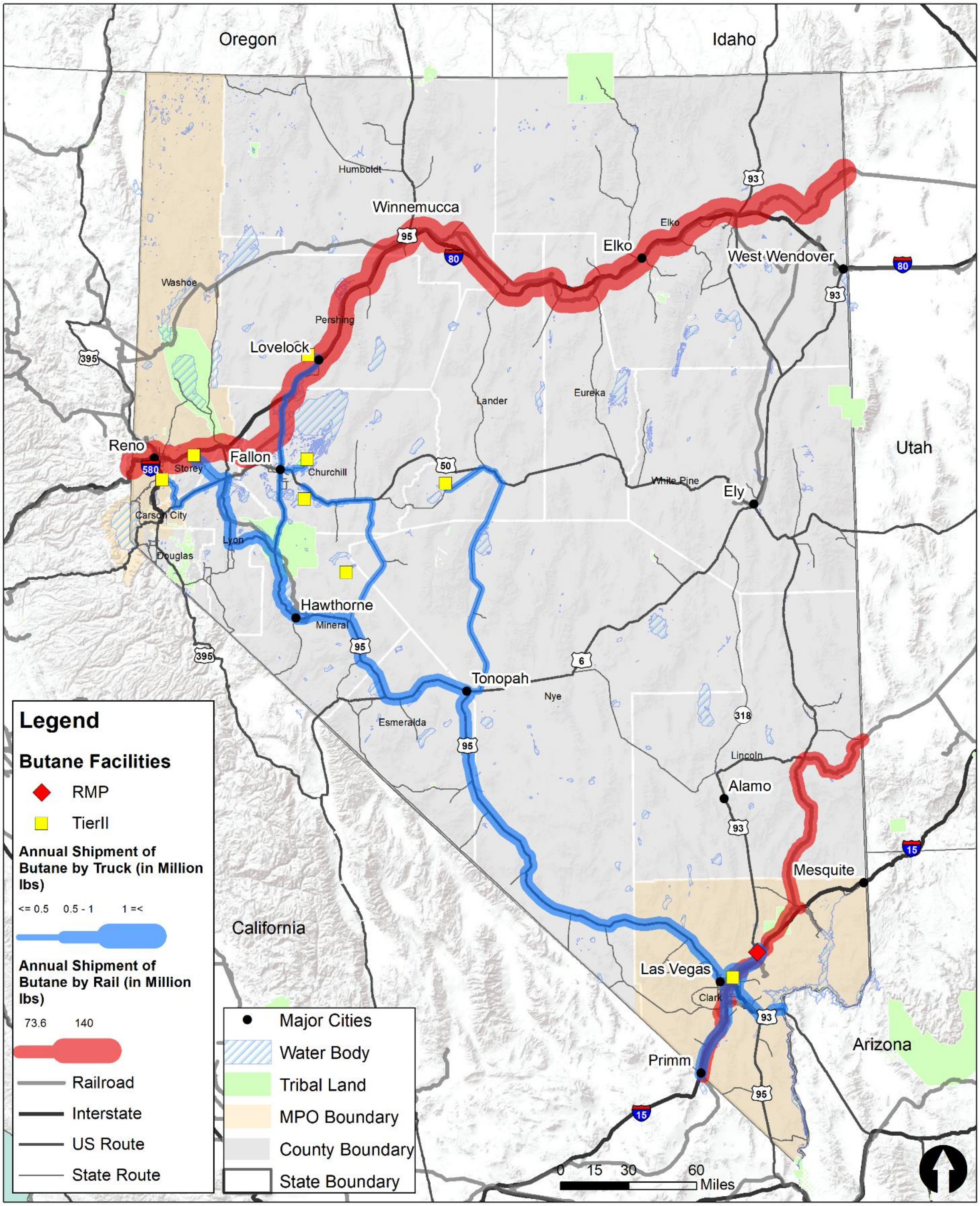


Source: Energy Information Administration, Cambridge Systematics.

Butane is transported as a liquefied gas under its vapor pressure in either a MC-331 cargo tank trailer or DOT 112 rail tank car. Contact with the liquid can cause frostbite. Its vapors are heavier than air and leaks can be either liquid or vapor. Under prolonged exposure to fire or intense heat, the containers may rupture violently and rocket. It is used as a fuel, an aerosol propellant, in cigarette lighters, as a refrigerant, and to make other chemicals.

In Nevada, Butane is transported by rail car across Northern and Southern Nevada and into California and by truck from Texas to power generation facilities by truck. Figure 6.4 depicts butane facilities and flows in the State.

Figure 6.4 Butane Facilities and Flows



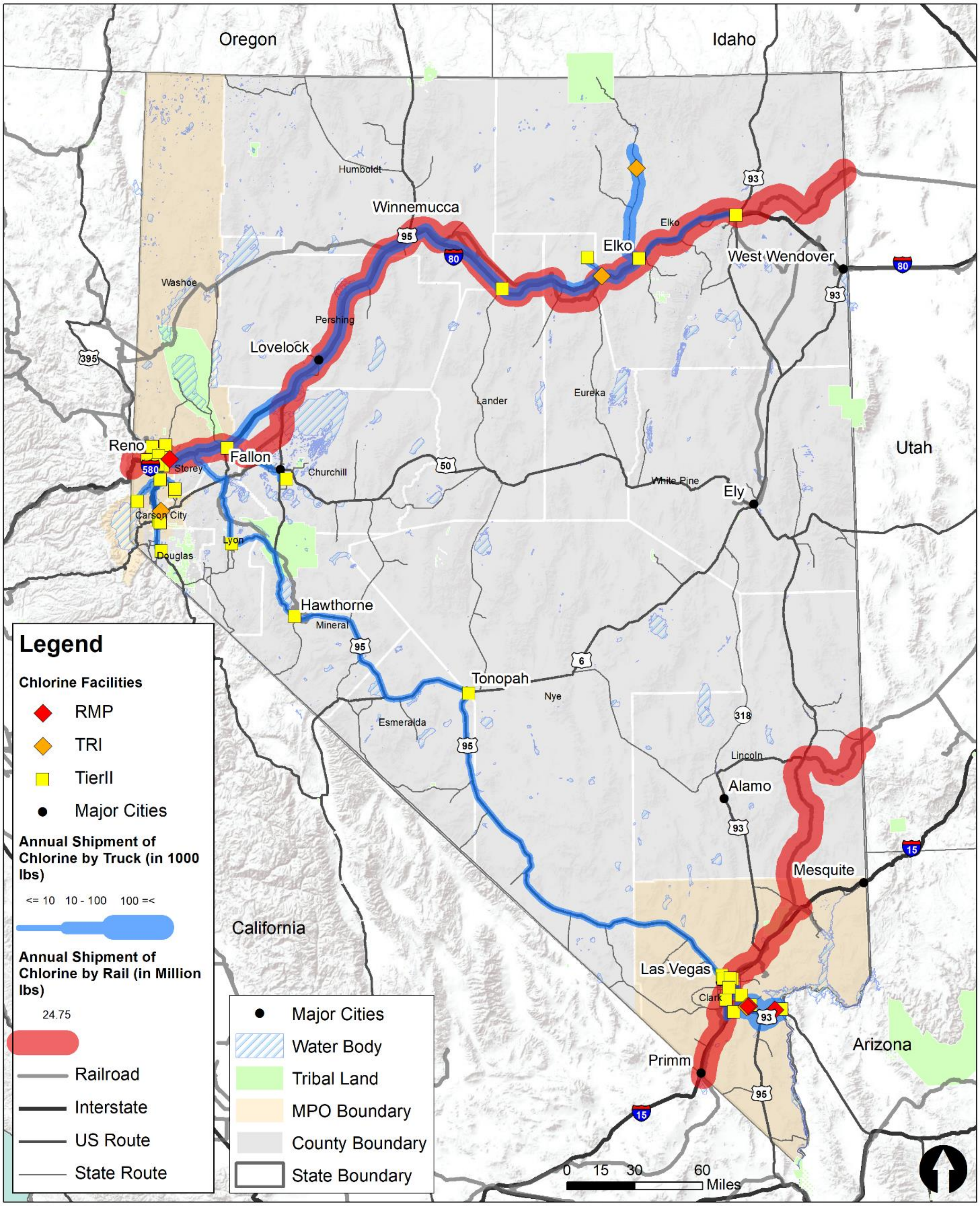
Source: UP Railway, industry outreach, SFMO, Cambridge Systematics.

6.3 Chlorine

Chlorine is used primarily for water and wastewater treatment and other manufacturing applications. It is both a toxic gas and an oxidizer, which may react with flammable materials. Today, chlorine is combined with sodium hydroxide to form sodium hypochlorite and used for water treatment and in swimming pools to control bacteria growth. Chlorine also is used to make ethane compounds for plastics, polyvinyl chloride (PVC), and titanium production, among other uses.

Chlorine is transported in pressure rail cars, cargo tank trailers, and cylinders for smaller quantities. In Nevada, chlorine is transported across Northern and Southern Nevada by rail, and shorter distances within metropolitan areas by cargo tank truck. In some cases, chlorine ton bottles are transported on flatbed truck trailers. Figure 6.5 depicts chlorine transportation in Nevada.

Figure 6.5 Chlorine Facilities and Flows



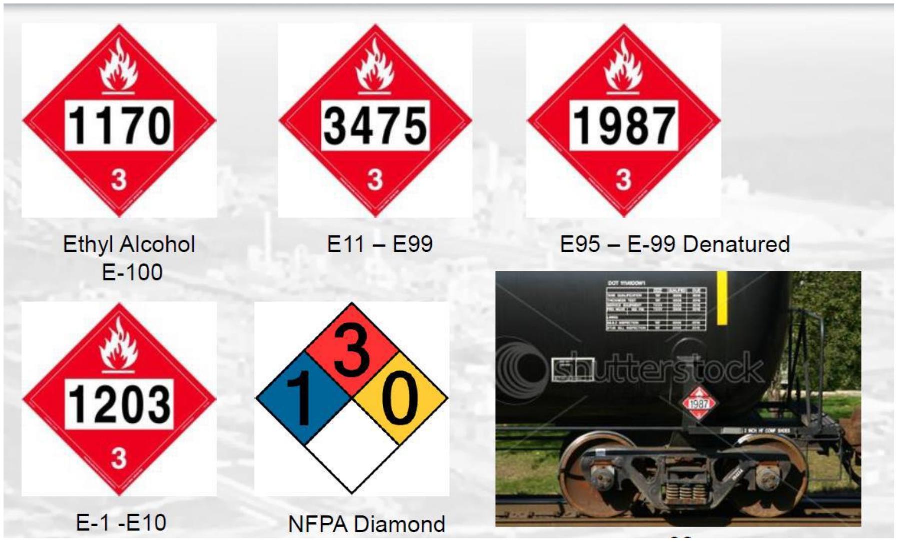
Source: UP, SFMO, CAPP, Hazmat Facilities, Cambridge Systematics.

6.4 Ethanol

Ethanol is primarily used as a biofuel to blend with gasoline. Produced from corn fermentation in the Midwest, ethanol (grain alcohol) is transported by rail, since it is too corrosive for long-distance pipeline transport. Since 1985, Under the Renewable Fuels Standard passed in 2007, the Federal Government requires certain volumes of ethanol to be blended into the U.S. transportation fuel supply. E10 is a low-level blend composed of 10 percent ethanol and 90 percent gasoline and is sold in every State. E15 is a low-level blend composed of 10.5 to 15 percent ethanol and gasoline. E85 (or flex fuel) is an ethanol-gasoline blend containing 51 to 83 percent ethanol, depending on geography and season, and can be used in flexible fuel vehicles designed to run on E85 and gasoline.

As a result of different fuel blends, the ground transportation of ethanol by rail and truck requires different placards. This poses challenges for fire fighters, because extinguishing ethanol fires requires alcohol-resistant foam. Figure 6.6 illustrates different placards used for different ethanol-gasoline concentrations.

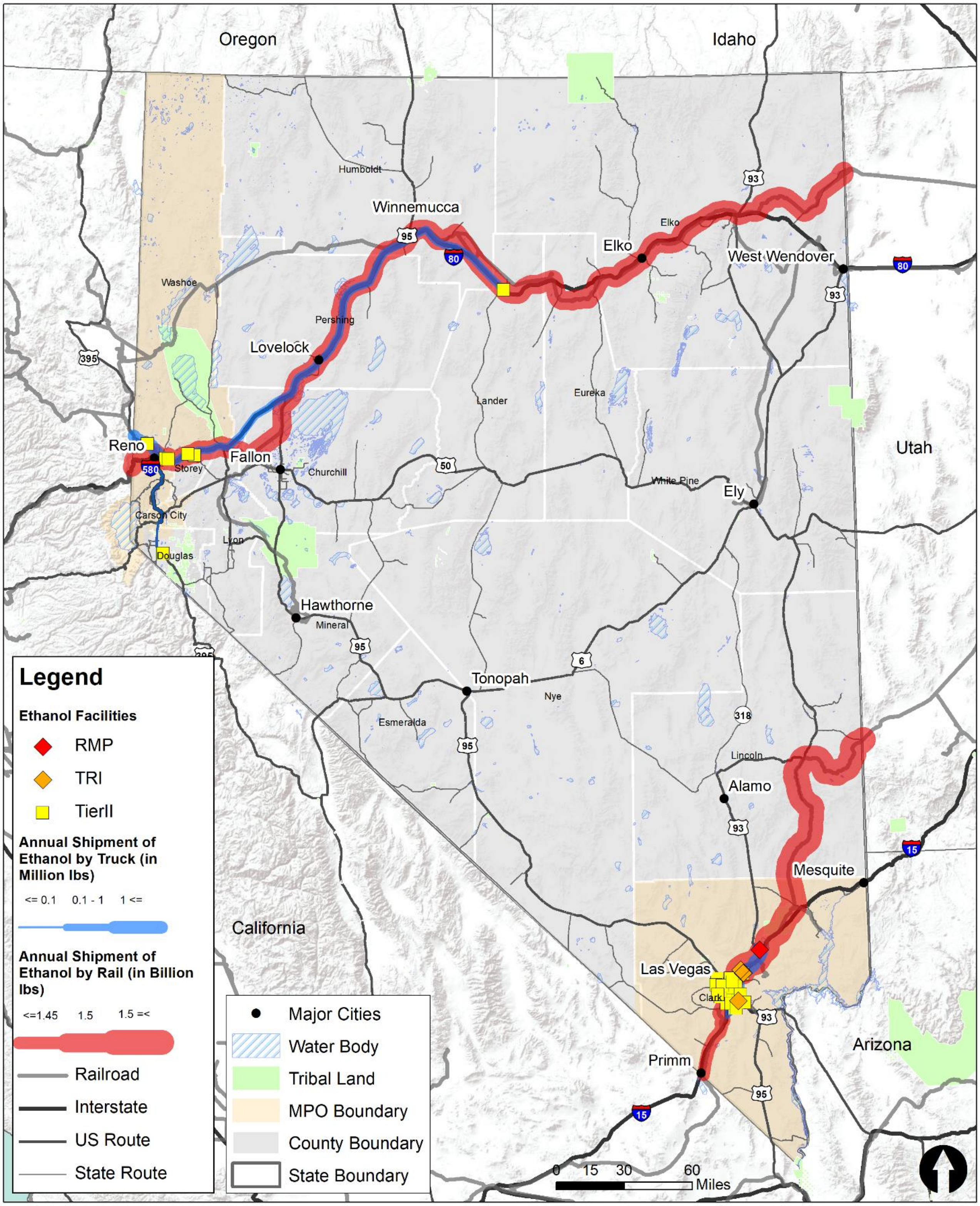
Figure 6.6 Ethanol Placards



Source: CS, Innovative Emergency Management, CAMEO Chemicals, David Willauer (photo).

Ethanol is transported to Nevada from Midwestern States by rail, and stored at fuel terminals in Reno and Las Vegas, where it is blended into gasoline before being transported to retail gasoline stations throughout the State. Figure 6.7 shows ethanol distribution in Nevada before blending with gasoline. Movements of ethanol blends can be seen in Figure 7.5.

Figure 6.7 Ethanol Facilities and Flows



Source: UP, SFMO, CS.

6.5 Hydrogen Fluoride

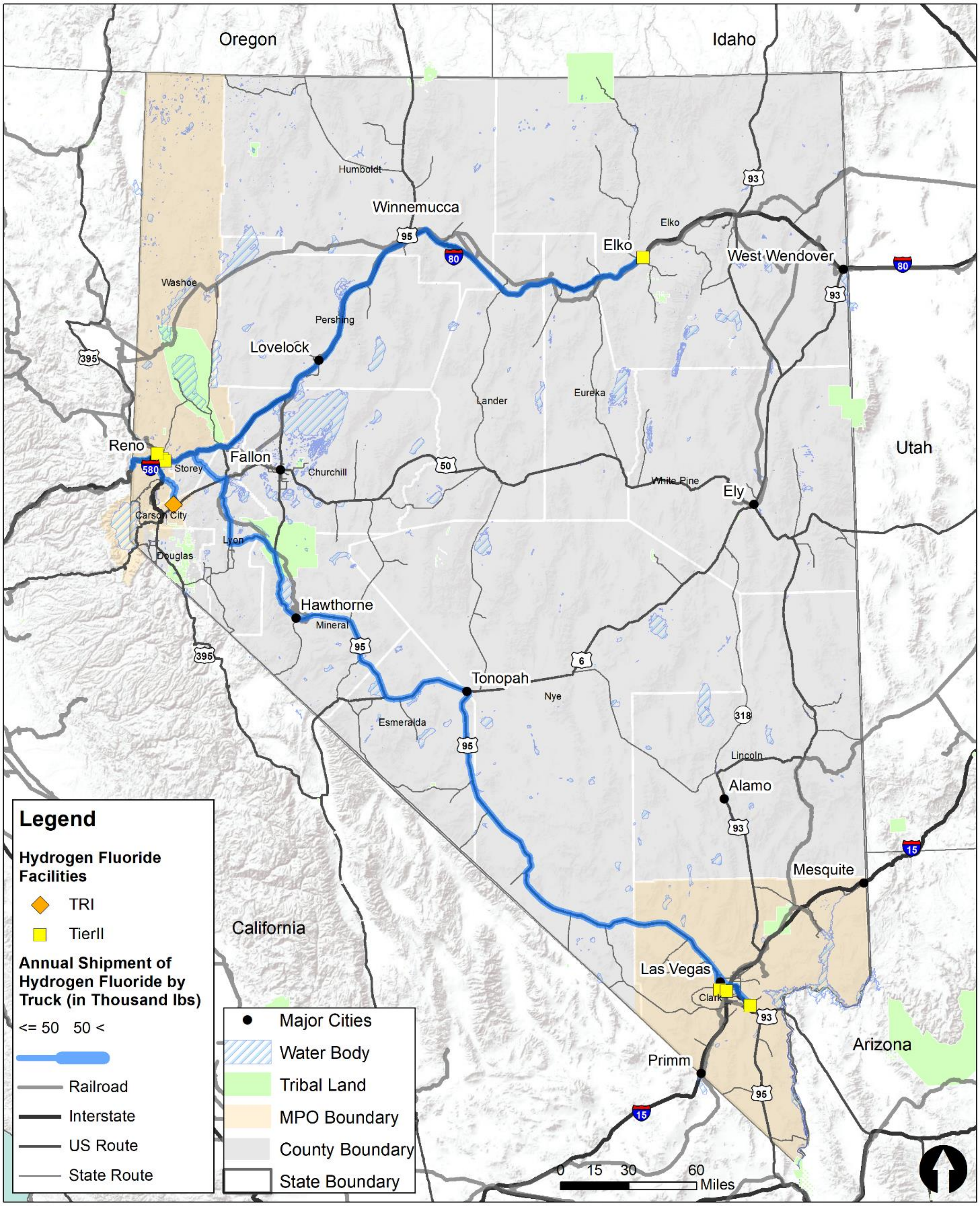
Hydrogen fluoride (HF) is used in over 500 industries in the U.S. as a major feedstock and the source of the fluorine molecule used for the production of fluorinated compounds. Very corrosive and toxic, HF can either be a gas, a liquid, or in a solution. It is used as a catalyst and raw material in chemical manufacturing to make refrigerants, herbicides, pharmaceuticals, gasoline, stainless steel kitchen products, aluminum, plastics, electrical components, and incandescent light bulbs. Sixty percent of the hydrogen fluoride used in manufacturing is for processes to make refrigerants used in refrigeration, freezer, and air conditioning systems. A colorless fuming liquid boiling at 67°F, HF is generally shipped as a liquid confined under its own vapor pressure. HF vapors are heavier than air and HF's corrosive action on metals can result in a fire hazard due to the formation of hydrogen in containers and pipes.[10]

Transportation of HF in Nevada is limited to Less-than-Truckload (LTL) deliveries in small quantities. Used primarily in laboratory environments, HF does not pose a significant transportation hazard. Therefore, no map was created for HF, which is transported in limited quantities to facilities in the State.

Figure 6.8 shows HF facilities and flows in the State, which are transported by truck only in small quantities.

[10] Cameo Chemicals (NOAA) website, https://cameochemicals.noaa.gov/

Figure 6.8 Hydrogen Fluoride Facilities and Flows



Source: Cambridge Systematics, industry outreach.

6.6 Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a catalyst and oxidizing agent. A reddish-brown gas or yellowish-brown liquid when cooled or compressed, NO_2 is shipped as a liquefied gas under vapor pressure. Its gas vapors are heavier than air, and it is toxic by inhalation and skin absorption. NO_2 is noncombustible but accelerates the burning of combustible materials. NO_2 is used in manufacturing chemical explosives, as a sterilization agent, and as a flour bleaching agent. It also is an oxidizer used in rocket fuel.

Since it is only transported in small quantities and shipped to a limited number of facilities, no map was created for NO_2.

6.7 Potassium Cyanide

Potassium cyanide (KCN) is a basic salt and a reducing agent. Cyanide salts are used in metallurgy for electroplating, metal cleaning, and removing gold from its ore. KCN reacts with acids of all kinds to generate poisonous hydrogen cyanide gas, which is used to exterminate pests. Since the chemical is shipped in small quantities to a limited number of locations, no map was created for KCN.

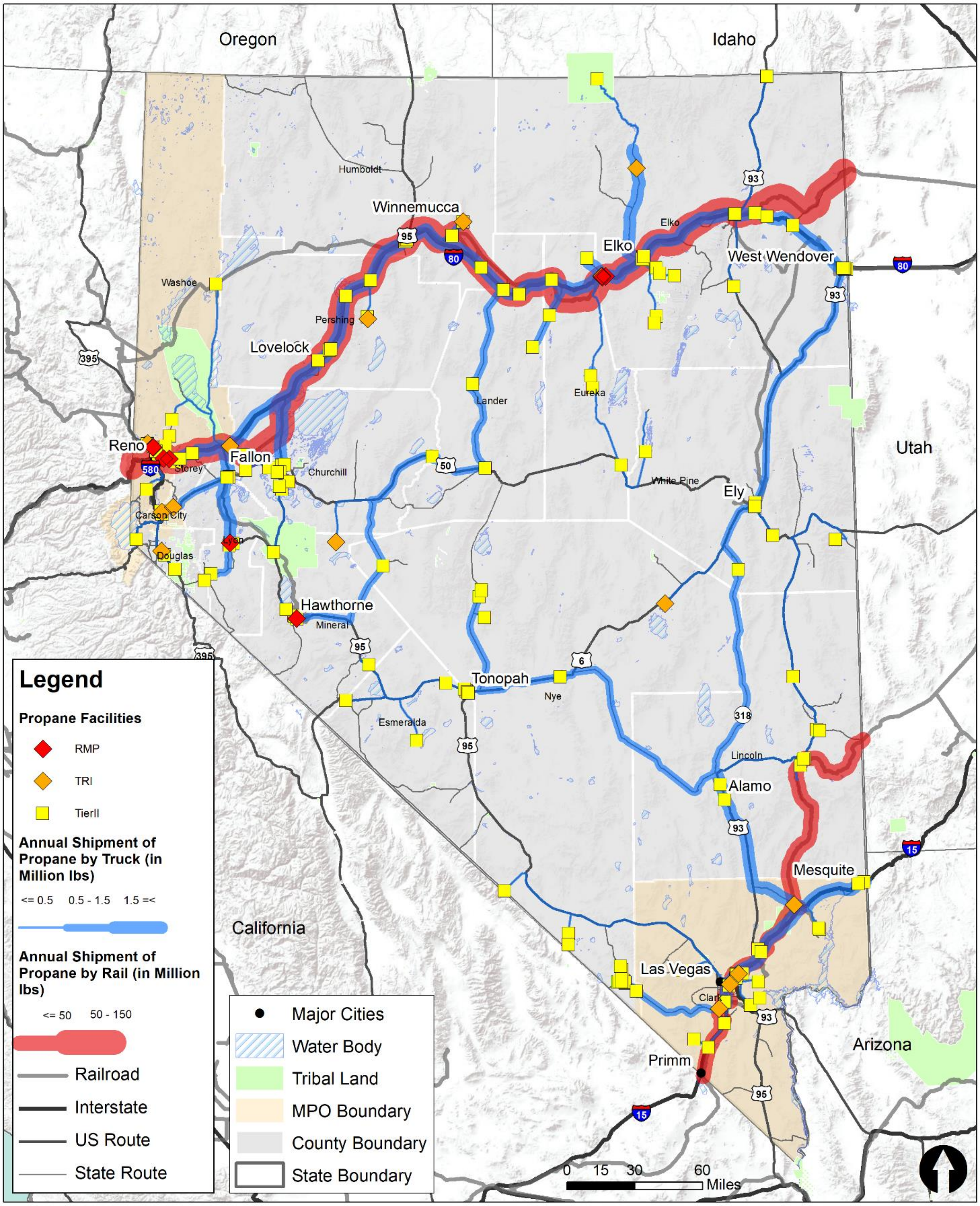
6.8 Propane

Propane is produced as a by-product of two other processes: natural gas processing and petroleum refining. The processing of natural gas involves removal of butane, propane, and large amounts of ethane from the raw gas. Additionally, oil refineries produce some propane as a by-product of cracking petroleum into gasoline or heating oil. Propane can be burned as an important heat source, but its unique chemical properties make it suitable as a refrigerant as well.

Like butane, propane is transported as a liquefied gas under its vapor pressure in either a MC-331 cargo tank trailer or DOT 112 rail tank car. Contact with the liquid can cause frostbite. Propane gas vapors are heavier than air and any leak can be either liquid or gas vapor. Under prolonged exposure to fire or intense heat the containers may rupture violently and rocket. Propane is used primarily as a fuel, but also as an aerosol propellant, as a refrigerant, and to make other chemicals.

In Nevada, propane is transported by rail and truck to over 600 facilities, seven of which store more than 500 pounds on site. Figure 6.9 illustrates propane facilities and flows by rail and truck throughout the state. Truck flows are shown only to facilities storing more than 500 pounds on site at any one time.

Figure 6.9 Propane Facilities and Flows



Source: SFMO, CAPP, Cambridge Systematics

6.9 Sodium Cyanide

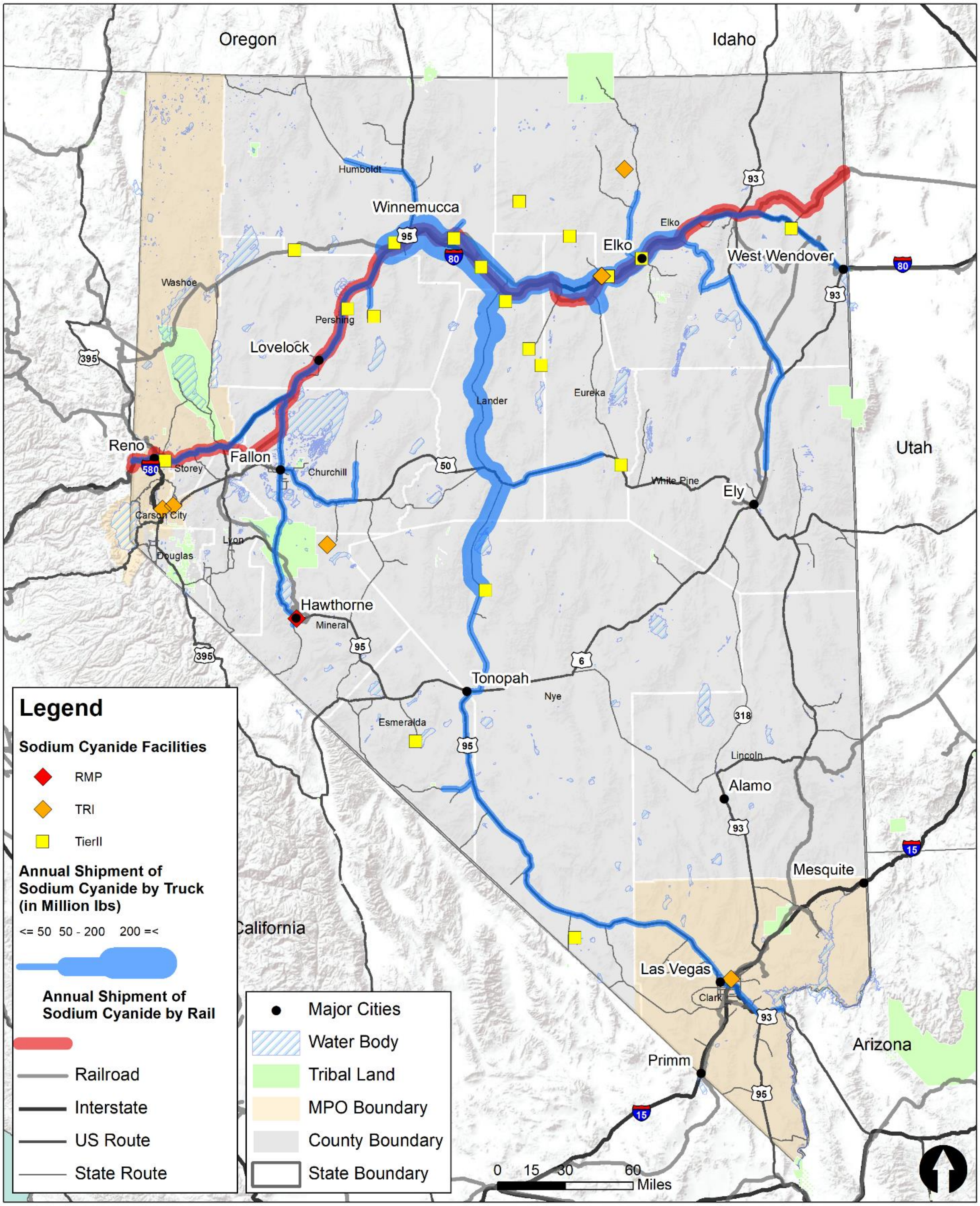
Sodium cyanide is used in mining operations and manufactured in Northern Nevada. This toxic compound is used in mining to extract gold and other precious metals from their ores. Sodium cyanide and an oxidant (such as oxygen) in solution are generally required to dissolve gold from ore. After 100 years of use and research, cyanide remains the predominant means by which gold is extracted from ore. Sodium cyanide is a hazardous substance that can be harmful to people and animals above certain levels.

The Cyanide Code, developed by the International Cyanide Management Institute (ICMI) provides best practices for transporting, storing, using, and disposing of cyanide. Developed under the auspices of the United Nations Environment Program (UNEP), the Cyanide Code is the product of multi-stakeholder input and is supported by environmental advocacy groups around the world. The ICMI monitors adherence to the Cyanide Code through independent third-party audits.

Materials are transported to and from mines typically by contractors. Suppliers are required to adhere to a Supplier Code of Ethics to mitigate the risk for environmental, safety, and health impacts. Transporters also must have emergency procedures in place to anticipate, assess, and respond to emergency situations in order to minimize any environmental impacts and protect people.

Sodium cyanide is transported by rail from Northern Nevada to Canada and Mexico and by truck to locations around the State. Figure 6.10 illustrates the sodium cyanide facilities and flows.

Figure 6.10 Sodium Cyanide Facilities and Flows



Source: Cyanco, Cambridge Systematics.

6.10 Titanium Tetrachloride

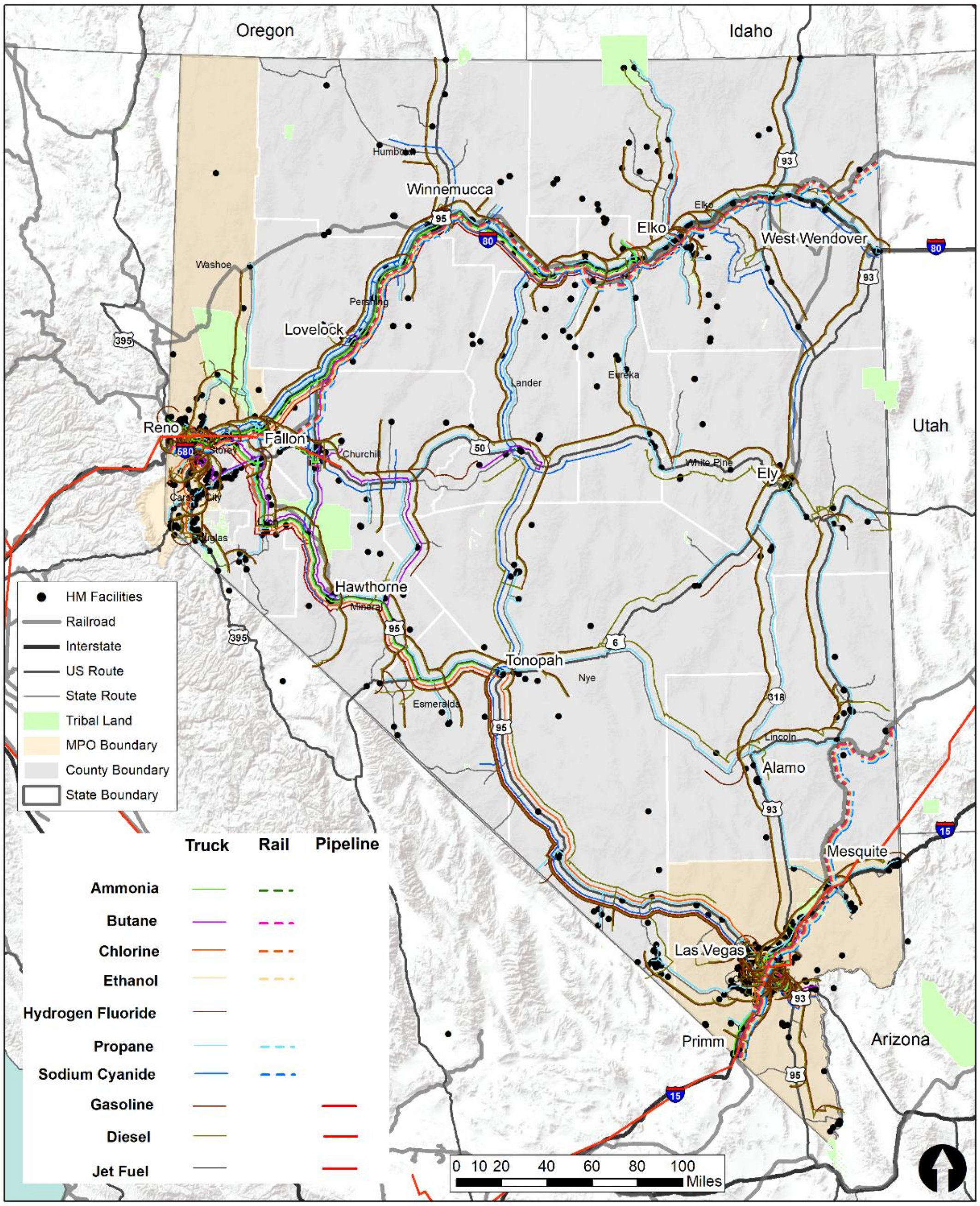
Titanium tetrachloride is used in manufacturing of titanium metal and paint. Typically, titanium tetrachloride is a corrosive chemical, however, when titanium tetrachloride reacts with moisture in the air it creates hydrogen chloride which is a toxic gas. The world's supply of titanium metal, about 250,000 tons per year, is made from titanium tetrachloride. The conversion involves the reduction of the tetrachloride with magnesium metal; this procedure is known as the Kroll process.[11] It also is used as an intermediate in the production of titanium metal, titanium dioxide, and titanium pigments, in the manufacture of iridescent glass, and as a polymerization catalyst. The study team interviewed industry representatives and determined that when used, this chemical is manufactured on-site, and only small amounts are transported in the State. Therefore, no map was developed for titanium tetrachloride.

11 The Kroll process is a pyrometallurgical industrial process used to produce metallic titanium.

6.11 Composite Maps

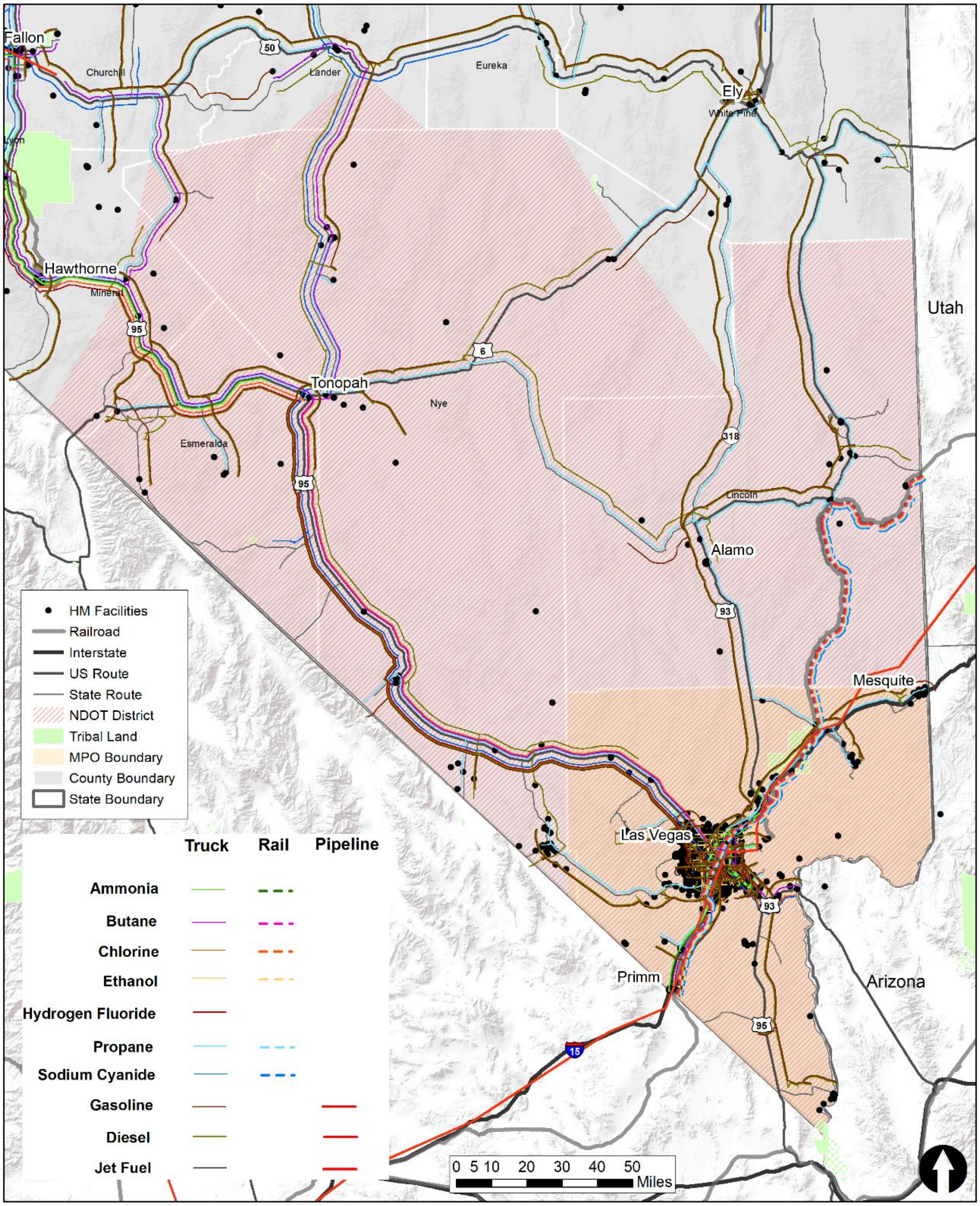
Using the results of the priority hazmat maps in Section 6.0, the CS Team added the three petroleum flows from the Petroleum Supply Chain Analysis to create a "composite" map of 10 hazmat routes. The resulting Hazmat Composite Map depicts 10 flows across Nevada highways, railroads and pipeline by route but not volume. Figure 6.11 to Figure 6.14 illustrate Hazmat Composite Maps by State and each NDOT District.

Figure 6.11 Statewide Hazmat Composite Map



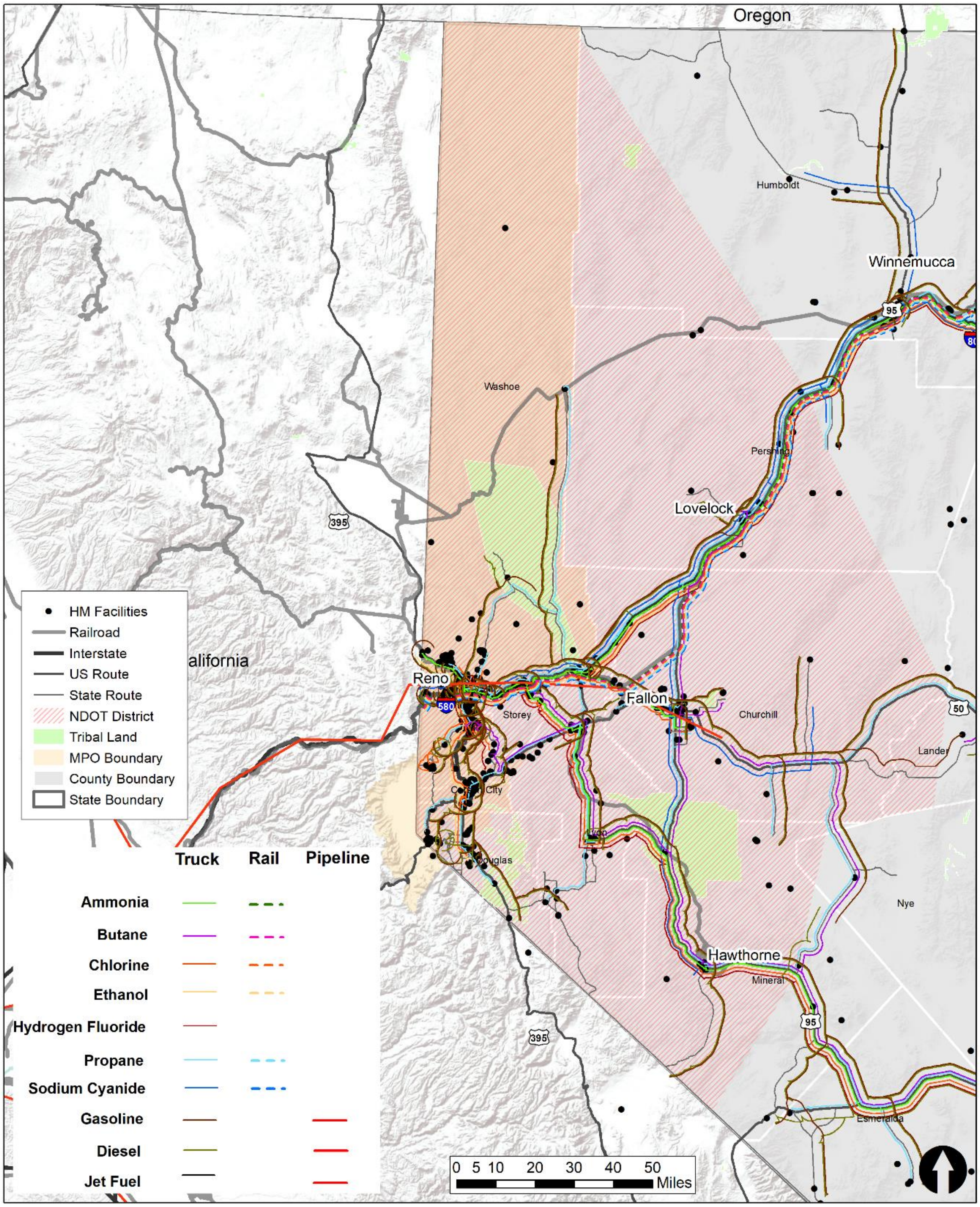
Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

Figure 6.12 NDOT District 1 Hazmat Composite Map



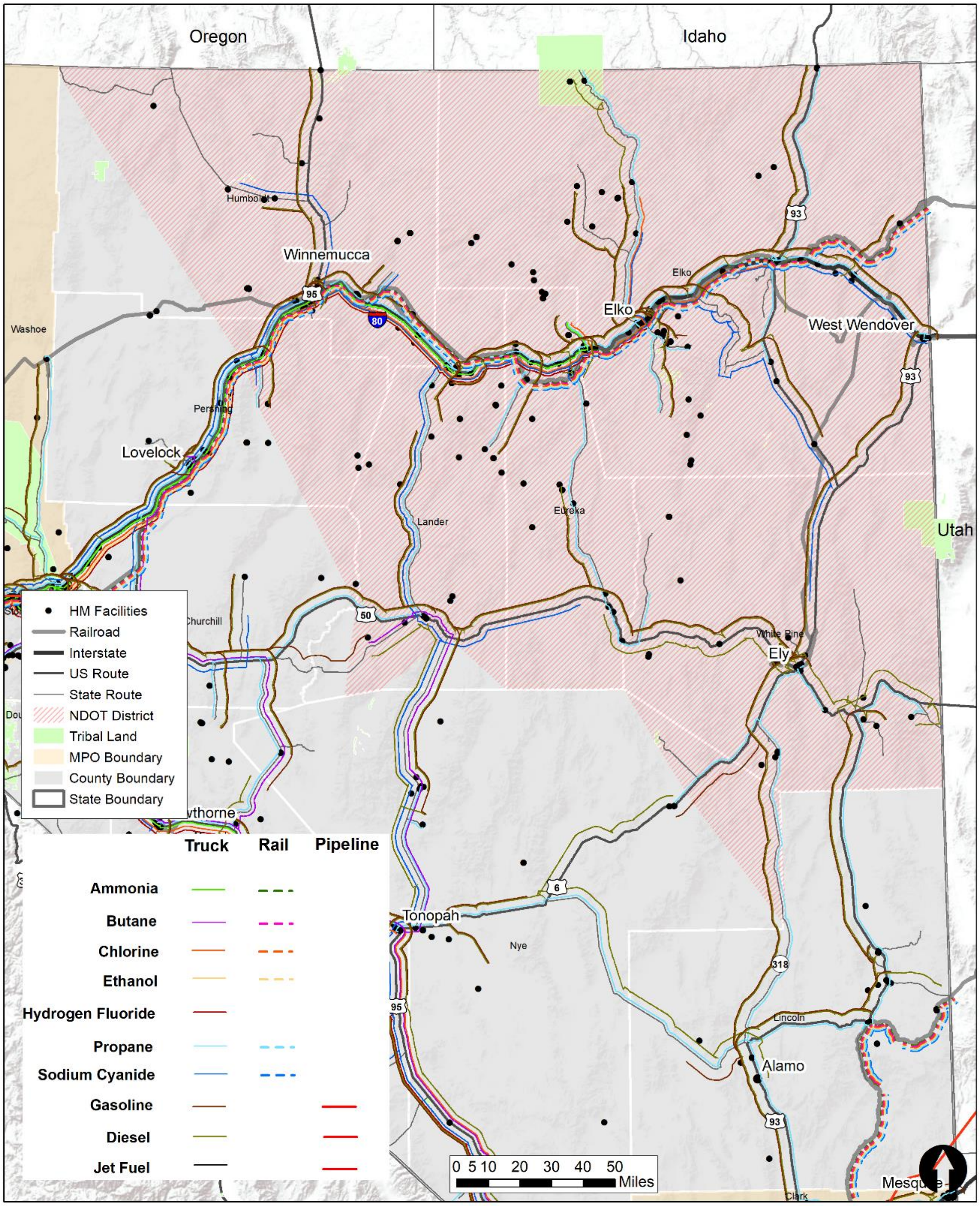
Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

Figure 6.13 NDOT District 2 Hazmat Composite Map



Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

Figure 6.14 NDOT District 3 Hazmat Composite Map



Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

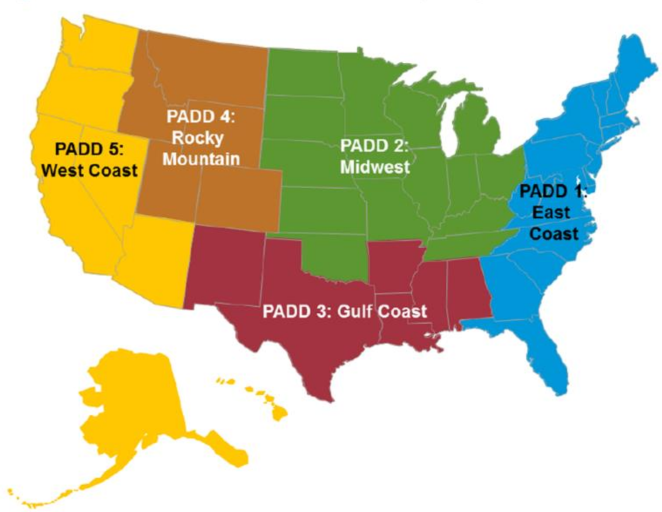
7.0 Petroleum Supply Chain Analysis

7.1 Introduction

To supplement the priority hazmat analysis, the study team also conducted a petroleum supply chain analysis. Refined petroleum products represent 86.4 percent of all hazmat shipments transported in the United States, including the required transportation fuels for automobiles, trucks, trains, and airplanes throughout Nevada.[12] Though the volume of petroleum products on the roads is greater than any other hazmat, emergency responders have experience with handling petroleum-related incidents. The primary fuels evaluated in this effort included gasoline, diesel, and jet fuel.

An important source for this research was the Energy Information Administration's (EIA) Petroleum Administration for Defense District 5 (PADD 5) Transportation Fuels Markets Study conducted in 2015.[13] The EIA Report examined the supply, demand, and distribution of transportation fuels in PADD 5, which includes the western States of California, Arizona, Nevada, Oregon, Washington, Alaska, and Hawaii as shown in Figure 7.1.

Figure 7.1 U.S. Petroleum Area Defense Districts (PADD)



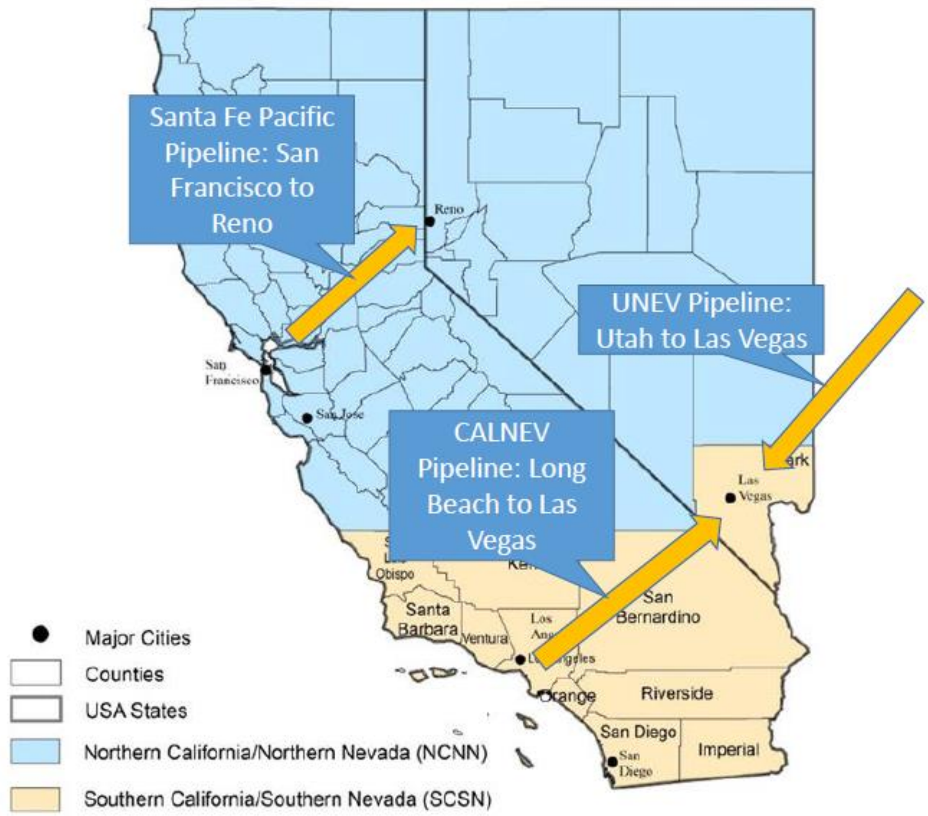
Source: U.S. Energy Information Administration (EIA), 2018.

Nevada relies on neighboring states for its petroleum supply; Southern California and Utah refineries supply Southern Nevada and Northern California refineries supply Northern Nevada (note Utah is in PADD 4). These regional markets are shown in Figure 7.2

12 BTS Freight Facts & Figures 2017. "Chapter 2: Freight Moved in Domestic and International Trade, Table 2-6."

13 U.S. Energy Information Administration, "West Coast Transportation Fuels Markets." Washington, D.C.: September 2015.

Figure 7.2 PADD 5 Regional Markets in California/Nevada, with SCSN Counties



Source: Cambridge Systematics. Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015 (Note: Utah is part of PADD 4).

7.2 Regional Petroleum Supply

Nevada relies on neighboring states for its petroleum supply; Southern California and Utah refineries supply Southern Nevada and Northern California refineries supply Northern Nevada. These regional Nevada fuel markets are shown in Table 7.1.

Table 7.1 Petroleum Demand and Production, by Region

Region	Fuel Type	2013 Refinery Production (b/d)	2013 Demand (b/d)	2013 Refinery Production / Demand (%)
SCSN	Gasoline[1]	526,800	606,600	87%
SCSN	Jet Fuel	178,100	194,100	92%
SCSN	Distillate	182,500	155,500	117%
NCNN	Gasoline	421,000	412,000	102%
NCNN	Jet Fuel	96,000	88,200	108%
NCNN	Distillate	185,000	125,600	147%

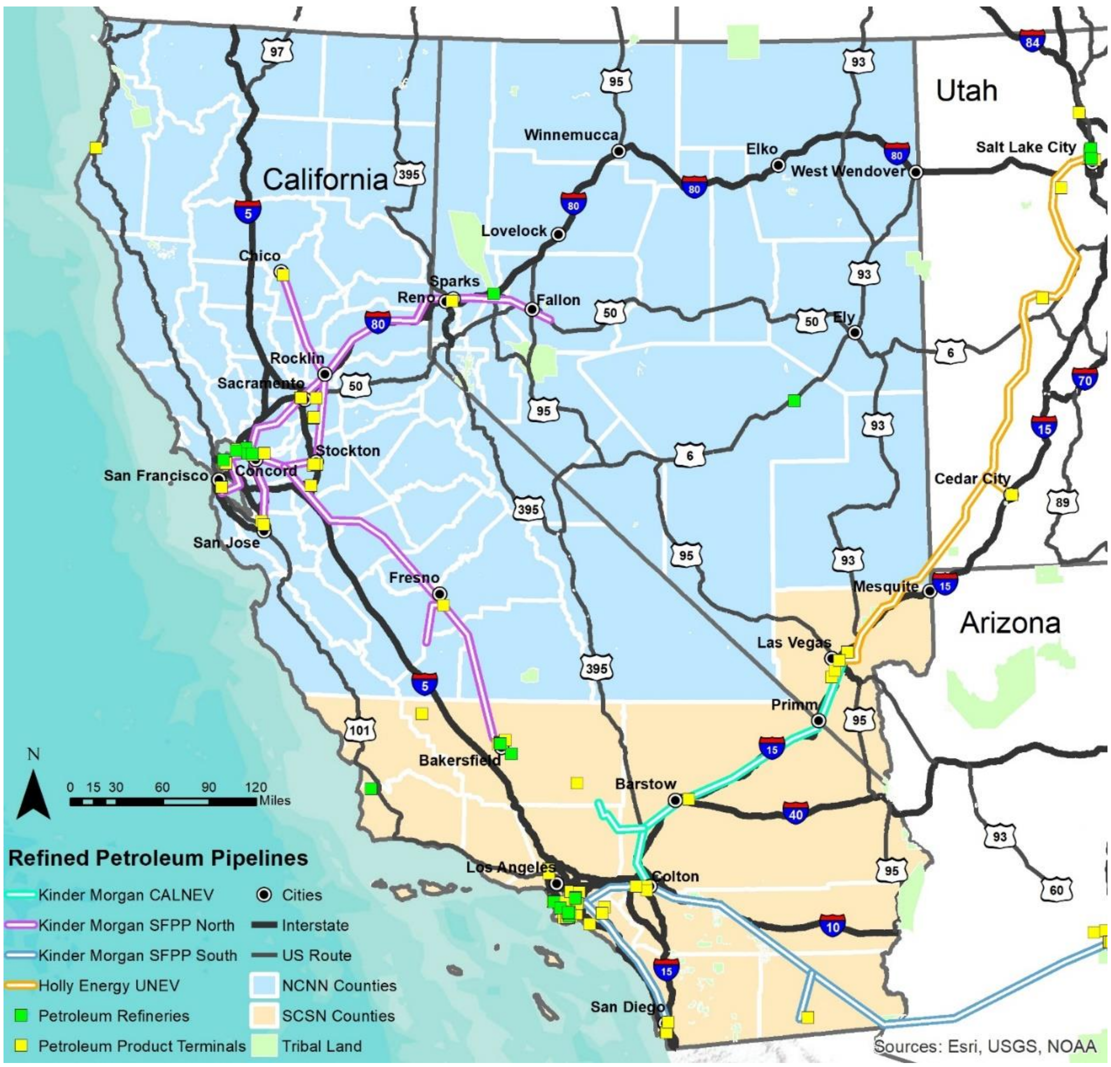
Region	Fuel Type	2013 Refinery Production (b/d)	2013 Demand (b/d)	2013 Refinery Production / Demand (%)
SCSN Subtotal		887,400	956,200	93%
NCNN Subtotal		702,000	625,800	112%

[1] Volumes for gasoline include 10 percent ethanol blending.

Source: Cambridge Systematics. Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

Figure 7.3 shows the refined petroleum pipelines that flow into Northern and Southern Nevada. The following sections will further evaluate the supply, demand, and distribution of fuels separately for Northern and Southern Nevada.

Figure 7.3 California and Nevada Refined Petroleum Pipelines



Source: Cambridge Systematics, Environmental Systems Research Institute, United States Geological Survey, NOAA, U.S. Energy Information Administration.

7.3 Southern Nevada Pipelines and Terminals

Two pipelines bring petroleum products into Southern Nevada from California and Utah: Kinder Morgan's CALNEV and Holly Energy's UNEV. The following section will examine the pipeline and storage terminal capacities in Southern Nevada.

7.3.1 CALNEV Pipeline and Las Vegas Terminal—Kinder Morgan

The CALNEV pipeline transports gasoline, jet fuel, and diesel fuel from Colton Terminal in Southern California to Kinder Morgan's Las Vegas Terminal, adjacent to Nellis Air Force Base in Southern Nevada. Kinder Morgan's Las Vegas Terminal is located on 66 acres, where 41 refined petroleum tanks have a combined storage capacity of 1.18 million barrels. Gasoline and ethanol are blended before being transported by truck to Nevada retail gas stations. Diesel fuel is transported by truck to retail gas stations and to fuel mine operations. Jet fuel is stored at the Nellis Air Force base and McCarran International Airport and transported by truck to other regional airports.

The gasoline is blended with ethanol at the "rack" or loading facility before distribution to retail facilities. Ethanol is transported to the terminal via Union Pacific Railroad. The CALNEV pipeline is 566 miles long, operated by Kinder Morgan, and consists of 14 inch and 8-inch parallel pipes.

7.3.2 UNEV Pipeline and Las Vegas Terminal—Holly Energy

The UNEV pipeline transports petroleum products into Las Vegas from Woods Cross, Utah to Holly Energy's Terminal at Apex Industrial Park in Southern Nevada. The Holly Energy Terminal is located on 53 acres, where 12 refined petroleum tanks have a combined storage capacity of 330,000 barrels. Gasoline and ethanol are blended before being transported by truck to Nevada retail gas stations. Diesel fuel is transported by truck to retail gas stations and to mines fuel operations.

The gasoline stored at the Holly Energy Terminal is blended with butane on site, then blended with ethanol at the "rack" or a loading facility before distribution to retail facilities. Butane and Ethanol are both transported to Apex Industrial Park by truck and stored in tanks onsite.

The UNEV pipeline is 427 miles long and operated by Holly Energy and consists of a 12-inch pipe. The UNEV pipeline is responsible for delivering a minority of Southern Nevada's petroleum supply to the Holly Energy Terminal for distribution to the market, but does provide redundancy to the market which is a vital resource to the state

7.4 Northern Nevada Pipelines and Terminals

The City of Sparks is critical to the distribution of petroleum products to Northern Nevada. Kinder Morgan's Sparks Terminal is located at at the end of the Santa Fe Pacific Pipeline (SFPP) that brings petroleum products from the San Francisco Bay Area into Northern Nevada.

7.4.1 Santa Fe Pacific Pipeline: North Line and Sparks Terminal

Kinder Morgan's SFPP North Line transports gasoline, jet fuel, and diesel fuel from Concord Station in Northern California to the Sparks Terminal in Northern Nevada. A 20-inch pipeline extends from Concord to Sacramento, then connects to Rocklin Station. From Rocklin, product is transported to the Sparks Terminal in Sparks, NV, a distance of 138 miles, where it is stored in 44 tanks. The pipeline between Rocklin and Reno varies between 6, 8, and 10 inches in diameter, depending on geography. Jet fuel is supplied by pipeline to Reno-Tahoe International Airport and to the Fallon Naval Air Station. The Sparks Terminal is operated by Kinder Morgan on 44 acres, where 45 refined petroleum tanks have a combined storage capacity of 748,377 barrels. Gasoline and ethanol are blended before being transported by truck to retail gas stations. Diesel fuel is transported by truck to retail gas stations and to fuel mine operations.

7.5 Nevada Petroleum Distribution by Truck

In Nevada, petroleum products are transported from storage facilities to industries, municipal facilities, mining operations, utilities, and retail petroleum facilities throughout the State. The study team used the Nevada Statewide Hazmat Database to identify refined petroleum facilities by type and develop estimates refined petroleum distribution across the State. Applying a 250-mile radius around Las Vegas for petroleum distribution, the study team used a shortest path algorithm to determine likely routing options, with the assumption that truck drivers will primarily stay on Interstates and U.S. highways as much as possible.

Nevada regulations allow for multiple cargo tank trailers for truck transport, which sometimes includes triple trailer configurations.

The petroleum distribution maps demonstrate that the volume of diesel on the roadways is greatest in Northern Nevada, while Southern Nevada is dominated by gasoline. These results are consistent with the large urban population around Las Vegas in the south and the increased prevalence of industrial facilities and mining operations in Northern Nevada. Figure 7.4 and Figure 7.5 illustrate the likely distribution of diesel and gasoline by truck in Nevada.

Jet fuel is transported by pipeline to Nevada, then further transported by pipeline to airports, military bases and regional airports. Some jet fuel is transported by truck. Aviation gas (also known as "Avgas") used to fuel small aircraft is transported by truck. Avgas shipments are limited in the U.S. because relatively small volumes of avgas are refined each year.

7.5.1 Aviation Gasoline

A small but important part of the petroleum supply chain includes the transportation of aviation gasoline. Known as “Avgas,” this leaded gasoline is used for piston aircraft. Because the gas is leaded, it requires dedicated manufacturing and transport.

Approximately 70 percent of the general aviation (GA) fleet uses avgas or other gasoline. There are over 210,000 piston aircraft in the US, requiring approximately 154 million gallons each year.[14] Piston aircraft need high quality, high performance fuel. Leaded fuels have higher octane levels needed for small aircraft engines. Avgas is also known as "100-Low-Lead" or “100-LL”. Without high-octane avgas, most existing aircraft engines will have to be de-rated from their currently certified power levels in order to maintain the FAA-required detonation margins.

In 2017, PADD 5 refineries produced 405,000 barrels of aviation gasoline, down from 611,000 barrels in 2016.[15] Factors leading to reduced production of avgas include limited refining locations, separate transportation and storage facilities, and the cost of production.[16]

In an effort reduce the use of 100-LL fuel in the U.S., the FAA recently selected two unleaded aviation fuels, developed by Shell and Swift Fuels, for further testing as part of its effort to qualify and deploy an unleaded aviation gasoline to replace the 100 low-lead avgas currently used in the piston aircraft fleet.

In conclusion, a small supply chain supplying avgas to airports in Nevada results in truck shipments from a limited number of avgas refineries to Nevada each year. The transportation of avgas represents a very small volume of the overall petroleum products transported in the state.

7.5.2 Natural Gas

Another important part of Nevada’s petroleum supply chain is the transportation of natural gas throughout the state by pipeline for power generation (68 percent), residential (14 percent), commercial (11 percent) and industrial (7 percent) purposes. There are eight gas utility companies in the state, transporting natural gas over 11,978 miles of pipelines.[17] Kern River supplies natural gas to Southwest Gas, NV Energy, Las Vegas Power Company, and several lateral lines to industries. Southwest Gas Corporation operates another natural gas pipeline that supplies most of the Las Vegas Valley’s natural gas needs. In addition, Southwest Gas Corporation operates a 16” natural gas pipeline that comes into Nevada just South of Laughlin, NV and travels North into Las Vegas. See Figure 4.1 to view Nevada’s natural gas pipeline network.

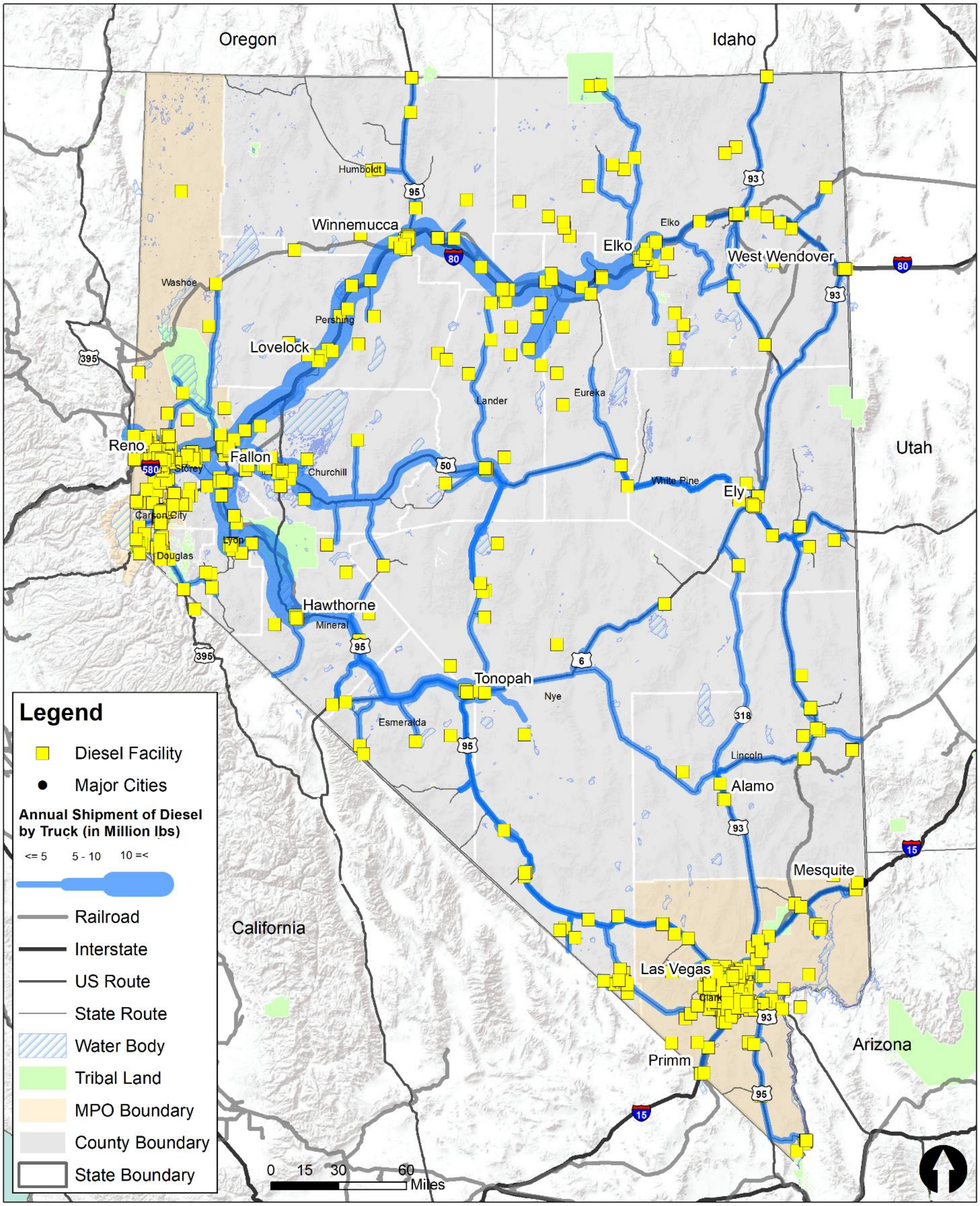
[14] General Aviation Manufacturers Association, “2016 General Aviation Statistical Databook & 2017 Industry Outlook.” Washington, DC: 2017. https://gama.aero/wp-content/uploads/2016-GAMA-Databook_forWeb.pdf

[15] U.S. Energy Information Administration, “Refinery Net Production.” Release data March 29, 2019. Accessed April 4, 2019 https://www.eia.gov/dnav/pet/PET_PNP_REFP2_A_EPPV_YPY_MBBL_A.htm

[16] EPI Inc. Web Site accessed April 4, 2019. http://www.epi-eng.com/aircraft_engine_products/demise_of_avgas.htm

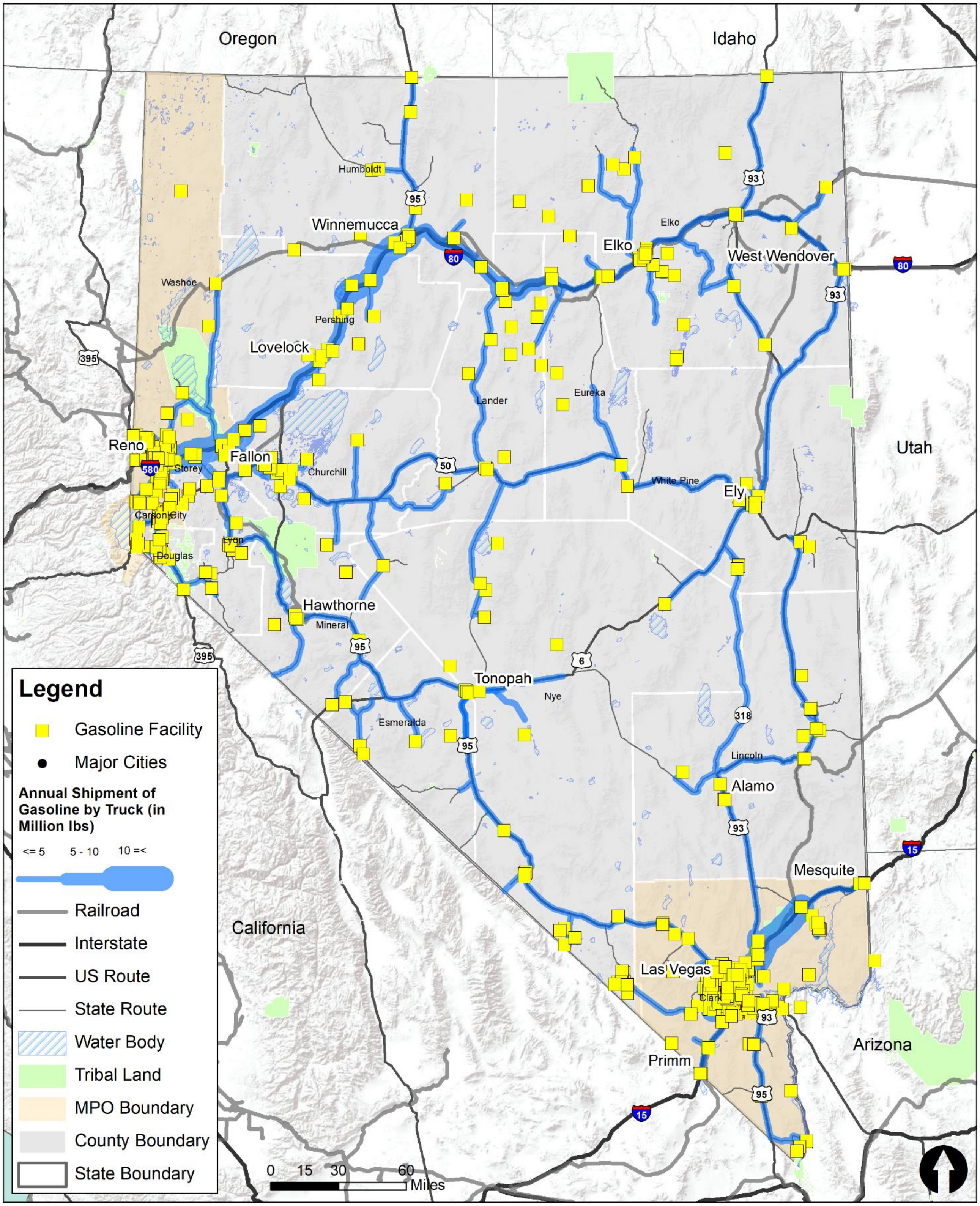
[17] American Gas Association (AGA), accessed July 31, 2019 https://www.aga.org.

Figure 7.4 Statewide Diesel Fuel Distribution by Truck



Source: SFMO, Kinder Morgan, Cambridge Systematics.

Figure 7.5 Statewide Gasoline Fuel Distribution by Truck



Source: SFMO, Kinder Morgan, Cambridge Systematics.

8.0 Air Cargo Hazmat

8.1 Overview

Four airports in Nevada provide commercial freight service, including McCarran International Airport (LAS) in Southern Nevada, Reno-Tahoe International Airport in Northwestern Nevada (RNO), Elko Regional Airport in Northeastern Nevada (EKO), and Ely Airport-Yelland Field (ELY) (see Figure 8.1). Air cargo represents a very small percentage of hazmats transported in the U.S. and in Nevada. Less than one percent of air cargo is classified as hazmat.[18]

McCarran International Airport hosts the Marnell Air Cargo Center, which is located on the east side of the airport, with direct access to loading facilities for both trucks and airplanes. Each day, several hundred trucks pick up or deliver goods at the Air Cargo Center and over 714,350 pounds of arriving/departing cargo is handled.[19] Current tenants include: UPS, U.S. Airways, Airport Terminal Services, Allegiant, Worldwide Flight Services, Inc., Southwest Airlines, and FedEx.

Reno-Tahoe International Airport delivers or receives on average 407,850 pounds of air cargo each day, less than one percent of which includes hazmats.[20] Companies handling air cargo include Amerijet, DHL, FedEx, and UPS.

Elko Regional Airport has steadily handled an average of 33,000 pounds of air cargo freight annually since 2009[21]. It receives two flights per day of Ameriflight cargo and freight in the belly of cargo space of passenger aircraft.

Ely Airport-Yelland Field is a county-owned airport located three miles northeast of Ely, Nevada. Shipments to Ely include packages from Ameriflight, UPS and FedEx to support the nearby Gold Mining operations. NDOT recently upgraded the main 7,000-foot runway and plans to upgrade the other 6,000-foot cross runway next year. FAA recently announced the “Airport of the Year” award to Ely Airport in recognition of the exemplary work by the County to accomplish the runway reconstruction.

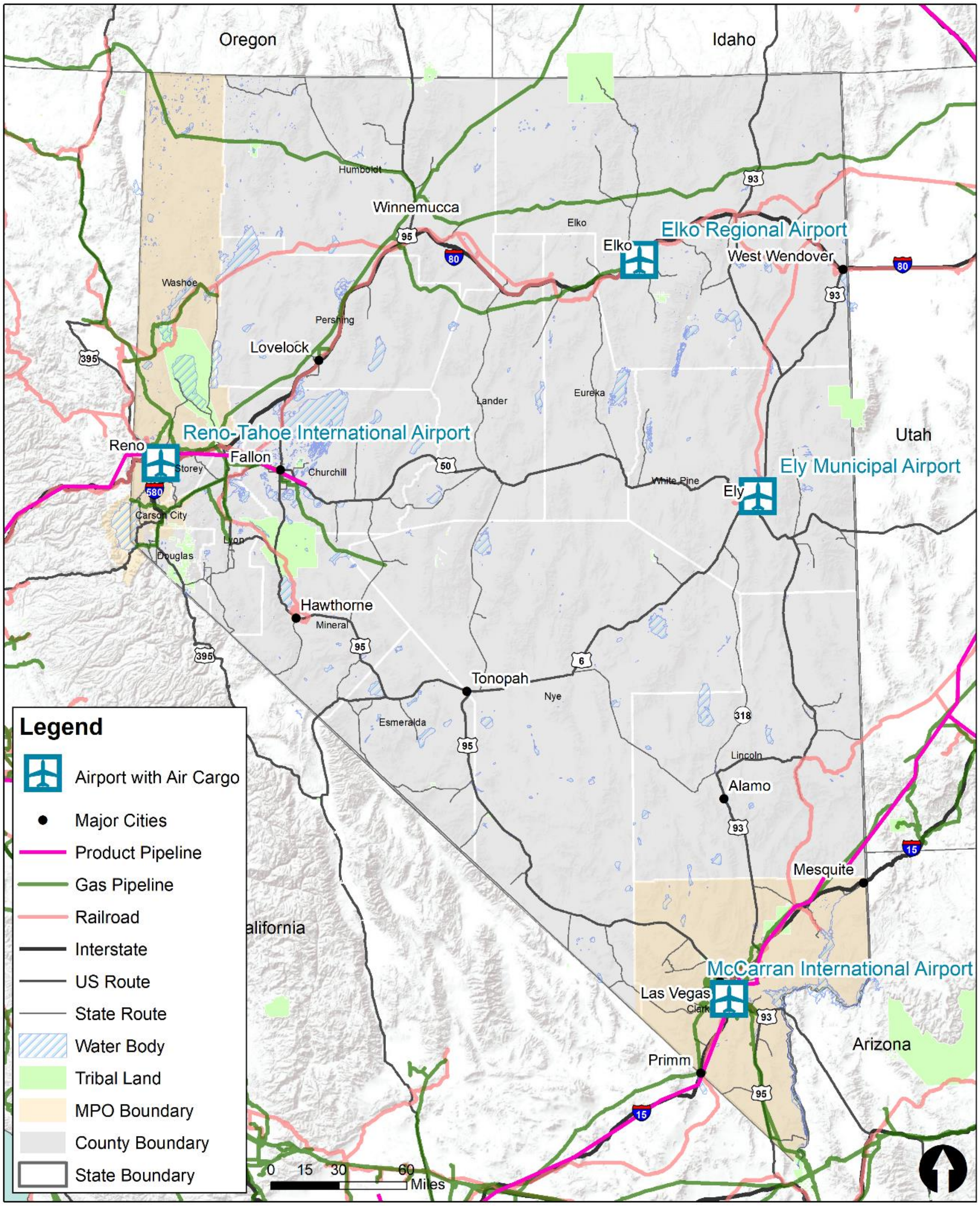
18 Phone interview with representative from large Air Carrier at LAS, February 15, 2019.

19 Michael Alonzo, “2018 Detailed Cargo by Airline Report (lbs.).” McCarran International Airport, Clark County Department of Aviation. January 28, 2019.

20 Reno-Tahoe Airport Authority, “Passenger and Cargo Statistics Report: Reno-Tahoe International Airport.” *2018 Total Cargo.* April 2019.

21 Aries Consultants LTD, “Regional Air Service Study.” Nevada Department of Transportation, 2009. https://www.nevadadot.com/home/showdocument?id=3556

Figure 8.1 Nevada Air Cargo Airports



Source: Nevada State Freight Plan, 2017, https://www.nevadadot.com/home/showdocument?id=5312.

8.2 Types of Hazmat Air Cargo

The most common types of hazmat transported by air include lithium (ion and metal) batteries and dry ice. Other hazmat air cargoes include limited quantities of aerosols, radioactive medical isotopes and pharmaceuticals, shipped by air to expedite next day air delivery requirements. These restrictions are described below.

8.2.1 Lithium Battery Prohibitions

All lithium ion cells and batteries shipped by themselves (UN 3480) are forbidden for transport as cargo on passenger aircraft. All packages prepared in accordance with Packing Instruction 965, Section IA, IB, and II, must bear a Cargo Aircraft Only label, in addition to existing marks and/or labels.

All lithium metal cells and batteries shipped by themselves (UN 3090) are forbidden for transport as cargo on passenger aircraft. All packages prepared in accordance with Packing Instruction 968, Section IA, IB, and II, must bear a Cargo Aircraft Only label, in addition to existing marks and/or labels.[22]

On cargo aircraft, lithium batteries are generally stored in the forward section of the cargo area so that the pilots can handle any situations that may develop in flight.

8.2.2 Dry Ice

Dry ice is commonly used to maintain temperature-controlled cargo requirements for pharmaceuticals and other sensitive shipments. Adding dry ice in perishable shipments has been a cost-effective solution to maintain cold temperatures for a limited time. Dry ice is solidified carbon dioxide (CO_2) at very low temperature. Dry ice is classified as a hazmat by the International Air Transport Association (IATA). Since high concentrations of odorless gaseous CO_2 in confined spaces such as airplanes can lead to breathing problems or even suffocation, the Federal Aviation Administration (FAA) in the U.S. has published guidelines for determining dry ice capacities. The maximum CO_2 concentration per volume allowed on board an aircraft is typically taken as 0.5 percent for freighter models and 0.25 percent for passenger aircraft, allowing cargo airlines to carry twice the amount of dry ice compared to passenger airlines for the same cargo compartment.[23]

8.2.3 Packaging and labeling

Packages identified as ORM-D or Limited Quantity contain hazmats intended for sale by retailers to individuals for personal care or household use. These types of shipments include (but are not limited to) materials such as:

- Aerosol sprays.
- Nail polish.
- Cosmetics.

---

[22] IATA, “2019 Lithium Battery Guidance Document, Revision 1." 2019. https://www.iata.org/whatwedo/cargo/dgr/Documents/lithium-battery-shipping-guidelines.pdf.

[23] Christelle Laot, “Dry Ice Shipments in Air Transport.” FedEx website, June 25, 2012. https://about.van.fedex.com/blog/dry-ice-shipments-in-air-transport/.

- Paints.
- Medicines.

8.2.4 Air Cargo Shipper Requirements

Shippers must ensure that the articles or substances tendered to cargo carriers are not prohibited for transport by air, and that the articles or substances are properly identified, classified, packed, marked, labeled, and documented in accordance with IATA Dangerous Goods Regulations, as well as all government regulations in the countries of origin transit and destination. Before packing dangerous goods for transport by air, the shipper must:

- Identify, correctly and fully, all dangerous articles and dangerous substances within the consignment.
- Classify each item as a dangerous good by determining under which of the nine classes it falls and, where relevant, determine any subsidiary hazards.
- Where relevant, assign each item to one of the three packing groups within its class.
- Ensure that the documentation accompanying the shipment is complete and in accordance with IATA Dangerous Goods Regulations. For further assistance, we recommend that you contact a Dangerous Goods Handler (i.e., Freight Forwarder) in your area.
- Ensure advanced arrangements are made for the shipment.

8.2.5 Air Cargo Variations

In addition to the requirements of the International Civil Aviation Organization (ICAO), IATA, and the U.S. Code of Federal regulations 49CFR, air cargo carriers may apply additional variations on hazmat shipments.

- All liquid dangerous goods in all classes and divisions must be packed in combination packaging. Single packaging is not allowed.
- An overpack, by definition, is not a combination packaging.
- Division 6.1 Toxic Substances are only accepted:
  - When shipments are PG II or PG III.
  - Without inhalation toxicity.
- The shippers declaration for the toxic materials must contain a certifying statement that indicates that the shipment contains materials intended for use in or incidental to medical purposes.
- Limited quantities are subject to the same requirements.
- The carriage of carbon dioxide, solid (dry ice), UN 1845, are limited by aircraft type and must be booked with weight of the dry ice to determine whether aircraft limits may be exceeded.

9.0 Hazmat Classification

9.1 Overview

Hazardous Materials, (known worldwide as dangerous goods), are materials or items with hazardous properties which, if not properly controlled, present a potential hazard to human health and safety, infrastructure and/or their means of transport. The transportation of dangerous goods is controlled and governed by a variety of different regulatory organizations, operating at both the national and international levels.

The U.S. DOT classifies hazmat for transport in the U.S. and the Occupational Safety and Health Administration (OSHA) classifies hazmat for shippers that must provide Safety Data Sheets (SDS). In other countries, prominent regulatory frameworks for the transportation of dangerous goods include the United Nations Recommendations on the Transport of Dangerous Goods, ICAO's Technical Instructions, IATA's Dangerous Goods Regulations and the International Maritime Organization's International Maritime Dangerous Goods Code. Collectively, these regulatory regimes mandate the means by which dangerous goods are to be handled, packaged, labelled and transported. This section describes hazmat classifications in the U.S. and which classifications of hazmat were documented in Nevada.

9.2 Hazard Classifications

Hazardous materials are classified according to the risks that they pose. U.S. DOT established nine hazmats classifications in order to provide consistency across all agencies that regulate commercial shipping. There are multiple sources for identifying the defined hazards of a material, including shipping papers, Safety Data Sheets, container labels and markings. HazMat diamonds or "placards" found on the packaging reference the U.S. DOT hazard class of the material. Some classes include multiple hazards denoted by the division number. The U.S. DOT defines hazmats as belonging to one of the nine hazard classes with subclasses/divisions, as shown below.

Table 9.1 Hazardous Material Classification

Hazard Class	Hazardous Material
Class 1	**Explosives**
Division 1.1	Mass Explosive Hazard
Division 1.2	Projection Hazard
Division 1.3	Mass Fire Hazard
Division 1.4	Minor Explosion Hazard
Division 1.5	Very Insensitive Explosives
Division 1.6	Extremely Insensitive Explosives
Class 2	**Gases**
Division 2.1	Flammable Gases[1]
Division 2.2	Nonflammable, Nontoxic Gases
Division 2.3	Poisonous or Toxic Gases
Class 3	**Flammable and Combustible Liquids[2]**

Hazard Class	Hazardous Material
Class 4	**Flammable Solids**
Division 4.1	Flammable Solid
Division 4.2	Spontaneously Combustible Material
Division 4.3	Dangerous When Wet
Class 5	**Oxidizing Substances, Organic Peroxides**
Division 5.1	Oxidizing Substances
Division 5.2	Organic Peroxides
Class 6	**Poisonous (Toxic) Materials and Infectious Substances**
Division 6.1	Poisonous (Toxic) Materials
Division 6.2	Infectious Substances
Class 7	**Radioactive Materials**
Class 8	**Corrosive Materials**
Class 9	**Miscellaneous Hazardous Materials**

[1] Includes gases that are compressed, dissolved under pressure, pressurized cryogenic liquids and liquefied gases.

[2] Includes materials whose flash point is not more than 141°F.

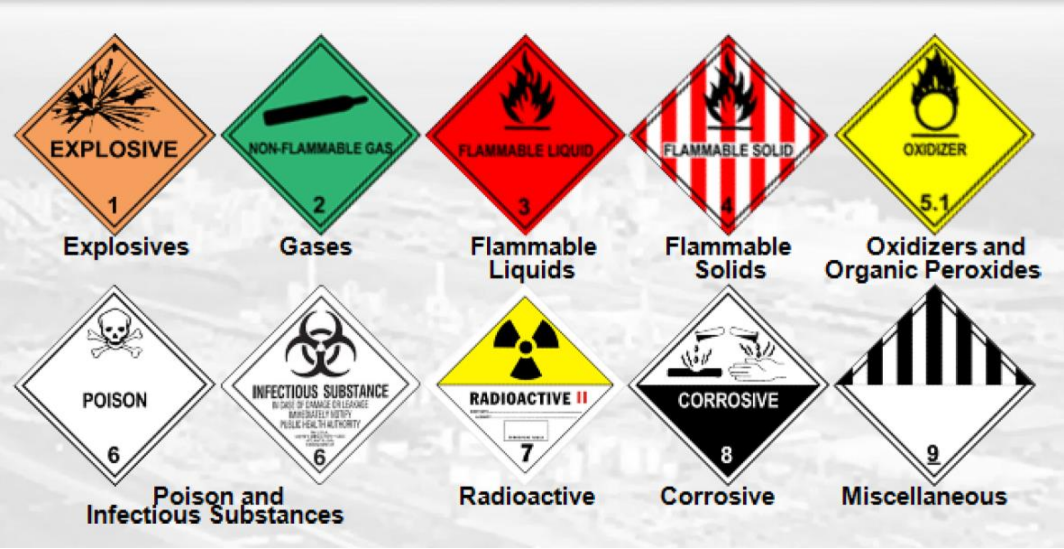
Source: PHMSA Emergency Response Guide, 2016.

Each class is identified with a diamond shaped placard that must be affixed to all sides of cargo trailers, portable containers and rail cars transporting hazmats. The placard may or may not display the United Nations (UN) number, which is four digits. The UN classification system has been adopted for worldwide use by the United Nations Committee of Experts on the Transport of Dangerous Goods. The UN system was incorporated into the Federal Code of Regulations by the U.S. Department of Transportation for domestic transportation in 1980. The North America system is a parallel hazard identification system used in North America when transporting hazmats that are not assigned a UN number or when transporting under specific North American exceptions. Figure 9.1 illustrates a hazmat placard identified as a flammable liquid (red color, Class 2) with the UN number for propane or butane (1075). Figure 9.2 illustrates the nine hazmat classification placards.

Figure 9.1 Hazmat Placard for Flammable Liquid (UN 1075)

Source: U.S..DOT, et al. Emergency Response Guidebook, 2016.

Figure 9.2 Hazmat Classification Placards



Source: U.S..DOT, et al. Emergency Response Guidebook, 2016.

This section describes the reason for regulating hazmat in different classifications.

9.2.1 CLASS 1—EXPLOSIVES

Explosives are materials or items which have the ability to rapidly conflagrate or detonate as a consequence of a chemical reaction. The reason for regulation is that explosives are capable of producing gases at temperatures, pressures, and speeds great enough to cause significant damage through force and/or of producing otherwise hazardous amounts of heat, light, sound, gas or smoke. There were no explosives shipments identified in the hazmat roadside survey. However, explosives are used in Nevada for fireworks, ammunition, construction and mining. Table 9.2 listed commonly transported explosives.

Table 9.2 Explosives

Ammunition, cartridges	Primers	Igniters
Fireworks, pyrotechnics	Explosive charges	Rockets
Flares	Detonating cord	TNT compositions
Blasting caps, detonators	Air bag inflators	PETN compositions

Source: PHMSA: Emergency Response Guidebook, 2016

9.2.2 CLASS 2—GASES

Gases are defined as substances which have a certain vapor pressure of 45 psi or greater at 122°F or are completely gaseous at 68°F at standard atmospheric pressure, and items containing these substances. The class encompasses compressed gases, liquefied gases, dissolved gases, refrigerated liquefied gases, mixtures of one or more gases with one or more vapors of substances of other classes, articles charged with a gas, and aerosols. The reason for regulation is that gases are capable of posing serious hazards due to their flammability, potential as asphyxiates, ability to oxidize, and/or their toxicity or corrosiveness impacting public health. Butane and propane are transported by rail and truck in Nevada, and natural gas is transported by pipeline. Table 9.3 displays commonly transported gases.

Table 9.3 Gases

Aerosols	Lighters	Chlorine
Compressed air	Acetylene/Oxyacetylene	Ammonia
Gas-powered devices	Carbon dioxide	Butane
Fire extinguishers	Helium/helium compounds	Propane
Gas cartridges	Hydrogen/hydrogen compounds	Ethane
Fertilizer ammoniating solution	Oxygen/oxygen compounds	Methane
Insecticide gases	Nitrogen/nitrogen compounds	Ethylene
Refrigerant gases	Natural gas	Nitrogen Dioxide

Source: PHMSA: Emergency Response Guidebook, 2016.

9.2.3 CLASS 3—FLAMMABLE AND COMBUSTIBLE LIQUIDS

Flammable and combustible liquids are defined by dangerous goods regulations as liquids, mixtures of liquids, or liquids containing solids in solution or suspension which give off a flammable vapor (have a flash point) at temperatures of not more than 140 to 149°F; or, liquids offered for transport at temperatures at or above their flash point or substances transported at elevated temperatures in a liquid state and which give off a flammable vapor at a temperature at or below the maximum transport temperature. The reason for regulation is that flammable liquids are capable of posing serious hazards due to their volatility, combustibility and potential in causing or propagating severe fires. Flammable liquids in Nevada include gasoline, diesel fuel, jet fuel and ethanol, representing more than 85 percent of all hazmat. Table 9.4 displays commonly transported flammable liquids.

Table 9.4 Flammable Liquids

Acetone	Petroleum crude oil	Pesticides
Adhesives	Petroleum distillates	Ethers
Paints	Gas oil	Benzene
Alcohols	Shale oil	Butanols
Perfumery products	Heating oil	Dichloropropenes
Gasoline	Kerosene	Diethyl ether
Diesel fuel	Resins	Isobutanols
Jet fuel	Tars	Isopropyls
Ethanol	Turpentine	Methanol
Aviation Gas	Insecticides	Octanes
Coal tar distillates		

Source: PHMSA, Emergency Response Guidebook, 2016.

9.2.4 CLASS 4—FLAMMABLE SOLIDS, RISK OF SPONTANEOUS COMBUSTION

Flammable solids are materials which under conditions encountered in transport are readily combustible, may cause or contribute to fire through friction, self-reactive substances which are liable to undergo a strongly exothermic reaction, or solid desensitized explosives. Also included are substances which are liable to spontaneous heating under normal transport conditions, or to heating up in contact with air and consequently liable to catch fire, and substances which emit flammable gases or become spontaneously flammable when in contact with water. The reason for regulation is that flammable solids are capable of posing serious hazards due to their volatility, combustibility and potential in causing or creating severe fires. Table 9.5 displays commonly transported flammable solids, although no flammable solids were observed during the hazmat roadside survey.

Table 9.5 Flammable Solids

Alkali metals	Cerium	Iron sponge
Metal powders	Copra	Methaldehyde
Aluminum phosphide	Seed cake	Naphthalene
Sodium batteries	Desensitized explosives	Nitrocellulose
Calcium carbide	Ferrocerium	Phosphorus
Camphor	Iron oxide	Sulphur

Source: PHMSA: Emergency Response Guidebook, 2016.

9.2.5 CLASS 5—OXIDIZING SUBSTANCES; ORGANIC PEROXIDES

Oxidizers are defined by dangerous goods regulations as substances which may cause or contribute to combustion, generally by yielding oxygen as a result of a chemical reaction. Organic peroxides are substances which may be considered derivatives of hydrogen peroxide where one or both hydrogen atoms of the chemical structure have been replaced by organic radicals. The reason for regulation is that oxidizers, although not necessarily combustible in themselves, can yield oxygen and in so doing cause or contribute to the combustion of other materials. Organic peroxides are thermally unstable and may exude heat whilst undergoing exothermic autocatalytic decomposition. Additionally, organic peroxides may be liable to explosive decomposition, burn rapidly, be sensitive to impact or friction, react dangerously with other substances, or cause damage to eyes. Chlorine and some pool chemicals were observed during the hazmat roadside surveys, but no other oxidizers were observed. Table 9.6 displays commonly transported oxidizers and organic peroxides.

Table 9.6 Oxidizers and Organic Peroxides

Chemical oxygen generators	Ammonium nitrate	Potassium nitrate
Ammonium nitrate fertilizers	Ammonium persulphate	Potassium perchlorate
Chlorates	Calcium hypochlorite	Potassium permanganate
Nitrates	Calcium nitrate	Sodium hypochlorite
Nitrites	Calcium peroxide	Sodium nitrate
Perchlorates	Hydrogen peroxide	Sodium persulphate
Permanganates	Magnesium peroxide	Chlorine
Persulphates	Lithium hypochlorite	
Ammonium dichromate	Potassium chlorate	

Source: PHMSA: Emergency Response Guidebook, 2016

9.2.6 CLASS 6—TOXIC SUBSTANCES; INFECTIOUS SUBSTANCES

Toxic substances are those which are liable either to cause death or serious injury or to harm human health if swallowed, inhaled, or by skin contact. Infectious substances are those which are known or can be reasonably expected to contain pathogens. Dangerous goods regulations define pathogens as microorganisms, such as bacteria, viruses, rickettsiae, parasites and fungi, or other agents which can cause disease in humans or animals. The reason for regulation is that toxic and infectious substances can pose significant risks to human and animal health upon contact. In Nevada, sodium cyanide is a toxic substance used in mining precious metals and transported by truck and rail. Table 9.7 displays commonly transported toxic and infectious substances.

Table 9.7 Toxic and Infectious Substances

Chemical oxygen generators	Ammonium nitrate	Potassium cyanide
Ammonium nitrate fertilizers	Ammonium persulphate	Potassium nitrate
Chlorates	Calcium hypochlorite	Potassium perchlorate
Nitrates	Calcium nitrate	Potassium permanganate
Nitrites	Calcium peroxide	Sodium cyanide
Perchlorates	Hydrogen peroxide	Sodium nitrate
Permanganates	Magnesium peroxide	Sodium persulphate
Persulphates	Lithium hypochlorite	Titanium Tetrachloride
Ammonium dichromate	Potassium chlorate	

Source: PHMSA: Emergency Response Guidebook, 2016.

9.2.7 CLASS 7—RADIOACTIVE MATERIAL

Dangerous goods regulations define radioactive material as any material containing radionuclides where both the activity concentration and the total activity exceeds certain predefined values. A radionuclide is an atom with an unstable nucleus and consequently subject to radioactive decay. The reason for regulation is that radionuclides emit ionizing radiation, which presents potentially severe risks to human health. Documenting radioactive material was outside the scope of work for this study. However, Table 9.8 displays such radioactive materials, some of which may be transported in Nevada.

Table 9.8 Radioactive Material

Radioactive ores	Surface contaminated objects	Thorium radionuclides
Medical isotopes	Caesium radionuclides	Uranium radionuclides
Yellowcake	Iridium radionuclides	Depleted uranium
Density gauges	Americium radionuclides	Uranium hexafluoride
Mixed fission products	Plutonium radionuclides	Enriched Uranium

Source: PHMSA: Emergency Response Guidebook, 2016.

9.2.8 CLASS 8—CORROSIVES

Corrosives are substances which by chemical action degrade or disintegrate other materials upon contact. The reason for regulation is that corrosives cause severe damage when in contact with living tissue or, in the case of leakage, damage or destroy surrounding materials. Hydrogen fluoride is used in laboratories, and sulfuric acid is used in batteries and water treatment. Table 9.9 displays commonly transported corrosives.

Table 9.9 Corrosive Materials

Acids	Amines	Hydrochloric acid
Batteries	Polyamines	Sulfuric acid
Battery fluid	Sulphides	Nitric acid
Fuel cell cartridges	Polysulphides	Sludge acid
Dyes	Chlorides	Hydrogen fluoride
Fire extinguisher charges	Chlorosilanes	Iodine
Formaldehyde	Bromine	Morpholine
Flux	Cyclohexylamine	Titanium Tetrachloride
Paints	Phenol / carbolic acid	Chlorine
Alkylphenols	Hydrofluoric acid	

Source: PHMSA: Emergency Response Guidebook, 2016.

9.2.9 CLASS 9—MISCELLANEOUS HAZARDOUS MATERIALS

Miscellaneous hazmats are substances and articles which during transport present a danger or hazard not covered by other classes. This class encompasses, but is not limited to, environmentally hazardous substances, substances that are transported at elevated temperatures, miscellaneous articles and substances, genetically modified organisms and micro-organisms, and (depending on the method of transport) magnetized materials and aviation regulated substances. Lithium batteries and dry ice are classified as miscellaneous hazmat and transported in small quantities by air and by truck in Nevada. Table 9.10 displays commonly transported miscellaneous hazmat.

Table 9.10 Miscellaneous Hazardous Materials

Dry ice	Internal combustion engines	Lifesaving appliances
Expandable polymeric beads	Vehicles	Air bag modules
Ammonium nitrate fertilizers	Magnetized material	Seatbelt pretensioners
Blue asbestos	Dangerous goods in apparatus	Plastics molding compound
Lithium ion batteries	Dangerous goods in machinery	Castor bean plant products
Lithium metal batteries	Genetically modified organisms	Polychlorinated biphenyls
Battery powered equipment	Genetically modified micro-organisms	Polychlorinated terphenyls
Battery powered vehicles	Chemical kits	Dibromodifluoromethane
Fuel cell engines	First-aid kits	Benzaldehyde

Source: PHMSA: Emergency Response Guidebook, 2016.

9.3 Nevada Hazardous Commodity Flow Study Classifications

While U.S. DOT regulates nine different hazard classes for hazmat transportation, hazmat flows were identified for five of the nine hazard classifications in Nevada. This is because not all hazmat classifications were identified as part of the chemical selection process and not all hazmat classes were identified during the Hazmat Roadside Surveys conducted at 18 locations around the State. Radioactive materials were not part of the study scope of work. Also, it is important to consider that some chemicals fall into multiple classifications, such as chlorine, which falls into three classifications: Class 2.3 (nonflammable gas), Class 5.1 (oxidizing substance) and Class 8 (corrosive substance). Table 9.11 illustrates the five hazmat classifications identified as part of this study and Figure 9.3 displays the routes over which the five classifications of hazmat are transported in the State.

Table 9.11 Nevada Hazardous Commodity Flow Study Classifications

Class	Description	Study Hazardous Materials
Class 2	Gases	Butane, Chlorine, Propane, Ammonia, Nitrogen Dioxide, natural (methane) gas
Class 3	Flammable and Combustible Liquids	Gasoline, Diesel, Jet Fuel, Ethanol
Class 5	Oxidizing Substances, Organic Peroxides	Chlorine[1]
Class 6	Poisonous (Toxic) Materials and Infectious Substances	Potassium Cyanide, Sodium Cyanide, Titanium Tetrachloride
Class 8	Corrosive Materials	Hydrogen Fluoride, Chlorine, Hydrofluoric Acid, Titanium Tetrachloride

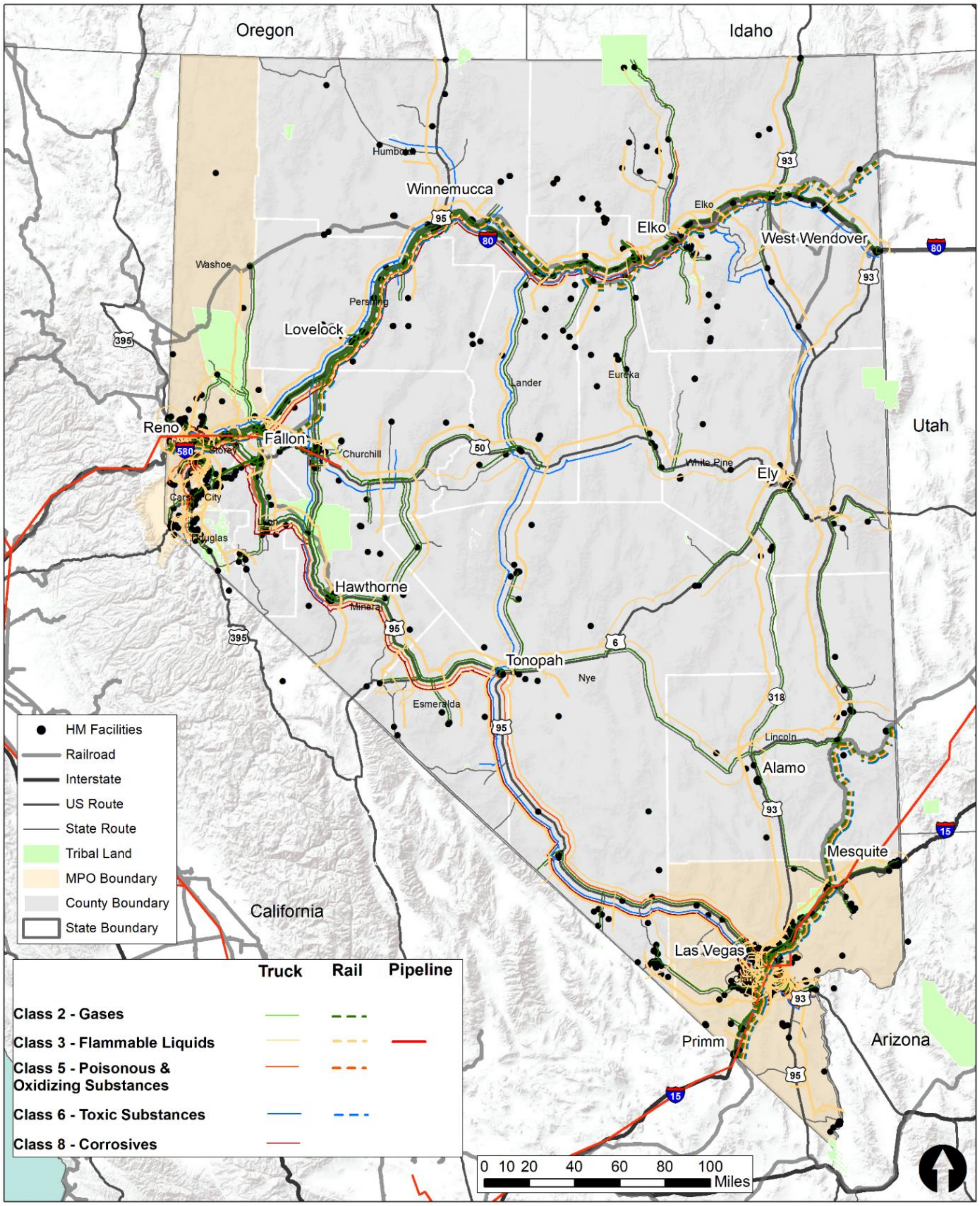
Note: Chlorine falls into Classes 2.3, 5.1 and 8 depending on its state of matter

Source: Industry interviews, Cambridge Systematics.

9.4 Classification Maps

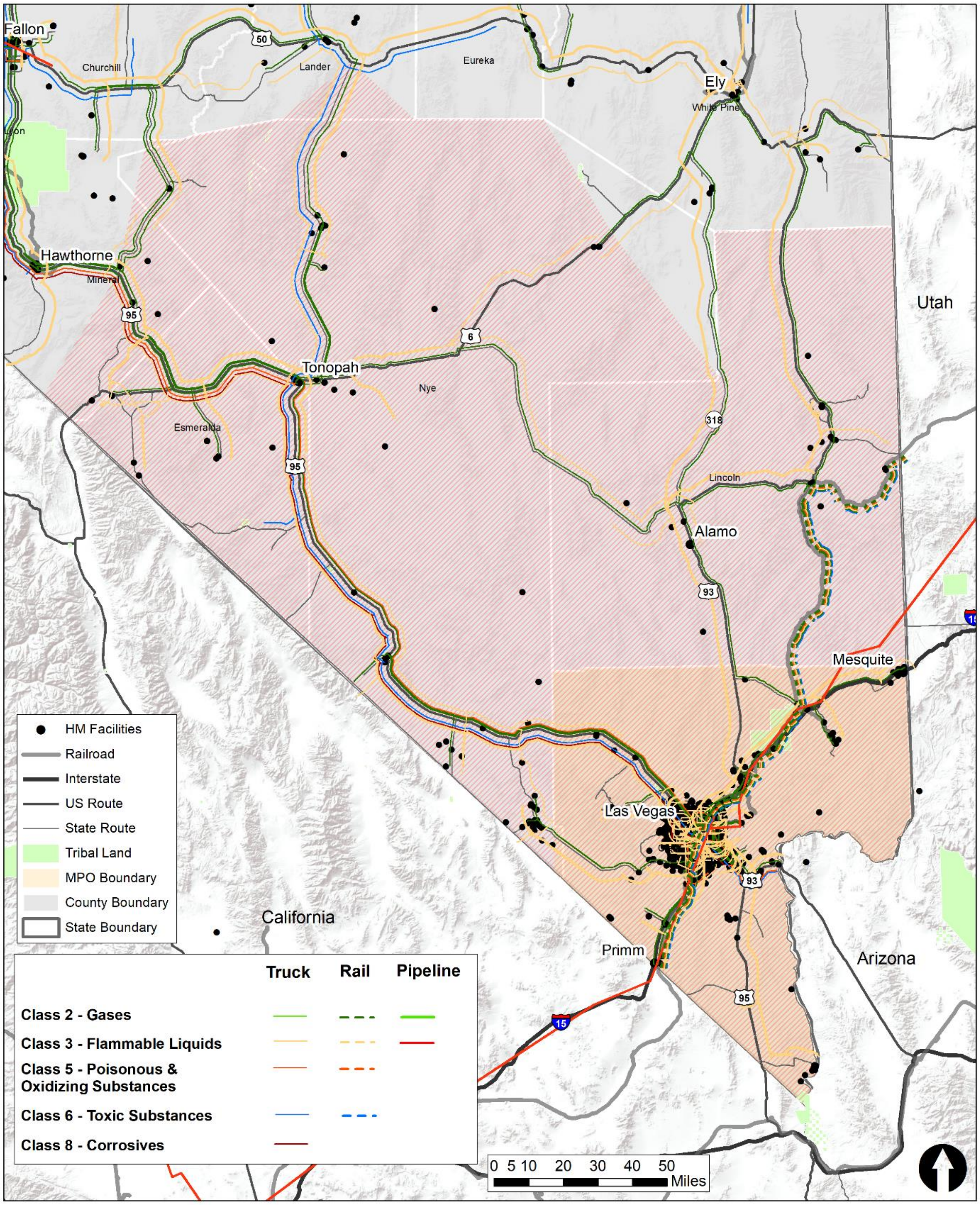
Using the results of the hazmat classification maps in Section 9.0, the CS Team used the hazmat classes create a “classification” map of five hazmat classes. The resulting Hazmat Classification Map depicts five flows, by route but not volume, across Nevada highways, railroads, and pipeline. Figure 9.3 to Figure 9.6 illustrate Hazmat Classification Maps by State and each NDOT District.

Figure 9.3 Statewide Hazmat Classification Map



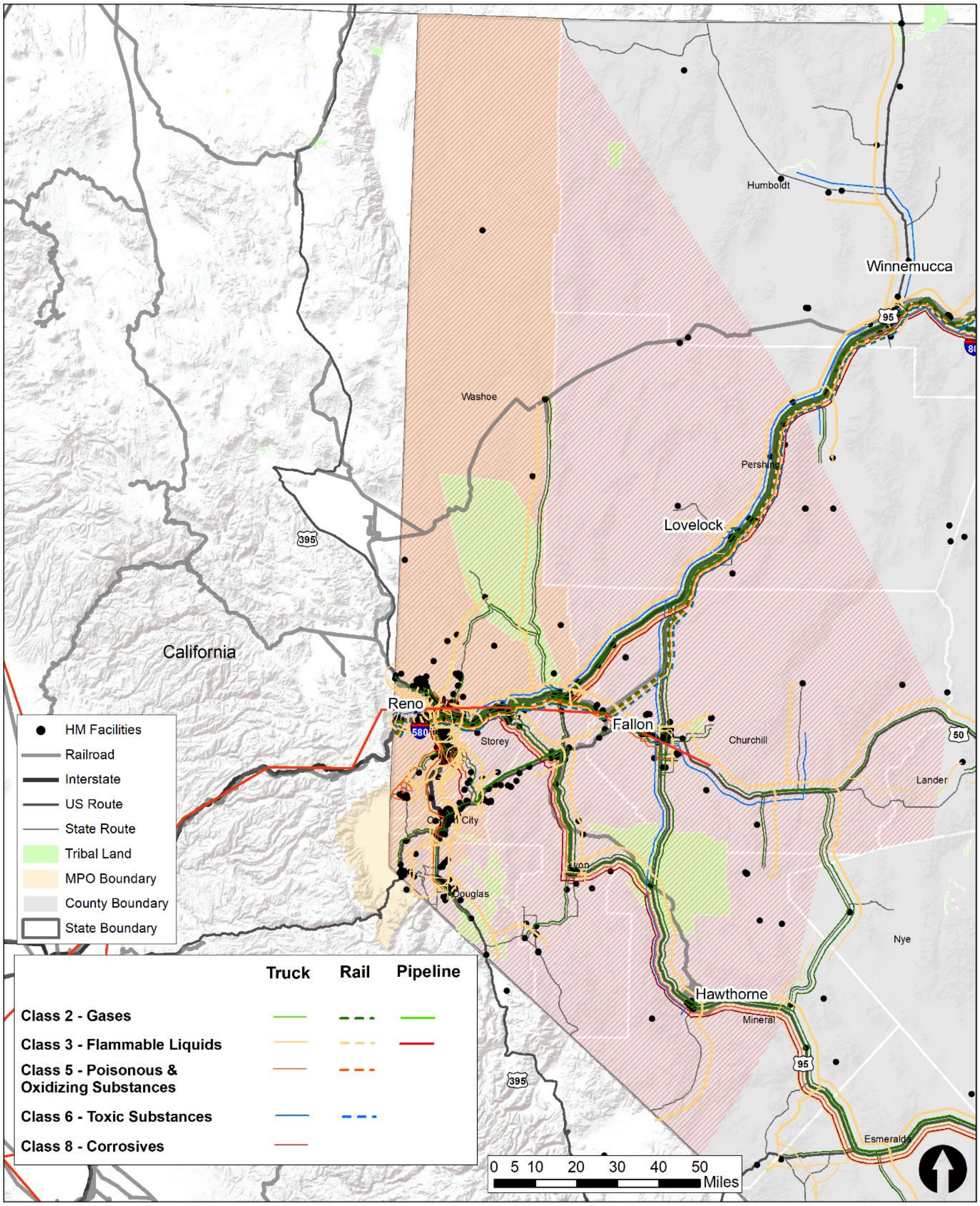
Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

Figure 9.4 NDOT District 1 Hazmat Classification Map



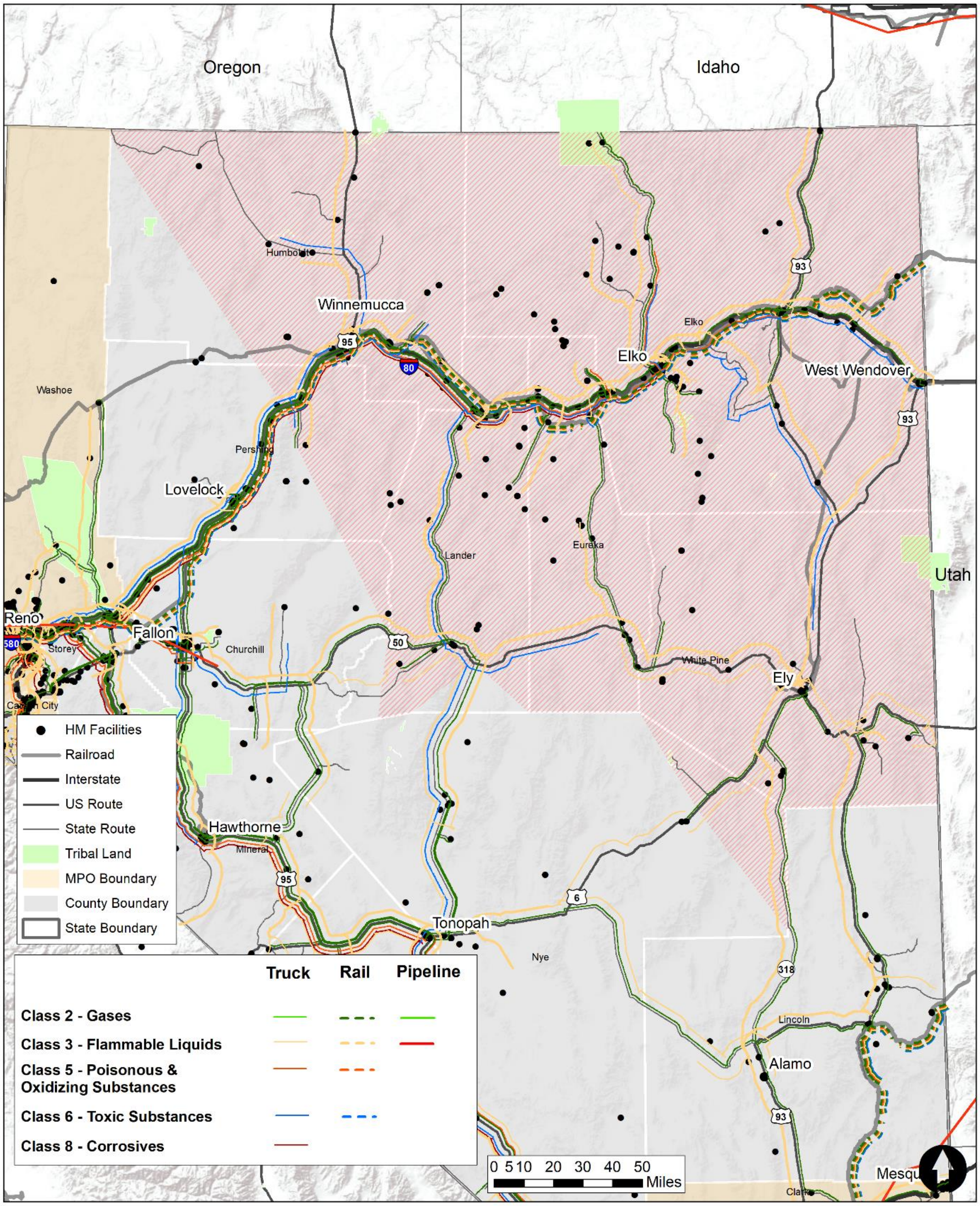
Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

Figure 9.5 NDOT District 2 Hazmat Classification Map



Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

Figure 9.6 NDOT District 3 Hazmat Classification Map



Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

10.0 Roadside Survey Results

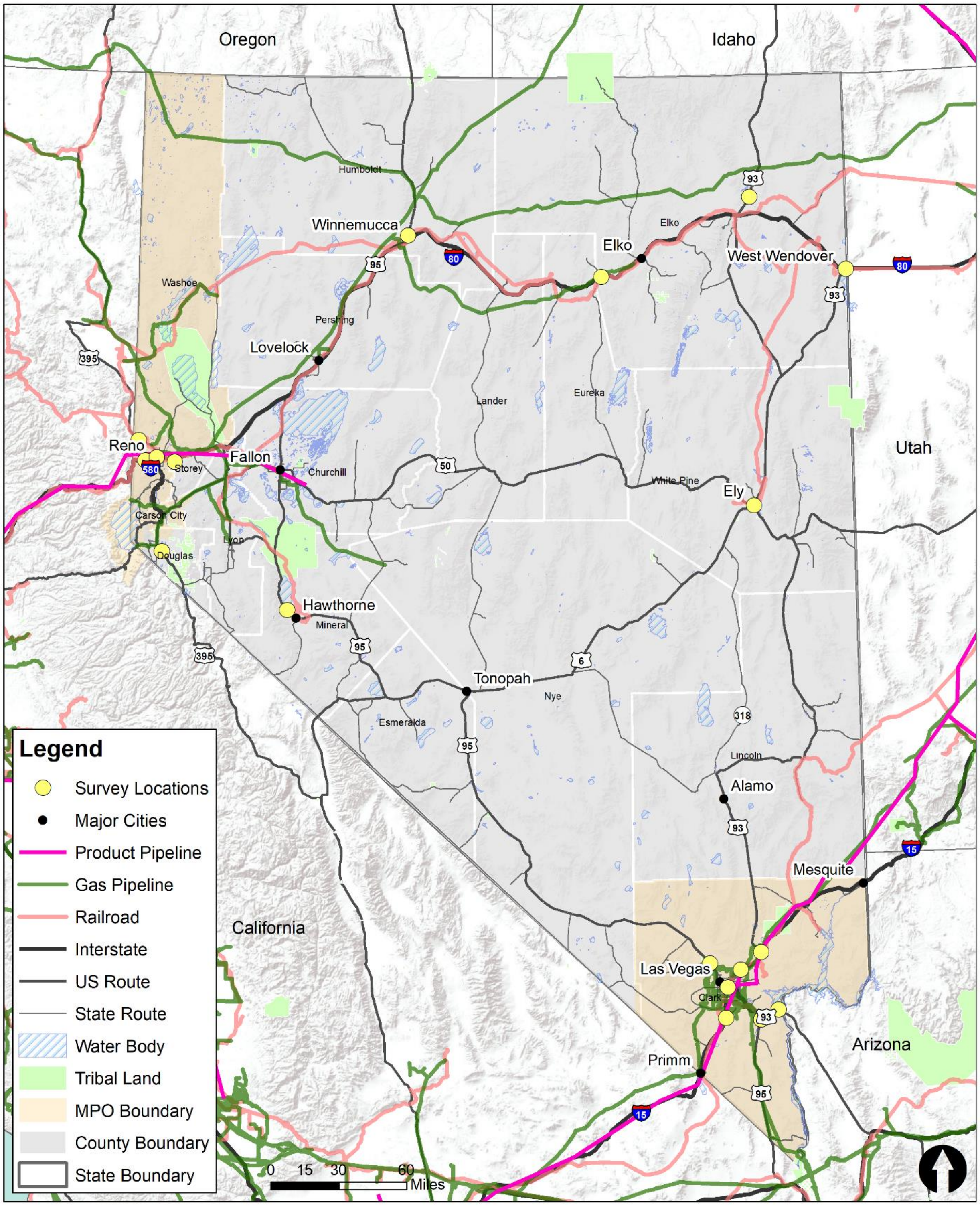
To corroborate the information collected in the Hazmat Analysis and Petroleum Supply Chain Analysis, the study team conducted roadside surveys at 18 locations in the State. This included 7 locations in the Las Vegas Area, 5 locations in the Reno Area, and 6 locations around the rest of the State. Between October, 2018 and February, 2019, survey technicians identified 195 trucks transporting hazmats. This section documents the methodology and results.

10.1 Survey Methodology

The study team positioned survey technicians at 18 locations, usually at overpasses to observe trucks transporting hazmats in both directions. Beginning in October 2018, surveyors counted hazmat trucks during 2-hour survey times during daylight hours on weekdays. Surveys continued through February 2019. At each location, surveyors documented the placard color, UN number and direction of each truck displaying a hazmat placard. When UN numbers could not be identified, the color of the placard was notated.

Figure 10.1 illustrates the 18 roadside survey locations in the State where surveys were conducted.

Figure 10.1 Roadside Survey Locations



Source: Cambridge Systematics.

10.2 Survey Results

Surveyors identified 195 trucks transporting hazmats at the 18 different survey locations. A total of 63 percent of the trucks were transporting flammable or combustible liquids (Class 3) in cargo tank trailers.

The top three placards observed on 123 trucks included gasoline, diesel, and propane, representing 63 percent of all hazmat trucks observed. The highest percentages were observed in the Las Vegas and Reno areas. The other placards were observed, including hexanes and heptanes, representing 72 trucks, or 37 percent of the total. Table 10.1 depicts the number of trucks transporting the top three hazmats identified at each location in the State.

Table 10.1 Hazmat Trucks Identified at 18 Survey Locations

Location	Region	Diesel	Gasoline	Propane	Other Flammable Gas or Liquid	All Other	Total
I-15 downtown Vegas	Vegas	5	17	1	7	5	35
I-80	Reno	5	14	1	5	6	31
I-80 downtown Reno	Reno	3	6	2	7	3	21
I-15 North at 215	Vegas	4	6	3	2	5	20
US 93 north of I-15	Vegas	6	6	3	0	1	16
I-80- Carlin	Rural	3	0	0	7	5	15
I-80- Wendover	Rural	3	5	0	1	2	11
US 93- south of I-11	Vegas	0	3	3	1	2	9
I-80- west of Reno	Reno	2	2	1	0	2	7
I-15 South at 146	Vegas	3	1	0	1	2	7
US 95 North at Skye	Vegas	0	4	1	1	0	6
US 395 at Route 427-	Reno	2	0	1	1	1	5
US-50/US-93- Ely	Rural	0	2	1	0	2	5
US 95- South of I-11	Vegas	0	0	1	2	0	3
US-95	Reno	1	0	0	0	1	2
US-95 North of Winnemucca	Rural	1	0	0	0	0	1
US-93 North of Wells	Rural	0	0	0	1	0	1
US 395 south of Gardnerville	Reno	0	1	0	0	0	1
Totals	All	38	67	18	35	38	196

Source: Cambridge Systematic, Silver State Survey.

There were some trucks observed for which the UN number was not listed or not visible during the survey. In these cases, surveyors were asked to identify the placard color to help identify the hazmat class.

11.0 Map Development

There were numerous maps developed during all stages of the study. This section and Table 11.1 summarizes these maps and where they can be found in the report or Appendix.

Section 4.0 describes the hazmat facility identification process. From the data collection efforts, CS first produced a **Statewide Hazmat Facilities Map** depicting RMP, TRI, and Tier II facilities in Nevada. This became the basis for determining where priority hazmats are stored.

Section 6.0 identifies the routes and volumes of priority chemicals transported to and from priority chemical facilities by different modes. CS mapped the routes using highway, railroad, and pipeline distribution data and networks to and from each facility. The maps identify volumes by truck, rail, and pipeline shipments with different line widths depicting annual volumes in pounds known as **Priority Hazmat Maps.** Figure 6.11 through Figure 6.14 describes the **Statewide Hazmat Composite Map** and **NDOT District-level Hazmat Composite Maps**, showing 10 different chemical and fuel profiles. These composite maps show routes only. For individual chemical flows, volumes, and frequencies, refer to Section 6.0. For individual petroleum flows, volumes, and frequencies, refer to Section 7.0.

Section 7.0 describes the Petroleum Supply Chain Analysis using maps for primary petroleum shipments in the State, including **California, Nevada and Utah Refined Petroleum Pipelines, Gasoline Facilities and Flows Map, Diesel Facilities and Flows Map**.

Section 8.0 describes the shipment of hazmat by air cargo and shows a map of **Nevada Air Cargo Airports.**

Section 9.0 describes hazmat the nine different classifications used by U.S..DOT, the UN, and other international agencies to identify hazards by class. The **Hazmat Classification Maps** depict which classes were identified as part of this study at the state level and the three NDOT districts.

Section 10.0 describes the Roadside Survey process in which the CS Team identified trucks transporting hazmat at 18 locations around the State, showing **Roadside Hazmat Survey Locations**.

Table 11.1 Hazardous Commodity Flow Study Map Summary

Section	Description	Maps	Map Count
Section 4	Hazmat Facilities	Hazmat Facilities Map	1
Section 6	Priority Hazardous Materials	Priority Hazmat Maps and Hazmat Composite Maps	11
Section 7	Petroleum Supply Chain Analysis	Petroleum Facilities and Flows Maps	3
Section 8	Air Cargo Hazmat	Nevada Air Cargo Airports	1
Section 9	Hazmat Classification	Hazmat Classification Maps	4
Section 10	Hazmat Roadside Surveys	Roadside Hazmat Survey Locations	1
		Total	**21**

Source: SFMO, CAPP, UP, Kinder Morgan, Holly Energy, Nevada Industries, Cambridge Systematics.

12.0 Conclusion

Modern society depends on, to great extent, the safe and efficient transportation of hazmats; they fuel our vehicles, heat and power our homes, and are essential in production of many of our manufactured goods. Hazmats are essential to Nevada's industries that manufacture chemicals, protect public water, and sewer systems, fuel transportation services and mine precious minerals. The public at large does not see how everyday chemicals reach their destinations because they are transported either underground by pipeline, in rail tank cars along the railroad right-of-way or in cargo tank trailers, identified only by the hazmat placards. However, these chemicals and fuels support Nevada's economy in many ways.

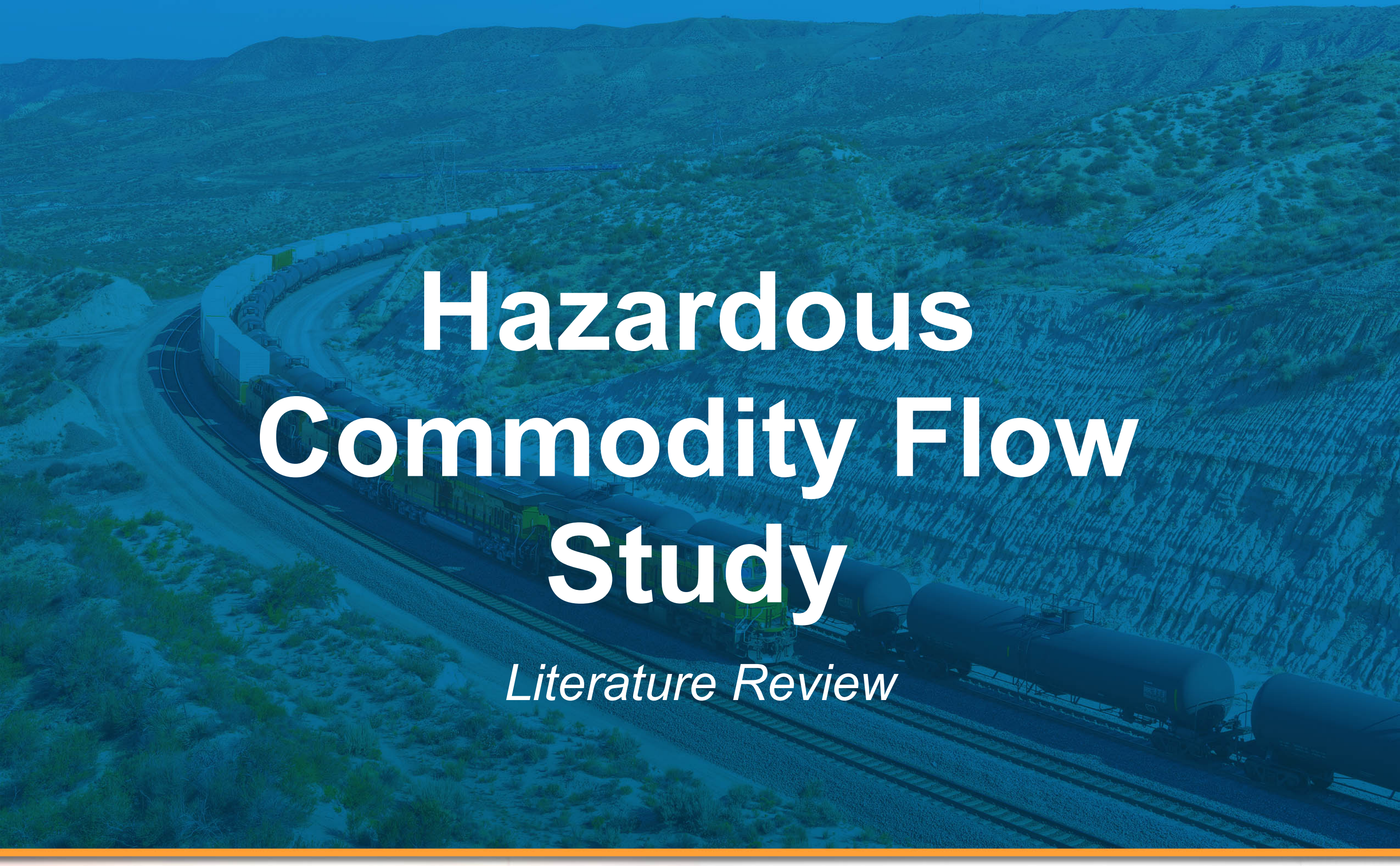
Because of Nevada's location between National east-west freight flows, approximately one third of U.S. hazmats pass through the State. Nearly all of Nevada's refined petroleum is transported from California and Utah by pipeline and distributed to mining operations and retail petroleum facilities by truck. This includes gasoline, diesel and jet fuel. Nevada industries use more diesel than gasoline, which is the opposite of most States, and likely the result of the extensive mining operations in Northern Nevada counties.

Nevada's priority hazmats are similar to priority hazmats in other States, including the truck and rail transportation of anhydrous ammonia, butane, chlorine, ethanol, and propane. However, Nevada specializes in mining precious minerals and specialty manufacturing facilities, resulting in the transportation of sodium cyanide and potassium cyanide, not typically used in other States. Several large-scale green energy utilities use butane and propane to transfer energy using specialty turbines. Most of the ethanol transported through the State by rail is destined for West Coast ports for export, and only 10 percent of ethanol is used in Nevada for biofuel blending purposes. However, Nevada and California are using proportionately higher volumes of ethanol than other States; primarily due to the increasing amounts of ethanol in retail gas stations.

Air cargo transportation of hazmats represents a small fraction of all air cargo, estimated by several air cargo carriers as less than one percent. Air cargo hazmat shipments are restricted by regulation that limits the types and amounts of hazmat that may be shipped. Examples of hazmat air cargo shipments include dry ice, lithium batteries medical aerosols, and small amounts of radioactive materials.

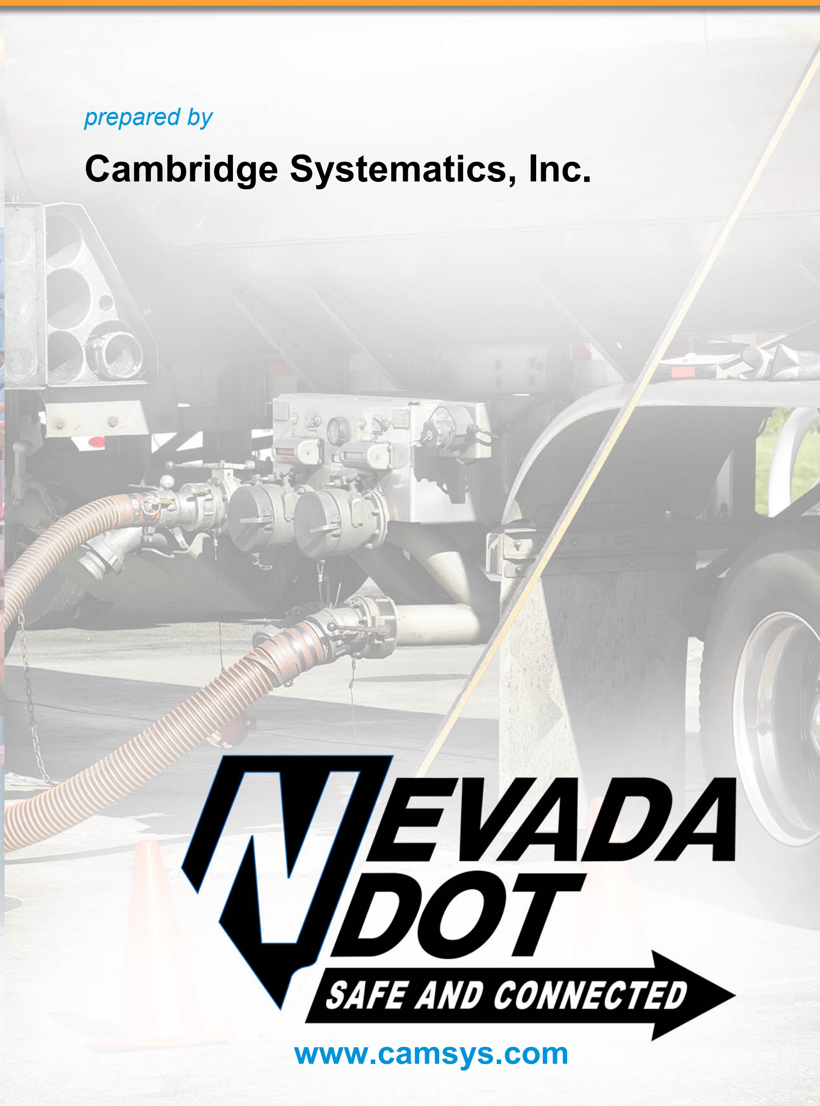
By identifying top hazmat volumes, routes, and frequencies, transportation officials will have more information on which portions of the existing infrastructure and facilities are used to transport high volumes of hazmats. This will help to prioritize transportation infrastructure investments for highway, rail, and pipeline facilities, and it will help first responders train for chemicals and fuels likely to be transported in their counties and help emergency managers locate hazmat response assets and resources in appropriate locations. At the local level, LEPCs will be able to use this information to conduct training and exercise programs that match up with the likely hazards in their jurisdictions.

Appendix A. Literature Review



Hazardous Commodity Flow Study

Literature Review



prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.

NEVADA DOT SAFE AND CONNECTED

August 31, 2018

www.camsys.com

technical memorandum

Hazardous Commodity Flow Study

Literature Review

prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, CA 94607

date

August 31, 2018

Table of Contents

1.0 Introduction

This Literature Review provides an overview of the federal and state requirements for hazmat transportation and storage, relevant hazmat statutes or restrictions in federal or Nevada law, and a review of previously conducted hazmat studies in Nevada and selected examples from other states.

1.1 Methodology

The project team compiled information from multiple sources to conduct the Literature Review. This included information from federal agencies and government web sites for federal hazmat regulations and state agency web sites and for state hazmat regulations. In addition, the study team researched university examples, research organizations such as the Transportation Research Board (TRB), industry web sites, and select state and local jurisdiction web sites for state, regional and local commodity flow study examples and best practices. The study team conducted internet searches with key terms to identify relevant literature and professional judgement to select those examples that best characterize the industry approach to conducting hazmat studies and to best describe hazmat regulatory requirements. This process was supplemented and corroborated by telephone interviews with federal and state regulatory staff, practitioners, first responders and other subject matter experts.

2.0 Hazardous Material Regulations for Transport and Storage

2.1 Hazardous Material Transportation

The Secretary of the Department of Transportation regulates the transportation of hazardous materials from the Hazardous Materials Transportation Act (HMTA) and the Pipeline and Hazardous Materials Safety Administration (PHMSA) has the responsibility to write the hazardous materials regulations (HMR). The USDOT modal administrations each apply the HMR to their respective modes, including the following:

- Federal Aviation Administration (FAA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railway Administration (FRA)
- Pipeline and Hazardous Materials Safety Administration (PHMSA).[1]

[1] https://www.fmcsa.dot.gov/regulations/hazardous-materials/how-comply-federal-hazardous-materials-regulations

Selected HMR sections are summarized in Table 2.1.

Table 2.1 Hazardous Materials Regulations 49 CFR 171-180

Section	Description
171	General Information and Definitions
172	Hazardous Materials Table, Emergency Response
173	Shippers and Packaging
174	Carriage by Rail
175	Carriage by Aircraft
176	Carriage by Vessel
177	Carriage by Public Highway
178	Specifications for Packaging
179	Specifications for Tank Cars
180	Package Qualification & Maintenance

Source: Hazardous Materials Regulations 49 CFR 171

2.1.1 Federal Railroad Administration (FRA)

FRA oversees compliance of transportation of hazmat by rail. Hazmat regulations include train routing for certain commodities, security, tank car design, and emergency response. This includes developing the Hazardous Materials Compliance Manual to guide federal and state hazardous materials inspectors. FRA also develops initiatives to promote emergency preparedness when an accident or release does occur. In a recent example, FRA and PHMSA combined efforts to develop new tank car standards (HM-251) and operational controls for High-Hazard Flammable Trains.

Photo by David Willauer

2.1.2 Federal Aviation Administration (FAA)

FAA requires hazardous materials transported using commercial aircraft comply with Hazardous Materials Regulations, 49 CFR Parts 171-179. FAA agents conduct inspections and investigations of hazmat shippers and hazmat carriers. Agencies that handle hazardous materials shipments for shippers or carriers, such as freight forwarders and repair stations, are subject to the regulations and FAA inspection. Because these regulations apply to the aircraft cabin as well as the cargo hold, passengers and their baggage are also subject to these rules and FAA jurisdiction.

2.1.3 Federal Motor Carrier Safety Administration (FMCSA)

Photo by David Willauer

FMCSA regulates hazmat transportation on U.S. highways and requires certain motor carriers to hold a Federal Hazardous Materials Safety Permit (HMSP). This permit is required for specified quantities of explosives, radioactive materials, toxic inhalation hazards (TIH) and certain compressed or refrigerated gases (such as LNG). If FMCSA is able to verify that a motor carrier has a safety permit issued by a State deemed to be equivalent to the provisions of the CFR, FMCSA can issue a safety permit to the motor carrier upon receipt of an application. FMCSA also employs the Safety Measurement System (SMS) data to monitor HMSP carrier performance and enforcement.

2.1.4 Pipeline and Hazardous Materials Safety Administration (PHMSA)

PHMSA is responsible for regulating and ensuring the safe and secure movement of hazardous materials to industry and consumers by all modes of transportation, including pipelines. PHMSA's Office of Hazardous Materials Safety develops regulations and standards for the classifying, handling and packaging of hazardous materials. Regarding hazmat transportation, PHSMA is responsible for container specifications for trucks, hazmat placards, and pipeline specifications. In order to promote hazmat planning and training activities, PHMSA allocates Hazardous Materials Emergency Preparedness (HMEP) funds to each state, including Nevada.

2.2 Hazardous Materials Storage

Federal agencies have developed hazardous materials storage regulations since the mid-1980s. As a result of several industrial accidents at that time, Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986. As part of this act, federal, state, and local governments, Indian tribes and industry are required to report hazardous and toxic chemicals in individual facilities, their uses, and releases into the environment to the public. Hazardous materials are regulated based on reportable quantities at facilities.

2.2.1 Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) is the federal agency that regulates hazardous materials storage at facilities to reduce or eliminate the release of pollutants and wastes, both on and off site. EPCRA provisions cover different types of hazardous material management depending on stored quantities on site or in process at hazmat facilities. Facilities that handle chemicals are required to report to the EPA if the chemical quantity is greater than a “reportable quantity” (RQ) for filing annual Tier 2 Reports, or if chemicals are released into the air, ground or water as part of the Toxics Release Inventory (TRI) program, or exceeds the Threshold Planning Quantity (TPQ) for Extremely Hazardous Substances for filing a Risk Management Plan (RMP). Details of these three programs are described below:

- **RMP** (Risk Management Program). Filing a Risk Management Plan is required by facilities that contain Extremely Hazardous Substances (EHS) and flammable substances above a certain TPQ. EPA currently lists 355 chemicals under EHS. A similar program in Nevada is explained under State Hazmat

- **TRI** (Toxics Release Inventory) Program. This program tracks the management of certain toxic chemicals that, if released into the air, ground or water, pose a threat to human health and the environment. Facilities that fall under TRI program must report on-site release, recycling, off-site transfers, and treatment of toxic chemicals. EPA's TRI list includes approximately 650 toxic chemicals and categories.

- **Tier II** reports. The EPA requires organizations and businesses in the U.S. with hazardous chemicals above RQ to fill out annual Tier II reports. There are approximately 500,000 chemicals that require Tier II reporting including gasoline, diesel, and other chemicals.

2.2.2 Occupational Safety and Health Administration (OSHA)

Part of the Department of Labor, OSHA sets and enforces protective workplace safety and health standards and provides guidance for workers that handle hazardous materials. Under OSHA regulations employers must maintain a material safety data sheet (MSDS) for any hazardous chemical stored or used in the workplace. They must also ensure that only properly authorized powered industrial trucks enter hazardous locations and that these locations are posted.

The following Table 2.2 summarizes selected regulatory requirements for hazardous materials.

Table 2.2 Hazmat Regulatory Requirements by Federal Agency

Agency	Description	Hazardous Materials Oversight
ATF	Alcohol, Tobacco and Firearms	Requires licensing for importing, or distributing explosives and permits to ship or transport explosives
DOE and NRC	Department of Energy and Nuclear Regulatory Commission	Develops environmental regulation, permitting, regulates radioactive materials, low-level radioactive waste
DOD	Department of Defense	Regulates military shipments by motor carrier, rail and ship and oversees explosives and munitions used in the military
EPA	Environmental Protection Agency	Clean Air Act and the Clean Water Act, Regulates facilities storing threshold quantities of hazmat on site or in process, including EPCRA and RMP Programs
FAA	Federal Aviation Administration	Regulates hazardous materials transported using commercial transportation, conducts inspections and investigations of hazmat shippers and hazmat carriers
FERC	Federal Energy Regulatory Commission	Oversees facility siting, permitting, interstate commerce
FMCSA	Federal Motor Carrier Safety Administration	Inspects cargo tanks, manufacturers and cargo tank safety, provides oversight, regulations, inspections
FRA	Federal Railroad Administration	Conducts inspections and investigations of hazmat shippers and hazmat carriers, track inspections
MSHA	Mine Safety and Health Administration	Regulates the use of explosives at above and below ground mining sites for coal and other metal or non-metal mining
NFPA	National Fire Protection Administration	Regulates first responder safety programs, provides guidance for hazmat emergency management and response
OSHA	Occupational Safety and Health Administration (Dept of Labor)	Regulates worker health and safety, workplace safety programs, requirements for material safety data sheets, including the use of explosives at job sites or manufacturing sites

PHMSA	Pipeline and Hazardous Materials Administration	Provides regulations and standards for the classifying, handling and packaging of hazardous materials, responsible for container specifications for trucks, hazmat placards, and pipeline specifications.
STB	Surface Transportation Board	Regulates commercial transportation and resolves disputes between carriers

Source: Federal agency Web Sites

2.3 State of Nevada Hazardous Materials Regulations

Nevada laws require any motor carrier transporting hazardous materials acquire a permit from The Highway Patrol if they are traveling in the State. Nevada is part of Alliance for Uniform Hazmat Transportation Procedures (Hazmat Alliance). This a group of four states (Michigan, Nevada, Oklahoma and West Virginia) that use the same registration and fee assessment process for hazmat permitting. Briefly, this program is a "base state system" whereby a motor carrier of hazardous materials obtains credentials in the state the carrier travels the most miles. These credentials are good in all participating jurisdictions.

Through the Nevada Department of Public Safety, the Nevada State Fire Marshal requires any person who stores, transports on-site, dispenses, uses or handles hazardous materials in excess of the amount listed in the International Fire Code is required to report chemicals and obtain a SFM hazardous materials permit. Facilities that have Material Safety Data Sheets (MSDSs) for chemicals held above certain TPQ are also required to submit copies to local fire department under EPCRA.

The SFM also maintains the Nevada Statewide Hazmat Database, a system managed by a vendor to facilitate submission of annual Tier II reports required by the EPA. Tier II reports are required for a facility that stores or processes certain reportable quantities of hazardous materials. In Nevada, there were approximately 2,600 facilities that submitted Tier II reports in 2018.

In 1991, the Nevada Legislature passed Senate Bill 641, the Chemical Catastrophe Prevention Act, primarily in response to a large chlorine release in Henderson and a large ammonium perchlorate explosion in 1988, also in Henderson. Subsequently, the Chemical Accident Prevention Program (CAPP) was developed and coordinated with the Nevada Occupational Safety and Health Enforcement Section (OSHES). The CAPP requirements were later modified to require facilities handling Highly Hazardous Substances (HHS) to meet certain regulations, similar to how the EPA Risk Management Program regulates Extremely Hazardous Substances (EHS). In Nevada, there are approximately 60 facilities storing HHS and 219 chemicals as defined by the CAPP program. Later legislation authorized CAPP to regulate explosives manufacturing, issue permits, and coordinate inspections in explosives manufacturing facilities.

3.0 Commodity Flow Studies of Hazardous Materials

Hazardous materials studies are usually conducted at the local or county level. In some examples, multiple counties have combined efforts to survey a larger area. Some states have conducted statewide studies. The most common approach is through the use of roadside surveys to document hazmat movements throughout the study area through truck counts and placard identification. Surveys are conducted along major routes, and the result is a list of hazardous materials transported on survey routes. This approach is limited to information collected at the time of the survey by week or weekend, depending on the methodology. This technique does not provide origin-destination, volume, or frequency of the movements. Therefore, the outcome of survey approach studies are limited and other than a list of hazardous chemicals no more insight is offered.

Nevada and several other states have employed an “Industry approach” to hazardous material identification which provides a much more detailed picture of hazmat flows in the state. This method requires outreach to hazmat industry to obtain sensitive information such as chemical information, origin-destination (OD) information, volume, direction, and mode of transport. Consequently, this is a much more complicated approach because it requires significant cooperation and trust between the research team and industry sector. Industry approach studies are usually conducted at the statewide level. Regional and statewide hazmat studies using this industry approach have been conducted in multiple states, including Delaware, Louisiana, Maine, North Carolina, and Texas. Some of these efforts were “stand alone” studies; others were conducted as part of the State Freight Plan (Table 3.1).

Table 3.1 Industry Approach Hazardous Commodity Flow Studies

Year	State	Description	Notes
2005	Maine	Statewide Hazmat Study, Phases 1-2	Industry approach, top 30 chemicals selected by SERC
2009-2015	North Carolina	5-Phase Hazmat Study by Domestic Preparedness Region	Industry approach, top 20 chemicals by formula with SERC input
2011	Louisiana	Ascension Parish	Industry approach, top 10 chemicals by formula with LEPC input
2012	Delaware	New Castle County	Industry approach, top 10 chemicals by formula with SERC input
2015	Maine	Statewide Update	Industry and Cameo approach, 17 chemicals selected by SERC
2017	North Carolina	Statewide Freight Plan	Industry approach to develop pipeline chapter
2017	Texas	Statewide Freight Plan	Industry approach to develop pipeline chapter

Source: Cambridge Systematics

3.1 U.S. Commodity Flow Survey

The Commodity Flow Survey (CFS) was a joint effort by the Bureau of Transportation Statistics (BTS) and the U.S. Census Bureau, and published by the U.S. Department of Commerce in 2015 using 2012 survey data. The survey was the primary source of national and state-level data on domestic freight shipments by establishments in mining, manufacturing, wholesale, auxiliaries, and selected retail and services trade industries located in the 50 states and the District of Columbia. The data from the 2012 CFS for hazardous material shipments were aggregated to the nine hazmat classes, as well as their subcategories known as divisions. Data were also shown for selected UN/NA codes. The nine classes included explosives, gases, flammable liquids, flammable solids, oxidizing substances and organic peroxides, toxic substances and infectious substances, radioactive materials, corrosive substances, miscellaneous hazardous materials.

3.2 Guidance for Conducting Hazardous Materials Flow Surveys

This report provided guidance on how to conduct a commodity flow study for hazardous materials moving by highway in 1995. It discussed the need for this type of study and detailed how to review baseline information and design a study. It included examples and instructions for collecting data via field studies, analyzing the results, and applying these results back to the purpose of the study. Descriptions of selected state and local hazardous material flow studies were provided, including the State of Nevada. It described how Nevada was able to create an overview of statewide hazardous materials transportation by locating survey sites throughout the state and dividing the roads into links. To obtain an average daily profile of commercially transported commodities via Nevada's highway system a total of 45 statewide information collection sites were used, including 19 points of entry, scattered across the state. The routes were divided into 95 "links" to track commodity movement.[2]

3.3 Hazardous Material Cooperative research program (HMCRP) Report 3: Guidebook for Conducting Local Hazardous Materials Commodity Flow Studies

Between 2008 and 2016, the Transportation Research Board (TRB) authorized the Hazardous Materials Cooperative Research Program (HMCRP) through which 18 different studies were conducted. Report 3 included an analysis of hazardous commodity flows across multiple jurisdictions. This guidebook, which updated the U.S. DOT Guidance for Conducting Hazardous Materials Flow Surveys, is targeted at transportation planning and operations staff at the local and regional levels, as well as local and regional personnel involved in hazardous materials training and emergency response. All modes of transportation, all classes and divisions of hazardous materials, and the effects of seasonality on hazardous materials movements are discussed.

3.4 TRANSCAER® Guidance for Conducting Commodity Flow Surveys

In response to the chemical accidents in the 1980s, the Union Pacific Railroad and Dow Chemical Company founded the Transportation Community Awareness and Emergency Response (TRANSCAER) program in 1986. The purpose of this program is to promote chemical transportation awareness and to assist communities to prepare for and to respond to hazardous material transportation incidents. TRANSCAER® members include volunteer representatives from the chemical manufacturing, transportation, distribution, and emergency response industries, as well as the government. TRANSCAER also provides an 11-step guidance for conducting a commodity flow survey.[3]

3.5 Nevada Commodity Report

The Nevada Commodity Report completed by NDOT and FHWA in 1988 included hazardous material estimates based on surveys at multiple locations over a period of 11 years between 1976 and 1987. Truck drivers were questioned to determine points of origin and destination, routes traveled and specific

[2] Guidance for Conducting Hazardous Materials Flow Surveys, January 1995, USDOT Research and Special Programs Administration and the John A. Volpe National Transportation Systems Center http://www.kansastag.gov/AdvHTML_doc_upload/Guidance_%20for_Conducting_Commodity_Flow_Surveys.pdf

[3] https://www.transcaer.com/docs/resources/FlowStudySteps31.pdf

commodities transported. The information reflected data collected at 95 weigh station sites for a total sample of 14,760 trucks. The methodology included creating 87 links and documenting 18 points of entry. A formula was developed in order to calculate an average daily condition based on 31 commodity classes. The formula adjusted for average annual daily truck traffic (AADTT), a percentage for each commodity for vehicle type, and a net weight by vehicle type and commodity.

3.6 Clark County Hazardous Material Commodity Flow Study

The Clark County Hazardous Material Commodity Flow Study documented and examined truck movements of hazardous materials to, from, through, and within Clark County in 2005. The purpose of this study was to describe and to empirically quantify baseline conditions of existing shipments of hazardous material by truck mode. The study examined what hazardous commodities move on Clark County highways, what the volumes of these flows are, what level of use these highways experience, and what the accident rates were on these highways. The baseline conditions revealed by this examination of vulnerability from hazardous waste shipments by truck established parameters for a future detailed risk assessment.

4.0 Acronyms and Abbreviations

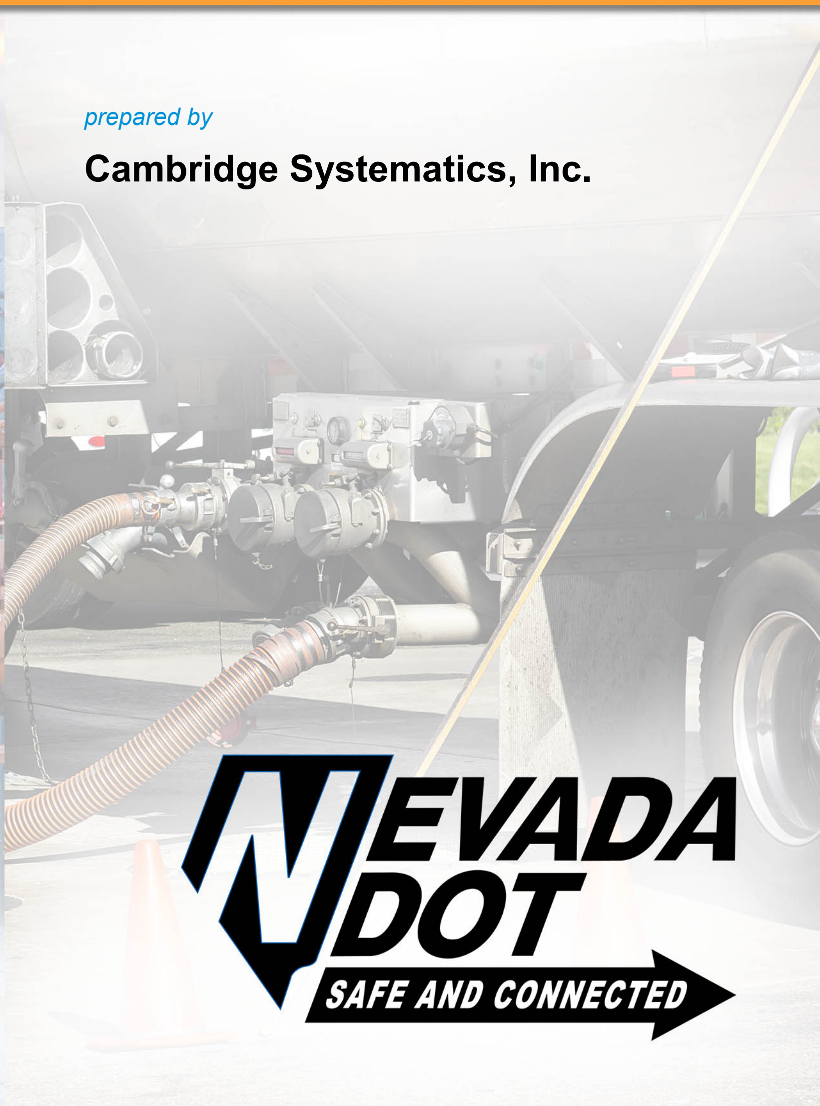
Acronym	Description
AADTT	Average Annual Daily Truck Traffic
ATF	Alcohol, Tobacco and Firearms
BTS	Bureau of Transportation Statistics
CFR	Code of Federal Regulations
CFS	Commodity Flow Survey
CAPP	Chemical Accident Prevention Program
DOE	Department of Energy
DOD	Department of Defense
EHS	Extremely Hazardous Substance
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know (Act)
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
HHS	Highly Hazardous Substance
HMCRP	Hazardous Materials Cooperative Research Program (TRB)
HMEP	Hazardous Materials Emergency Preparedness (funds)
HMR	Hazardous Materials Regulations
HMSP	Hazardous Materials Safety Permit

HMTA	Hazardous Materials Transportation Act
LNG	Liquid Natural Gas
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Administration
NRC	Nuclear Regulatory Commission
OD	Origin-Destination
OSHA	Occupational Safety and Health Administration (Dept of Labor)
OSHES	Occupational Safety and Health Enforcement Section (Nevada)
PHMSA	Pipeline and Hazardous Materials Administration
RMP	Risk Management Program
RQ	Reportable Quantity
SFM	State Fire Marshal
SMS	Safety Management System
STB	Surface Transportation Board
TIH	Toxic Inhalation Hazard
TPQ	Threshold Planning Quantity
TransCAER	Transportation Community Awareness and Emergency Response
TRB	Transportation Research Board
TRI	Toxics Release Inventory
UN	United Nations (numbers to identify hazardous chemicals)
NA	North American (numbers are identical to UN numbers)

Appendix B. Chemical Selection Process

Nevada Hazardous Commodity Flow Study

Chemical Selection Process



prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.

NEVADA DOT SAFE AND CONNECTED

November 1, 2018

technical memorandum

Nevada Hazardous Commodity Flow Study

Chemical Selection Process

prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, CA 94607

date

November 1, 2018

Overview

There are thousands of chemicals transported every day in Nevada by motor carrier, rail and pipeline. Since it is not feasible to assess the hazards of every chemical, the Study Team employed a chemical selection process to prioritize hazardous materials for transport. This report documents the chemical selection process presented to Nevada DOT and the State Emergency Response Commission (SERC) for review.

The process focused on hazardous materials that if released in storage or in transport will have the greatest impact on health and safety. Using the information collected from multiple sources, the Study Team identified all the extremely hazardous substances (EHS) stored at hazmat facilities. Then a chemical selection process was used to identify chemicals which pose the greatest hazard to the public. This process helps to prioritize transportation investments, evaluate response team locations, provide public protective actions, and prioritize hazmat response resources.

Data Sources

The primary data sources for this process included the Nevada Chemical Action Protection Program (CAPP) data, EPA's Toxics Release Inventory (TRI) and the Nevada Statewide Database from the State Fire Marshal's Office. CAPP requires companies that store or process "Highly Hazardous Substances" (HHS) to submit annual stored volumes of toxic and flammable chemicals. CAPP is similar to what EPA requires for companies required to file Risk Management Plans (RMP), based on threshold planning quantities of certain chemicals stored on site. TRI reporting tracks the management of certain toxic chemicals that may pose a threat to human health and the environment. Tier II reporting is conducted through the Nevada State Fire Marshal's Office (SFMO). Private, public, and Government facilities must submit annual Tier II reports on their inventories of hazardous and toxic chemicals if they meet established thresholds and requirements. Facilities are required to submit Tier II reports to the Local Emergency Planning Committee (LEPC), the SERC and their local fire department.

Methodology

Using the data collected from CAPP, TRI, and Tier II, the Study Team focused on toxic and high volume flammable chemicals and applied selection criteria to organize the chemicals into a "top ten" list of priority chemicals for analysis. The criteria used to rank the hazardous materials included isolation protection distance, threshold planning quantity, lower flammable limit, and flash point. Additional professional judgment was applied to determine final hazmat priority. Table 1 describes each criterion, description and source.

Table 1 Chemical Selection Criteria

Criterion	Description	Source
Isolation Distance	Recommended distance from a spill source within which first responders should position emergency assets.	Emergency Response Guidebook
Threshold Planning Quantity	Minimum amount of chemical that if present at a facility poses a hazard.	EPA/CAMEO
Lower Flammable Limit (LFL)	Lower limit of a concentration range of a gas or vapor that will burn if exposed to an ignition source.	Engineering Toolbox
Flash Point	Temperature at which vapor from gas ignites	NFPA

Using the list of hazardous materials stored at Nevada facilities, the CS Team conducted a hazmat analysis using the criteria above to sort and rank the hazardous materials in order of impact to health and safety. For example, the larger the isolation distances for large spills, the higher the ranking. The hazmat analysis provides justification for contacting companies that store or transport priority chemicals to determine transport routing, frequencies and volumes. An input dataset comprising of CAPP, TRI, and Tier II datasets was created for hazmat analysis. The input dataset included all facilities with HHS and Extremely Hazardous Substances (EHS). First, all of CAPP data was added to the input dataset since it was available from NDEP. Next, all the facilities with EHS were selected from TRI data, which was available from EPA. These facilities were compared to the facilities existing already in the input data and duplicate facilities were removed. Finally, all the facilities from the Nevada Statewide Hazmat Database were added to the input dataset and additional duplicate facilities removed.

The input dataset was divided into "toxic" and "flammable" chemicals. This separation was necessary due to the differences in chemical characteristics and types of hazards they pose. In addition, toxic chemicals can create a hazard immediately upon release, whereas flammable chemicals require an additional agent (i.e., ignition source) after a release to create a hazard.

For both toxic and flammable chemicals, two characteristics were considered for isolation distance. They included: 1) Isolation Distance for Large Spills from Truck (in feet); and 2) Isolation Distance for Large Spills from Rail (in feet). Isolation distance is defined as the recommended distance from a spill source within which first responder should position emergency assets. These two characteristics along with other characteristics specific to either toxic chemicals or flammable chemicals were obtained from the CAMEO Chemicals website.[1]

Next, distance ranges were established to help with the scoring process. The isolation distance was divided into four ranges: 0-500 ft., 501-1,000 ft., 1,001-2,000 ft., and 2,001-3,000 ft. The greater the isolation distance, the higher the resulting score. The rail and truck isolation distance ranges are shown in Tables 2 and 3.

Table 2 Rail Isolation Distance Ranges for Toxic Chemicals

Isolation Distance (feet)	Score
0–500	1
501–1,000	2
1,001–2,000	3
2,001–3,000	4

[1] https://cameochemicals.noaa.gov/.

Table 3 Truck Isolation Distance Ranges for Toxic Chemicals

Isolation Distance (feet)	Score
0–500	1
501–1,000	2
1,001–2,000	3
2,001–3,000	4

Similar to toxic chemicals, truck and rail isolation distances were scored for flammable chemicals. The rail and truck isolation distance ranges for flammable chemicals are shown in Tables 4 and 5.

Table 4 Rail Isolation Distance Ranges for Flammable Chemicals

Isolation Distance (feet)	Score
1,000	1
2,500	2

Table 5 Truck Isolation Distance Ranges for Flammable Chemicals

Isolation Distance (feet)	Score
1,000	1
2,500	2

In addition to isolation distances, the Study Team examined Threshold Planning Quantity TPQ (in lbs.). TPQ is defined as the minimum amount of chemical that if present at a facility, the EPA requires the development of a Risk Management Plan (RMP). Consequently, the lower the level of TPQ, the more hazardous the chemical. Similar to isolation distances, TPQ was divided into the following ranges: 0-100 lbs., 101-500 lbs., and 501-1,000 lbs. Scores were assigns based on each range. The lower the TPQ, the higher the score. The ranges for TPQ are shown in Table 6.

Table 6 Threshold Planning Quantity (TPQ) Ranges for Toxic Chemicals

TPQ (lbs.)	Score
0–100	3
101–500	2
501–1,000	1

For flammable chemicals, Lower Flammable Limit (% by volume of air) was considered in addition to isolation distances. The Flammable Range (explosive range) is the concentration range within which a gas or vapor that will burn if exposed to an ignition source. Below the explosive or flammable range the mixture is too lean to burn, and above the upper explosive or flammable limit the mixture is too rich to burn. The limits are commonly called the "Lower Explosive or Flammable Limit" (LEL/LFL) and the "Upper Explosive or Flammable Limit" (UEL/UFL). LFL for flammable chemicals in the input data was obtained from The Engineering Toolbox website.[2] Similar to TPQ, the lower the level of LFL, the higher the score. LFL was divided into four ranges: 0–2, 2–4, 4–6, and 6–8. Scores were subsequently developed using these ranges. Table 7 display LFL ranges below.

Table 7 Lower Flammable Limit (LFL) Ranges for Flammable Chemicals

Lower Flammable Limit Range	Score
0–2	2
2–4	1.5
4–6	1
6–8	0.5

For flammable chemicals, Flash Point was also considered. The Flash Point is the temperature at which vapor from flammable liquids ignite. This can be a positive or negative number. For example, the flash point for Butane is -76° F and for ethanol is 61.9° F. Table 8 displays Flash Point ranges.

Table 8 Flash Point Ranges for Flammable Chemicals

Flash Point	Score
-100+° F	1.5
0 to -100° F	1
0-100° F	0.5

The final score for toxic chemicals was calculated by summing the score of isolation distance and TPQ, and for flammable chemicals was calculated by summing the score of Isolation Distance and LFL.

Chemical Selection Results

The Study team used the results of this analysis to generate a list consisting the chemical final score, stored amount, number of corresponding facilities and EHS designation. The higher the score, the more hazardous the toxic or flammable chemical. Table presents the preliminary list of chemicals in priority order based on the results of the analysis.

[2] https://www.engineeringtoolbox.com/explosive-concentration-limits-d_423.html.

Table 9 Preliminary Chemicals for Study

	Chemical Name	Isolation distance (ft.)	TPQ (lbs.)	LFL	Flash Point (°F)	Isolation Dist. Score	TPQ Score	LFL Score	Flash Point Score	Final Score	On-Site (lbs.)	Facilities	EHS[3]
1	Chlorine	3,000	100	0		4	3	0	0	7	5,461,350	6	Yes
2	Sulfur Dioxide, Anhydrous	3,000	500	0		4	2	0	0	6	288,521	1	Yes
3	Nitrogen Dioxide	1,250	100	0		3	3	0	0	6	69	2	Yes
4	Isobutane	2,640	0	1.8	-117	2	0	2	1.5	5.5	2,128,779	4	No
5	Hydrocyanic Acid	1,000	100	0		2	3	0	0	5	19,194	1	Yes
6	Butane	2,640	0	1.86	-76	2	0	2	1	5	2,450,876	6	No
7	Propane	2,640	0	2.1	-155	2	0	1.5	1.5	5	4,545,685	7	No
8	Methane	2,640	0	4.4	-36.4	2	0	1	1	4	296,347	4	No
9	Titanium Tetrachloride	100	100	0		1	3	0	0	4	6,519,723	4	Yes
10	Ammonia, Anhydrous	1,000	500	0		2	2	0	0	4	5,506,188	18	Yes
11	Sodium Cyanide	300	100	0		1	3	0	0	4	7,094,766	26	Yes
12	Potassium Cyanide	300	100	0		1	3	0	0	4	270,021	3	Yes
13	Methyl Ether	2,640	0	0		4	0	0	0	4	48,508	1	No
14	Difluoroethane	2,640	0	0		4	0	0	0	4	10,000	1	No
15	Hydrofluoric Acid	150	100	0		1	3	0	0	4	5,708	8	Yes
16	Tetraethyl Lead	150	100	0		1	3	0	0	4	1,377	1	Yes
17	Nitrogen Oxide	300	100	0		1	3	0	0	4	715	1	Yes
18	Hydrofluoric Acid Solution	150	100	0		1	3	0	0	4	562	1	Yes
19	Cyanide	300	100	0		1	3	0	0	4	330	1	Yes
20	Hydrochloric Acid	150	100	0		1	3	0	0	4	167	1	Yes
21	Nitric Oxide	300	100	0		1	3	0	0	4	100	2	Yes

[3] EHS=**Extremely Hazardous Substance** as defined by EPA: chemicals subject to reporting requirements under the Emergency Planning and Community Right-to-Know Act (EPCRA) https://www.epa.gov/sites/production/files/2015-03/documents/list_of_lists.pdf

	Chemical Name	Isolation distance (ft.)	TPQ (lbs.)	LFL	Flash Point (°F)	Isolation Dist. Score	TPQ Score	LFL Score	Flash Point Score	Final Score	On-Site (lbs.)	Facilities	EHS[3]
22	Pentane	1,000	0	1.4	-56.2	1	0	2	1	4	3,562,099	13	No
23	Isopentane	1,000	0	1.32	-6	1	0	2	1	4	847,264	4	No
24	Hydrogen	2,640	0	4		2	0	1.5	0	3.5	8,693	1	No
25	Ammonia Solution	330	500	0		1	2	0	0	3	148,590	3	Yes
26	Boron Trichloride	100	500	0		1	2	0	0	3	104,890	1	Yes
27	Ethanol	1000		3.3	61.9	1		1.5	0.5	3	148,590	37	No
28	Acetylene	150	0	2.5		1	0	1.5	0	2.5	2,530,707	7	Yes
29	Hydrogen Peroxide Solution	150	1,000	0		1	1	0	0	2	650,000	1	Yes
30	Sulfuric Acid	150	1,000	0		1	1	0	0	2	–	1	Yes
31	Oleum Solution	1,000	0	0		2	0	0	0	2	–	1	No
32	Nitromethane	1,000	0	7.3	95	1	0	0.5	0	1.5	2,088	1	No
33	Red Phosphorus	330	0	N/A		1	0	0.5	0	1.5	229	2	Yes
34	Mercury	330	0	0		1	0	0	0	1	9,785,988	1	No

Top Ten Chemical Selection

From the list of 34 preliminary chemicals in Table 9, the Study Team examined the stored volumes at facilities and the number of facilities storing chemicals and used professional judgment from previous studies to determine a proposed “top ten” list of chemicals for study. Several “non-EHS” chemicals were included as part of the “top ten” list. These include ethanol and butane since these fuels are transported in larger volumes and have been subject to new Federal and State regulations pertaining to transport by “High-Hazard Flammable Trains.” Ethanol is transported by rail in large volumes from the Midwest to urban areas for fuel blending and to ports for export. Butane is used to supplement gasoline stocks and also to increase fuel octane levels. Table displays the proposed “top ten” chemicals for study. The Study Team will conduct additional outreach to the facilities storing these chemicals to determine routing, frequencies and volumes.

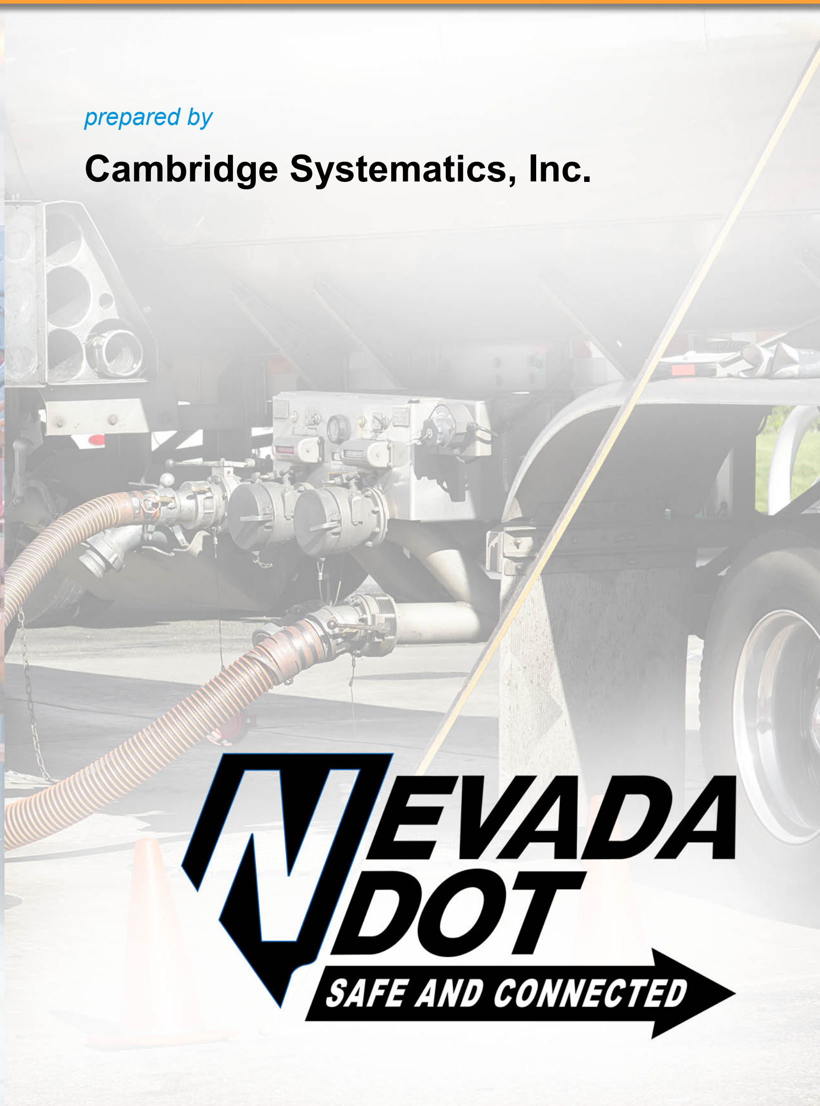
Table 10 Top Ten Chemicals for Study

#	Chemical Name	Score	Chemical Uses	Facilities	EHS
1	Anhydrous Ammonia	4	Refrigerant, fertilizer	18	Yes
2	Butane	5	Fuel and blending	6	No
3	Chlorine	7	Water treatment	6	Yes
4	Ethanol	3	Biofuel	5	No
5	Hydrofluoric acid	4	Manufacturing	8	Yes
6	Nitrogen Dioxide	6	Catalyst, oxidizing agent	2	Yes
7	Potassium Cyanide	4	Mining and electroplating	2	Yes
8	Propane	5	Fuel and heating	7	No
9	Sodium Cyanide	4	Mining operations	18	Yes
10	Titanium tetrachloride	4	Titanium, whitening	4	Yes

Appendix C. Petroleum Supply Chain

Nevada Hazardous Commodity Flow Study

Petroleum Supply Chain



prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.

February 19, 2019

technical memorandum

Nevada Hazardous Commodity Flow Study

Petroleum Supply Chain

prepared for

Nevada Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, CA 94607

date

February 19, 2019

Table of Contents

List of Tables

List of Figures

Glossary

Atmospheric Crude Distillation Unit (ACDU) operating capacity: The operating capacity of a refinery as determined by the maximum amount of crude oil that can flow into the distillation unit.

Barrel: A unit of volume equal to 42 U.S. gallons.

Barrels per calendar day (b/cd): The capacity of a refinery as defined by the number of barrels that a distillation facility can process in a 24-hour period under usual operating conditions.

Barrels per stream day: The capacity of a refinery as defined by the maximum number of barrels that a distillation facility can process within a 24-hour period when operating at full capacity without any downtown. Barrels per stream day is typically about 6% higher than calendar day capacity.

Barrels per day (b/d): A measure of refinery output represented by the number of barrels produced in a single day.

California Air Resources Board (CARB) gasoline: Gasoline that conforms to the gasoline and diesel specifications as defined by the California Air Resources Board. CARB diesel requires lower aromatic hydrocarbon content and a higher cetane number.

Distillate: Distillate is a general category of refined petroleum that includes diesel and fuel oils.

Ethanol: Ethanol is a clear, colorless alcohol made from a variety of biomass materials called feedstocks. Gasoline is blended with 10% ethanol to make E10 fuel and higher concentrations such as E85.

Petroleum Administration for Defense Districts (PADDs): Geographic aggregations of the 50 States and the District of Columbia into five districts. The PADDs allow data users to analyze patterns of crude oil and petroleum product movements throughout the nation.

Petroleum Administration for Defense District (PADD) 5: The West Coast PADD district includes the western states of California, Arizona, Nevada, Oregon, Washington, Alaska, and Hawaii.

Rack: A loading facility for truck distribution to petroleum retail facilities.

Transmix: A mixture of gasoline, diesel, and/or jet fuel. Transmix forms when transported in pipelines. Transmix processing plants use distillation to separate the mix into individual transportation fuels, specifically gasoline, diesel, and jet fuel. After distillation, some additional treatments may be necessary in order to meet fuel specifications.

Transportation fuel: A category of fuel that includes the different types of gasoline, diesel, and jet fuel needed to provide fuel for automobiles, trucks, and airplanes.

1.0 Introduction

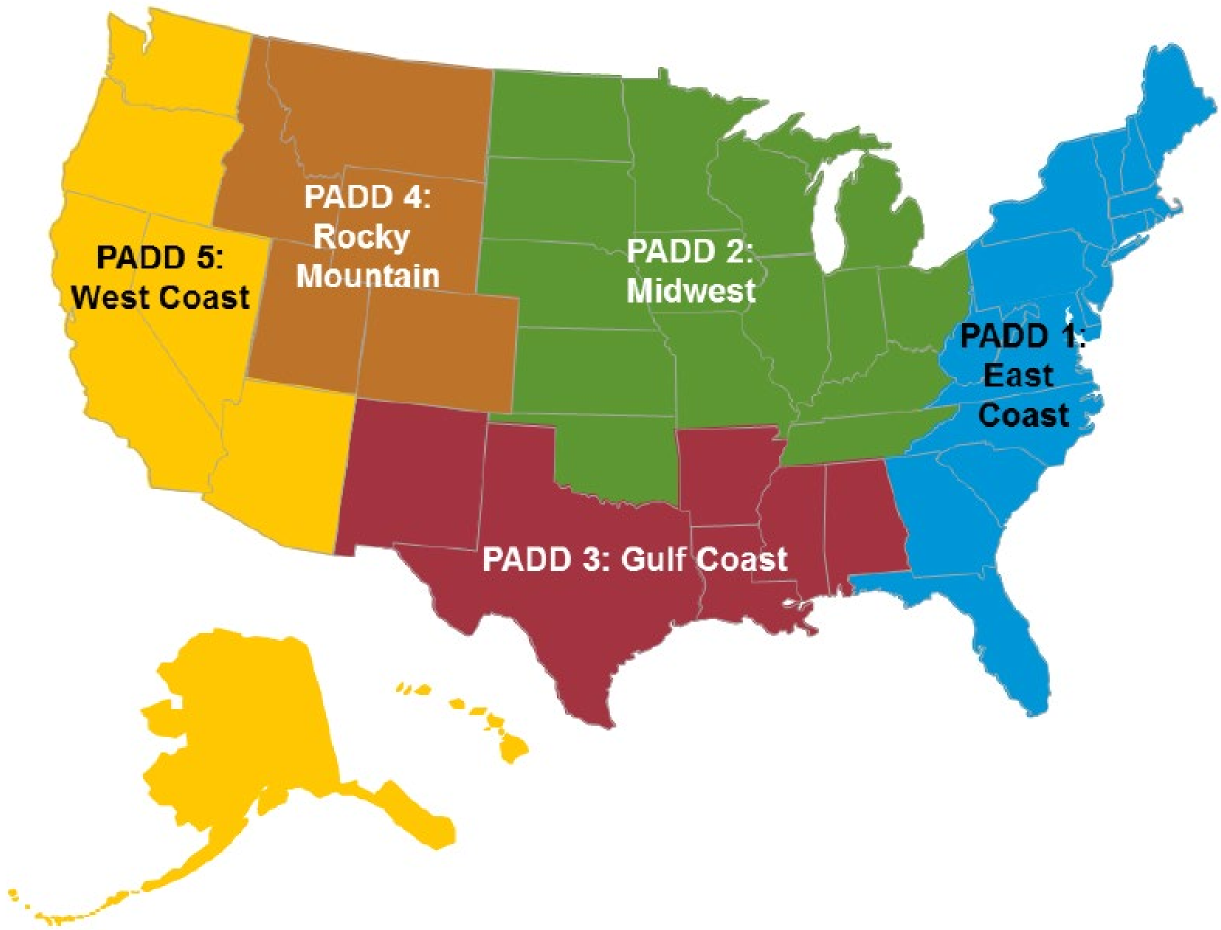
This Petroleum Supply Chain Analysis was conducted as one of three hazmat analyses as part of the Nevada Hazardous Commodity Flow Study. The other two parts included a Top Ten Hazmat Analysis and a Hazmat Roadside Survey. This research is important because refined petroleum represents 85 percent of all hazmat shipments transported in the United States.[1] Refined petroleum products include the transportation fuels needed to provide fuel for automobiles, trucks, and airplanes throughout Nevada. Though the volume of petroleum products on the roads is greater than any other hazardous material, emergency responders are experienced in handling petroleum-related incidents. This report documents the petroleum supply chain from the refining "origins" to retail "destinations." Pipelines are used to transport refined petroleum from neighboring states then stored in Northern and Southern Nevada fuel terminals. Trucks, and in some cases additional pipelines, are used to transport refined petroleum from fuel terminals to retail fuel stations, military facilities, and general service airports throughout the state.

An important source for this research is the Energy Information Administration's Petroleum Administration for Defense District 5 (PADD 5) Transportation Fuels Markets Study conducted in 2015 (EIA Report). The EIA Report examined the supply, demand, and distribution of transportation fuels in PADD 5, which includes the western states of California, Arizona, Nevada, Oregon, Washington, Alaska, and Hawaii as shown in Figure 1.1. Using a 2013 base year, The EIA Report examined PADD 5 petroleum product regional markets, marine vessel availability, and distribution infrastructure such as storage terminals, pipelines, rail facilities, marine loading and unloading facilities.[2] This study supplemented the petroleum distribution trends apparent in the EIA Report with interviews of mid-stream petroleum operators. The combination of commodity flow information and operator interviews provides a comprehensive look at the supply, demand, and distribution of transportation fuels in Nevada.

[1] BTS Freight Facts & Figures 2017 - Chapter 2: Freight Moved in Domestic and International Trade ,Table 2-6

[2] Sources included Stillwater Associates, California Energy Commission (CEC), the Army Corps of Engineers Waterborne Commerce Statistics Center, and publicly available data from various sources.

Figure 1.1 Petroleum Area Defense Districts (PADDs)



Source: U.S. Energy Information Administration

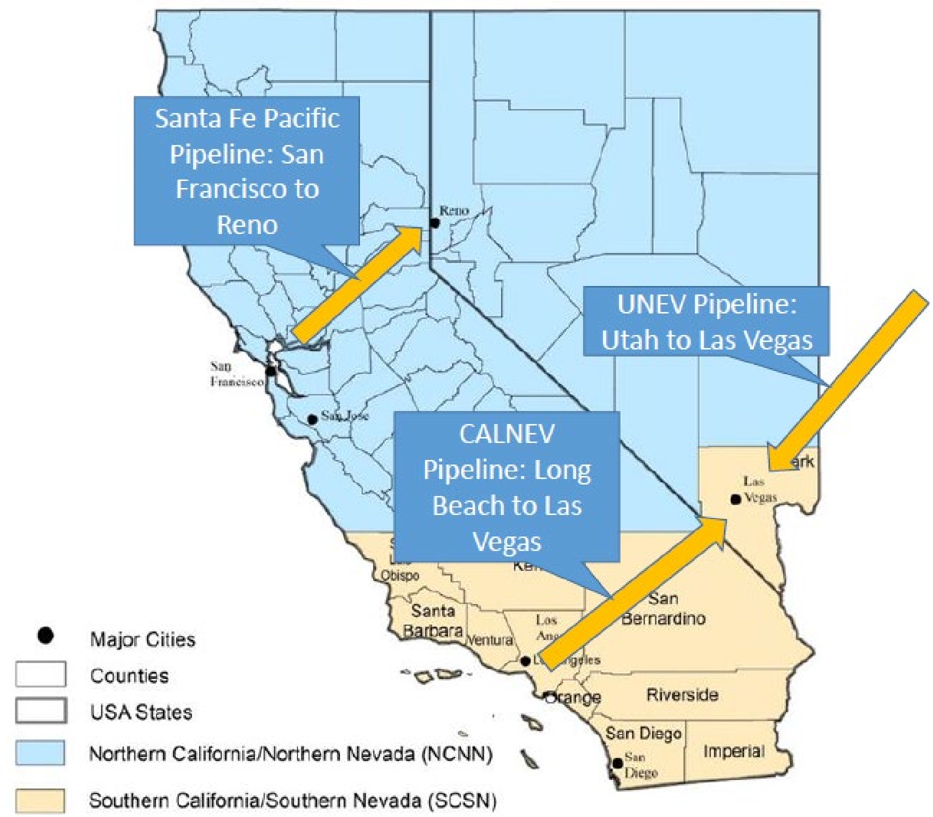
2.0 PADD 5 Transportation Fuel Supply and Demand

The PADD 5 district has limited petroleum infrastructure connections to other districts. Highways and four pipelines connect PADD 5 to PADDs 3 and 4. The Pacific coastline also connects PADD 5 with maritime transportation, but vessels must travel for 10 days from the Gulf Coast and three weeks from Asia. The infrastructure limitation stems from the lack of pipeline infrastructure that traverses the mountainous and oceanic geography between PADD 5 and other districts, as well as governance constraints dictating different fuel specifications between states. As a result, PADD 5 manufacturers and consumes the majority of its own fuel, and is essentially self-sufficient. Even so, PADD 5 does have some exchanges with other districts. The districts rely on each other to supplement any fuel type/specification shortfalls or to consume any local surpluses. The interior PADD 5 regions of Arizona, Las Vegas, and Eastern Washington do benefit from their proximity and pipeline connections to PADD 3 and 4 refineries, but the majority of the supply comes from PADD 5 production. Overall, PADD 5 has limited infrastructure for exchanging fuel with other districts and international markets, and has refineries that are able to satisfy the majority of the district's demand.

In 2013, PADD 5 refineries supplied 91 percent of gasoline demand, 96 percent of jet fuel demand, and 113 percent of distillate demand. PADD 5 refineries produce more distillate than used by the district, but does not produce enough gasoline or jet fuel for internal demand. Only a limited number of refineries outside of PADD 5 actually supply refined petroleum products that meet specifications for PADD 5 states. For example, California Air Resources Board (CARB) gasoline is expensive and difficult to manufacture, and other areas of PADD 5, such as Arizona, also require special gasoline formulas. Despite fuel specification requirements, there are exchanges between PADD 5, other PADD districts, and the global market. The vast majority of gasoline, jet fuel, and diesel are produced locally. Since more distillate is produced than needed, PADD 5 exports some distillate and brings in a small amount of gasoline and jet fuel in order to meet demand and supply shortfalls. Based on this pattern, it would be expected that imports into Nevada from non-PADD 5 states would mostly be gasoline or jet fuel. This finding is consistent with the ratio of fuel that arrives in Nevada from PADD 4 discussed in Section 3.2.2.

Nevada only has two operating refineries. One of the refineries, Foreland Refining Corporation Eagle Springs Refinery in Nye County, produces thick asphalt and fuel oils from locally sourced crude. The other refinery, Golden Gate Petroleum in Storey County east of Reno, is a splitting facility which distills transmix into individual transportation fuels. Transmix is a mixture of gasoline, diesel, and/or jet fuel that forms when petroleum is transported in pipelines. Transmix processing plants (also referred to as splitters) use distillation to separate the mix into individual transportation fuels, specifically gasoline, diesel, and jet fuel. After distillation, some additional treatments may be necessary in order to meet fuel specifications. The majority of the transportation fuels studied in this analysis supplying Nevada are refined in California and Utah, but Golden Gate Petroleum does account for some additional production as a transmix processing plant. Golden Gate Petroleum also blends their fuel with additional additives before distributing to their retail centers. Figure 2.1 shows the petroleum product flows from California and Utah refineries to Nevada's major cities (Reno and Las Vegas).

Figure 2.1 PADD 5 Regional Markets in California/Nevada, with SCSN Counties



Source: Cambridge Systematics. Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

Within PADD 5, regional fuel markets can be identified based on product flows. The refineries in PADD 5 together can produce 2.5 million barrels of refined petroleum products per day (bbl/d). Southern California and Utah refineries supply Southern Nevada, and Northern California refineries supply Northern Nevada. The PADD 5 regional fuel markets in Nevada are shown in Figure 2.1. The Northern California/Northern Nevada (NCNN) region is typically able to produce enough gasoline, diesel, and jet fuel to supply the local region demand as well as exports to other regional markets and the international market. NCNN does not have any pipeline connection to other PADD districts, but is able to export product for maritime transportation via the Pacific Coast. Table 2.1 summarizes petroleum demand and production in the NCNN and SCSN regions. In 2013, NCNN refineries produced 102 percent of gasoline demand, 108 percent of jet fuel demand, and 147 percent of diesel fuel demand. The Southern California/Southern Nevada (SCSN) region produces and consumes the most transportation fuels between the regions. In 2013, SCSN produced 87 percent of gasoline demand, 117 percent of distillate demand, and 92 percent of jet fuel demand. The gasoline and jet fuel production shortfall in SCSN is supplemented by the oversupply in NCNN and the UNEV pipeline from PADD 3 (Salt Lake City, Utah) and Las Vegas.

Table 2.1 Petroleum Demand and Production, by Region

Region	Fuel Type	2013 Refinery Production (b/d)	2013 Demand (b/d)	2013 Refinery Production / Demand (%)
SCSN	Gasoline[1]	526,800	606,600	87%
SCSN	Jet Fuel	178,100	194,100	92%
SCSN	Distillate	182,500	155,500	117%
NCNN	Gasoline	421,000	412,000	102%
NCNN	Jet Fuel	96,000	88,200	108%
NCNN	Distillate	185,000	125,600	147%
	SCSN Subtotal	887,400	956,200	93%
	NCNN Subtotal	702,000	625,800	112%

Note: Volumes for gasoline include 10 percent ethanol blending.
Source: Cambridge Systematics. Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

Table 2.2 combines the NCNN and SCNN demand and production. When totaled, NCNN and SCSN produce 93 percent of gasoline demand, 99 percent of jet fuel demand, and 129 percent of diesel fuel demand. Combining all of the fuel types together, NCNN and SCSN actually produce quantities of fuel equivalent to 100 percent of the regions' demand, but the regions do not actually consume 100 percent of their own fuel. NCNN also produces enough product to satisfy internal demand as well as contribute to SCSN supply.

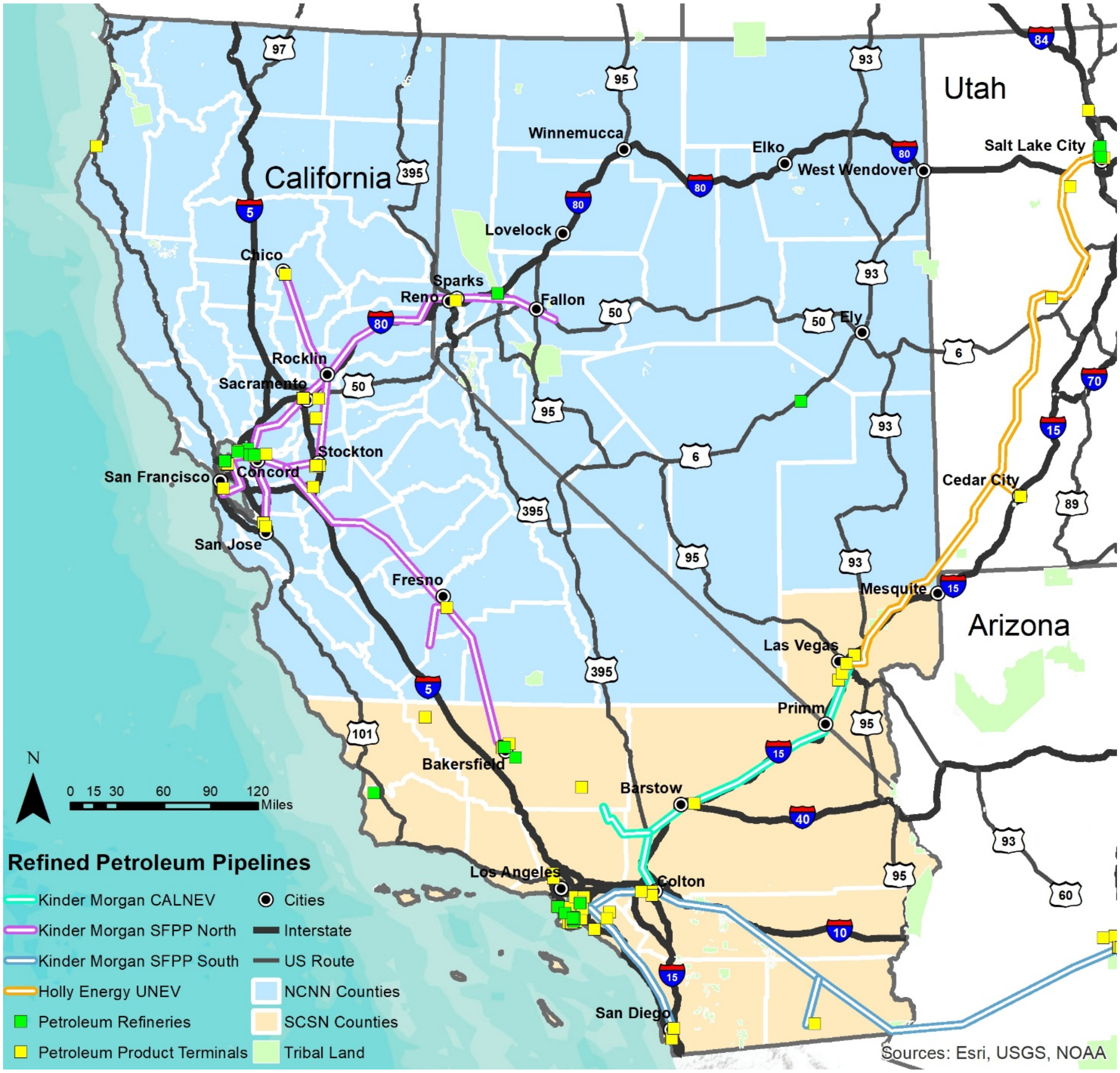
Table 2.2 Petroleum Demand and Production for California and Nevada, by Fuel Type

Fuel Type	2013 Refinery Production (b/d)	2013 Demand (b/d)	2013 Refinery Production / Demand (%)
Gasoline[1] Subtotal	947,800	1,018,600	93%
Jet Fuel Subtotal	274,100	282,300	97%
Distillate Subtotal	367,500	281,100	131%
Total	1,589,400	1,582,000	100%

Note: Volumes for gasoline include 10 percent ethanol blending.
Source: Cambridge Systematics. Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

Figure 2.2 shows the refined petroleum pipelines that flow into Northern and Southern Nevada. The following sections will further evaluate the supply, demand, and distribution of fuels separately for Northern and Southern Nevada.

Figure 2.2 California and Nevada Refined Petroleum Pipelines



Source: Cambridge Systematics. U.S. Energy Information Administration

3.0 Southern Nevada Supply, Demand, and Storage

SCSN is reliant on the refineries, pipelines, ports, and storage facilities for the effective functioning of the petroleum supply chain. Refineries receive crude oil and produce specified petroleum products. Pipelines transfer products between refiners and storage facilities. Ports import and export products by maritime transport, and storage facilities hold product until it is sold and brought to market. In the SCSN region, Watson Station, a pipeline hub in Carson, near Long Beach, California, is also an important part of infrastructure for the petroleum supply chain. Watson Station is a non-redundant pipeline hub, and refineries to the West, such as Chevron, Shell Carson, Tesoro, Phillips, and ExxonMobil must move product through Watson Station to reach bulk storage and distribution facilities to the east and south in Colton and San

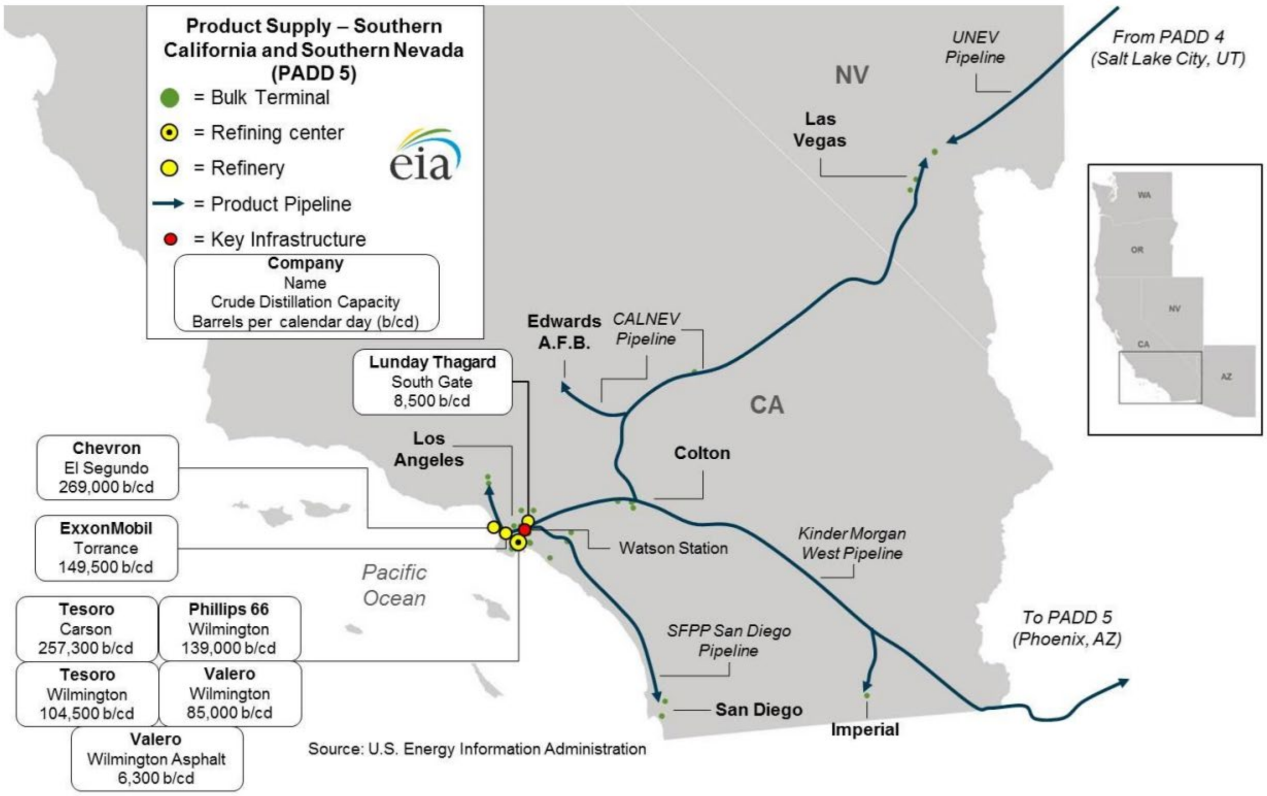
Diego. Without Watson Station, product would not be able to move by pipeline from 88 percent of the SCSN refineries to the rest of the region east of Los Angeles. Watson Station, therefore, is particularly important to the pipeline flow of refined petroleum products from refinery to market. Refinery outages also affect the ability of SCSN to provide enough fuel for the region. When a refinery is unable to produce, such as the outage at the Torrance refinery in March 2015, maritime deliveries of supply from other regions, districts, and counties are critical for meeting the shortfall. Each part of the supply chain: production, transportation, and storage of petroleum is important for meeting the demand of SCSN. The following sections will examine the refineries, storage, and distribution of petroleum in Southern Nevada.

3.1 Southern California Southern Nevada (SCSN) Region Profile

The Southern California and Southern Nevada (SCSN) region is the largest demand area in PADD 5. SCSN includes the southernmost counties of California and the Las Vegas metropolitan area in Southern Nevada. SCSN has large metropolitan areas and many military air bases and large commercial aviation hubs. In 2013, the SCSN region accounted for 39 percent of total PADD 5 demand, which is the largest share of gasoline, diesel, and jet fuel demand of the six regional PADD 5 markets. The SCSN region consumes the most petroleum products in PADD 5.

There are eight operating refineries in the California part of the SCSN region, which supply the region's majority of motor gasoline, diesel and jet fuel. All eight refineries are located in the Los Angeles metropolitan area. Figure 3.1 shows the petroleum product bulk terminals, refineries, and pipelines in the SCSN region. Table 3.1 lists the refineries with their location, markets served, and operating capacities. The refineries have combined capacity of 1,019,100 b/cd, but only produced 940,080 b/d in 2013. Overall demand in the SCSN regional market was 956,200 b/d in 2013. SCSN has the capacity to supply all of the demand in SCSN; however, in 2013 only operated at 92 percent of capacity, and only produced 98 percent of demand. Since some of the product does not conform to the specifications required for the area even if it is produced in the area, some products are exported to other markets. SCSN provides product to Arizona and international markets by maritime exports, and receives product from Utah, NCNN, and maritime imports. SCSN is mostly self-sufficient, but does rely on other markets for selling and buying transportation fuels.

Figure 3.1 Southern California and Southern Nevada Product Flows



Source: Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

Table 3.1 Southern California Petroleum Refineries

Company	Location	Atmospheric Crude Distillation Unit (ACDU) operating capacity b/cd	Markets served
Valero Asphalt	Wilmington, California	6,300	
Lunday Thagard	Southgate, California	8,500	Local
Valero	Wilmington, California	85,000	Southern California (S. CA), Las Vegas, Phoenix
Tesoro	Wilmington, California	104,500	S. CA, Las Vegas
Phillips 66	Wilmington, California	139,000	S. CA, Las Vegas
ExxonMobil	Torrance, California	149,500	S. CA
Tesoro	Carson, California near Long Beach	257,300	S. CA, Las Vegas
Chevron	El Segundo, California	269,000	S. CA, Las Vegas, Phoenix
	Total	1,019,100	

Source: Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

3.2 Pipelines and Storage Facilities in Southern Nevada

Two pipelines bring petroleum products into Southern Nevada from California and Utah: Kinder Morgan's Calnev and Holly Energy's UNEV. The following section will examine the pipeline and storage terminal capacities in Southern Nevada.

3.2.1 Calnev Pipeline and Las Vegas Terminal: Kinder Morgan

The Calnev pipeline transports gasoline, jet fuel, and diesel fuel from Colton Terminal in Southern California to Kinder Morgan's Las Vegas Terminal adjacent to Nellis Air Force Base in Southern Nevada. Las Kinder Morgan's Las Vegas Terminal is located on 66 acres, where 41 refined petroleum tanks have a combined storage capacity of 1.8 million barrels (see Figure 3.2).[3] Pro Petroleum also operates from this facility, and 10 to 20 trucks per day transport refined petroleum to the mines in Northern Nevada. Gasoline and ethanol are blended before being transported by truck to Nevada retail gas stations. Diesel fuel is transported by truck to retail gas stations and to fuel mine operations. Jet fuel is stored at the Nellis Air Force base. Kinder Morgan's Las Vegas Terminal stores the vast majority of Southern Nevada's petroleum supply before it is released to the market.

The gasoline is blended with ethanol at the "rack" or loading facility before distribution to retail facilities in Southern Nevada. Ethanol is transported to the terminal via Union Pacific Railroad. Union Pacific transports ethanol to Las Vegas.

The monthly supply of petroleum to Kinder Morgan's Las Vegas Terminal is roughly double the storage capacity. Figure 2.2 shows the Kinder Morgan Calnev pipeline and other Kinder Morgan facilities in Southern Nevada, Southern California, and Arizona. The Calnev pipeline is 566 miles long, operated by Kinder Morgan, and consists of 14 inch and 8 inch parallel pipes. The supply consists of gasoline, diesel, and jet fuel. The refined petroleum capacity from Colton to Las Vegas is currently 157,000 b/d.[4] About one third of the product represents jet fuel supplied to Nellis Air Force Base, one third gasoline, one sixth diesel fuel, and the balance is dedicated to other terminals.

---

[3] Kinder Morgan. United States Securities and Exchange Commission: Form 10-K for the fiscal year ended December 31, 2016. https://ir.kindermorgan.com/sites/kindermorgan.investorhq.businesswire.com/files/report/additional/KMI-2016-10K_Final_with_Exhibits.pdf)

[4] Bannigan, Tom. "Products Pipelines." Kinder Morgan Presentation. https://ir.kindermorgan.com/sites/kindermorgan.investorhq.businesswire.com/files/event/additional/2008_Analysts_Conf_05_Products_Pipelines.pdf

Figure 3.2 Kinder Morgan Terminal

Source: Imagery ©2018 Google

3.2.2 UNEV Pipeline and Las Vegas Terminal: Holly Energy

The UNEV pipeline transports petroleum products into Las Vegas from Woods Cross, Utah to Holly Energy's Terminal at Apex Industrial Park in Southern Nevada, roughly 20 miles northeast of the Kinder Morgan Terminal discussed in Section 3.2.1. The Holly Energy Terminal is located on 53 acres, where 12 refined petroleum tanks have a combined storage capacity of 330,000 barrels (see Figure 3.3).[5] Holly Energy's Las Vegas Terminal stores a minority of Southern Nevada's petroleum supply before it is released to the market. Gasoline and ethanol are blended before being transported by truck to Nevada retail gas stations. Diesel fuel is transported by truck to retail gas stations and to mines fuel operations.

Figure 3.3 Holly Energy Terminal, Apex Industrial Park

Source: Imagery ©2018 Google

The gasoline stored at the Holly Energy Terminal is blended with ethanol at the "rack" or loading facility before distribution to retail facilities in Southern Nevada. Ethanol is transported to Apex Industrial Park by truck and stored in tanks on site. Ethanol is then blended with gasoline to be transported to retail petroleum facilities throughout Nevada.[6]

The monthly supply of petroleum to the Holly Energy Terminal is roughly double the storage capacity. Figure 2.2 shows the Holly Energy UNEV pipeline in Southern Nevada and Utah. A schematic of the UNEV pipeline is also shown in Figure 3.4 below. The UNEV pipeline is 427 miles long and operated by Holly Energy. The monthly supply of petroleum to the Terminal is approximately 70 percent gasoline and 30 percent diesel

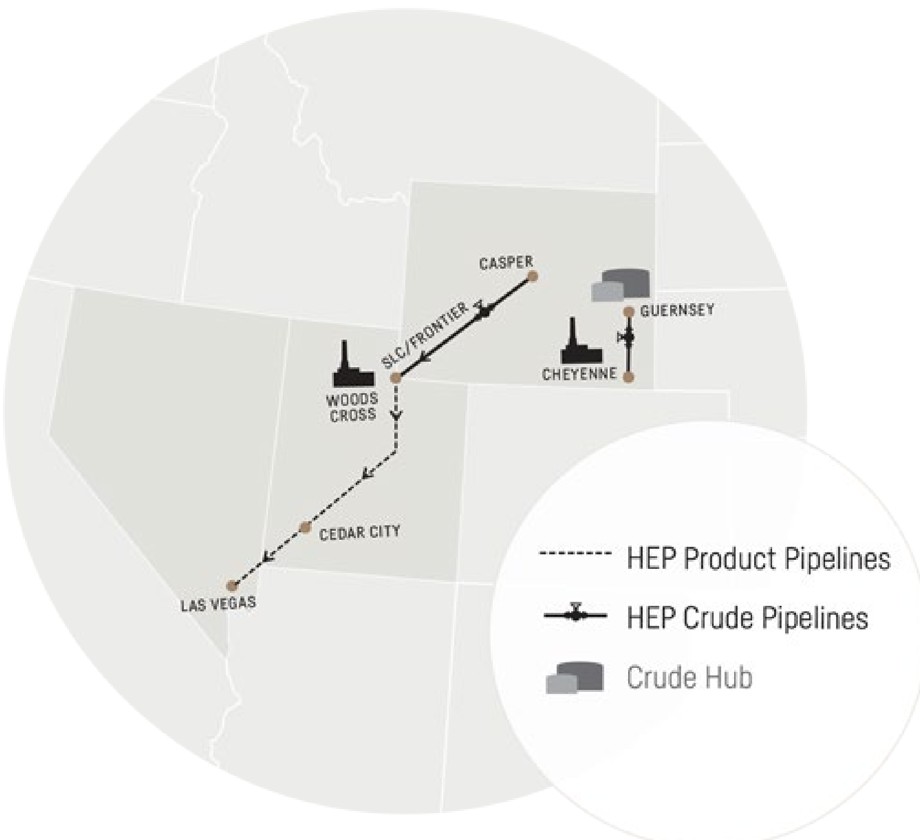
[5] 378,000 barrel storage capacity is listed in 2017 Annual Report, but 2018 interview of UNEV listed 330,000 barrel storage capacity for petroleum products. http://www.annualreports.com/HostedData/AnnualReports/PDF/NYSE_HEP_2017.pdf

[6] Interview with Holly Energy Apex Terminal Manager August 2, 2018.

(Footnote continued on next page...)

fuel.[7] The refined petroleum capacity from Woods Cross to Las Vegas is currently 62,000 b/d with the availability to expand up to 118,000 b/d with limited capital investment.[8] The UNEV pipeline is responsible for delivering a minority of Southern Nevada's petroleum supply to storage the Holly Energy Terminal for distribution to the market.

Figure 3.4 Holly Energy's UNEV Pipeline Map



Source: Holly Energy.

4.0 Northern Nevada Supply, Demand, and Storage

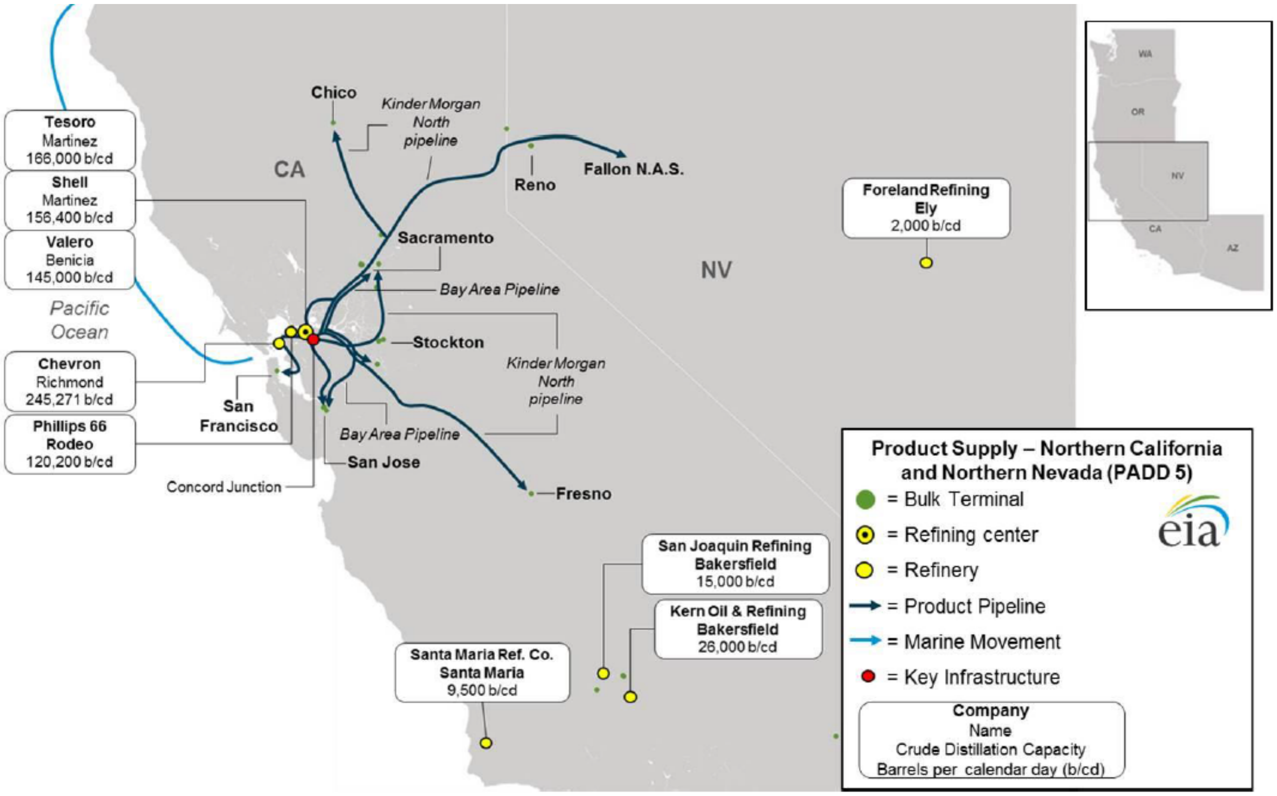
4.1 Northern California Northern Nevada (NCNN) Region Profile

The Northern California and Northern Nevada region (NCNN) is the most self-sufficient regional market in PADD 5. NCNN includes and all of Nevada except for Clark county and the counties of California north of San Luis Obispo, Kern, and San Bernardino counties. In 2013, the NCNN region accounted for 37 percent of total PADD 5 demand, which is the second largest of the six regional PADD 5 markets. The NCNN region is the least reliant on other regional markets and the second-largest regional market in PADD 5.

[7] Interview with Holly Energy Apex Terminal Manager July 2018.

[8] http://www.annualreports.com/HostedData/AnnualReports/PDF/NYSE_HEP_2017.pdf

Figure 4.1 Northern California and Nevada Refineries and Petroleum Flows



Source: Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015.

There are 10 operating refineries in the NCNN region which supply most of the motor gasoline, diesel and jet fuel for the region. Five refineries are located in the San Francisco Bay area which is the largest concentration of refining capacity in the region, three refineries are located north of Los Angeles near Bakersfield and Santa Maria, Golden Gate Petroleum (GGP) in Storey County east of Reno distills transmix and blends fuel with additives for the retail market, and Eagle Foreland Refinery in Nye County, Nevada produces only asphalt and fuel oil which is mined locally. Figure 4.1 shows the petroleum product bulk terminals, refineries, and pipelines in the NCNN region. Golden Gate Petroleum is located between Reno and Fallon N.A.S. Table 4.1 lists the refineries with their location, markets served, and operating capacities. The refineries have combined capacity of 887,371 b/cd. In 2013, the refineries produced 744,100 b/d in 2013 (excludes Golden Gate Petroleum). Overall demand in the NCNN regional market was 625,800 b/d in 2013. NCNN has more capacity and production than the demand in NCNN, and in 2013 operated at only 84 percent of capacity but produced 119 percent of demand. NCNN provides product to other parts of PADD 5, such as SCNN, and international markets by maritime exports. NCNN is self-sufficient, and provides fuel to other markets.

NCNN is reliant on the refineries, pipelines, ports, and storage facilities for the effective functioning of the petroleum supply chain. Refineries receive crude oil and produce specified petroleum products. Pipelines transfer products between refiners and storage facilities. Ports import and export products by maritime transport, and storage facilities hold product until it is sold and brought to market. In the NCNN region, product is shipped by pipeline from NCNN refineries in San Francisco Bay, Santa Maria, and Bakersfield to storage and distribution terminals near San Francisco, Fresno, Chico, and Reno. The Concord pipeline junction is an important gateway pipeline transmissions in NCNN as it is the gathering and entry point for the main trunk of the Kinder Morgan pipeline system. NCNN region is not connected by pipeline to any other region or PADD, and supply from NCNN region to other markets is moved by marine vessel through ports in the San Francisco Bay. Supply chain disruptions can be caused by power outages, earthquakes, and heavy fog in the Bay. Each part of the supply chain: production, transportation, and storage of petroleum is important for meeting the demand of NCNN. The following section will examine the storage and distribution of petroleum in Northern Nevada.

Table 4.1 Northern California and Northern Nevada Refineries

Company	Location	ACDU[1] operating capacity b/cd	Markets Served
Chevron	Richmond, California	245,271	
Tesoro	Martinez, California	166,000	
Shell	Martinez, California	156,400	Northern California (N. CA), Reno, Oregon
Valero	Benicia, California	145,000	N. CA, Reno
Phillips 66[2]	Rodeo, California	120,200	N.CA, Los Angeles, Reno, Nevada, exports
Kern Oil & Refining	Bakersfield, California	26,000	N.CA, Reno, Nevada, exports
San Joaquin Refining	Bakersfield, California	15,000	S. CA, Las Vegas
Santa Maria Refinery	Santa Maria, California	9,500	Central California
Foreland Refining	Nye County Nevada	2,000	Central California
Golden Gate Petroleum	Clark, Nevada	2,000[3]	N. CA, Reno
	Total	887,371	

Note: [1] Atmospheric Crude Distillation Unit
[2] A portion of this facility is actually located in San Luis Obispo County but is operated as part of the Rodeo refinery.
[3] This operating capacity came from interview with company, and is an approximation.

Source: Energy Information Administration's PADD 5 Transportation Fuels Markets Study, 2015. Interview with Golden Gate Petroleum December 2018.

4.2 Pipelines and Storage Facilities in Northern Nevada

Reno is critical to the distribution of product to Northern Nevada. At the Northeast border of Nevada and near the California border, Reno is removed from the refinery production in Northern California but is at the end of one pipeline that brings petroleum products from the San Francisco Bay Area into Northern Nevada. The following section will examine the pipeline and storage terminal capacities in Northern Nevada.

4.2.1 SFPP North Line and Sparks Terminal

Kinder Morgan's Santa Fe Pacific Pipeline (SFPP) North Line transports gasoline, jet fuel, and diesel fuel from Concord Station in Northern California to the Sparks Terminal in Northern Nevada. Concord station is a 25 acre fuel storage complex located just outside of San Francisco where there are 23 refined petroleum tanks with a total capacity of 1.2 million barrels. A 20-inch pipeline extends from Concord to Sacramento, then connects to Rocklin Station. From Rocklin, product is transported to the Sparks Terminal in Sparks, NV, a distance of 138 miles, where it is stored in 44 tanks. The pipeline between Rocklin and Reno varies between six, eight and ten inches in diameter, depending on geography. Figure 2.2 shows the Kinder Morgan SFPP North Line and other Kinder Morgan facilities in Northern Nevada and Northern California. The Sparks Terminal is operated by Kinder Morgan on 44 acres, where 45 refined petroleum tanks have a combined storage capacity of 748,377 barrels. Figure 4.2 is an aerial photo of the Sparks Terminal and its tank that store gasoline, diesel, and jet fuel before being transported to market. Gasoline and ethanol are blended before being transported by truck to Nevada retail gas stations. Diesel fuel is transported by truck to retail gas stations and to fuel mine operations. The Sparks Terminal stores the vast majority of Northern Nevada's petroleum supply before it is released to market.

Figure 4.2 Sparks Terminal

Source: Imagery ©2018 Google

The gasoline stored at the Sparks Terminal are blended with ethanol at the "rack" or loading facility before distribution to retail facilities in Northern Nevada. The Sparks Terminal is sandwiched between I-80 and the Union Pacific Railroad, and ethanol is transported to the terminal via Union Pacific Railroad. There are six truck loading racks, and ethanol is sequentially blended with gasoline for transport to retail gasoline stations throughout Northern Nevada.

Many truck trips from the Sparks Terminal extend into Northern California to serve petroleum retail stations[9] since the closest alternative petroleum distribution facility is in Rocklin, California which is more than 100 miles away from the border, whereas the Sparks Terminal is less than 20 road miles from the border. Triple trailers are allowed in Nevada and commonly used for deliveries within the state. They consist of one 53 foot cargo tank trailer and two 28 foot "pups" for a total capacity of 20,000 gallons. However, triple trailers are not allowed in California and therefore not used for deliveries into California.

The monthly supply of petroleum to the Sparks Terminal is roughly double the storage capacity. The supply consists of roughly 40 percent gasoline, 40 percent diesel, and 20 percent jet fuel. Diesel is supplied by a six-inch pipeline to the neighboring Fallon Naval Air Station located 70 miles east. The SFPP North Line is responsible for delivering a vast majority of Northern Nevada's petroleum supply, and the Sparks Terminal is where it is stored until it is distributed to the market.

[9] Interview with Kinder Morgan Terminal Manager August 20, 2018.

4.2.2 Golden Gate Petroleum Refinery

Roughly 20 miles east of the Sparks Terminal is the Golden Gate Petroleum (GGP) splitter facility. GGP receives about 2,000 barrels of transmix per day, 50 percent arriving by rail and 50 percent by truck. The transmix is sourced by truck from pipeline terminals in California and Reno, and by rail from pipeline terminals in Phoenix and Denver. Another 2,000 barrels of diesel and gasoline leave the facility per day by truck. Golden Gate Petroleum has about 75,000 barrels of storage capacity for transmix, feedstock, gasoline, and diesel. GGP also uses some of the transmix as feedstock for their operations. For gasoline blending, GGP also brings in renewable diesel from California. GGP does not supply enough gasoline to supply all of their retail facilities and also buys finished gasoline. Other fuel additives are also used for fuel blending. Product leaving GGP is mostly going to GGP retail facilities, but a surplus of diesel is also sold on the open market.

5.0 Nevada Petroleum Distribution Profile

In Nevada, petroleum products are transported from storage facilities to industries, municipal facilities, mining operations, utilities, and retail petroleum facilities throughout the State. Petroleum products arriving in Nevada are likely to arrive by one of the three pipelines that supply the area from Northern California, Southern California, or Utah. These pipelines, Calnev, UNEV, and SFPP supply the vast majority of Nevada's petroleum usage. Each pipeline feeds a storage terminal, and together, these pipelines provide over 230,000 barrels per day of petroleum to Nevada, with 2,878,377 barrels of storage.

The distribution process brings petroleum product from storage facilities to retail petroleum facilities. The study team used the Nevada Statewide Hazmat Database to identify refined petroleum facilities by type and develop estimates refined petroleum distribution across the State. Assuming a 250 mile radius around Las Vegas for petroleum distribution, the Study Team used a shortest path algorithm to determine likely routing, assuming truck drivers will primarily stay on interstate and U.S. highways as much as possible.

The petroleum distribution maps demonstrate that the volume of diesel on the roadways is greatest in Northern Nevada, while Southern Nevada is dominated by gasoline. These results are consistent with the large urban population around Las Vegas in the south and the increased prevalence of industrial facilities and mining operations in Northern Nevada. Figure 5.1 depicts Statewide diesel distribution and Figure 5.2 depicts Statewide gasoline distribution by truck.

5.1.1 Aviation Gasoline

A small but important part of the petroleum supply chain includes the transportation of aviation gasoline. Known as "Avgas," this leaded gasoline is used for piston aircraft. Because the gas is leaded, it requires dedicated manufacturing and transport.

Approximately 70 percent of the general aviation (GA) fleet uses avgas or other gasoline. There are over 210,000 piston aircraft in the US, requiring approximately 154 million gallons each year.[10] Piston aircraft need high quality,

[10] General Aviation Manufacturers Association, "2016 General Aviation Statistical Databook & 2017 Industry Outlook." Washington, DC: 2017. https://gama.aero/wp-content/uploads/2016-GAMA-Databook_forWeb.pdf

high performance fuel. Leaded fuels have higher octane levels needed for small aircraft engines. Avgas is also known as "100-Low-Lead" or “100-LL”. Without high-octane avgas, most existing aircraft engines will have to be derated from their currently-certified power levels in order to maintain the FAA-required detonation margins.

In 2017, PADD 5 refineries produced 405,000 barrels of aviation gasoline, down from 611,000 barrels in 2016.[11] Factors leading to reduced production of avgas include limited refining locations, separate transportation and storage facilities, and the cost of production.[12]

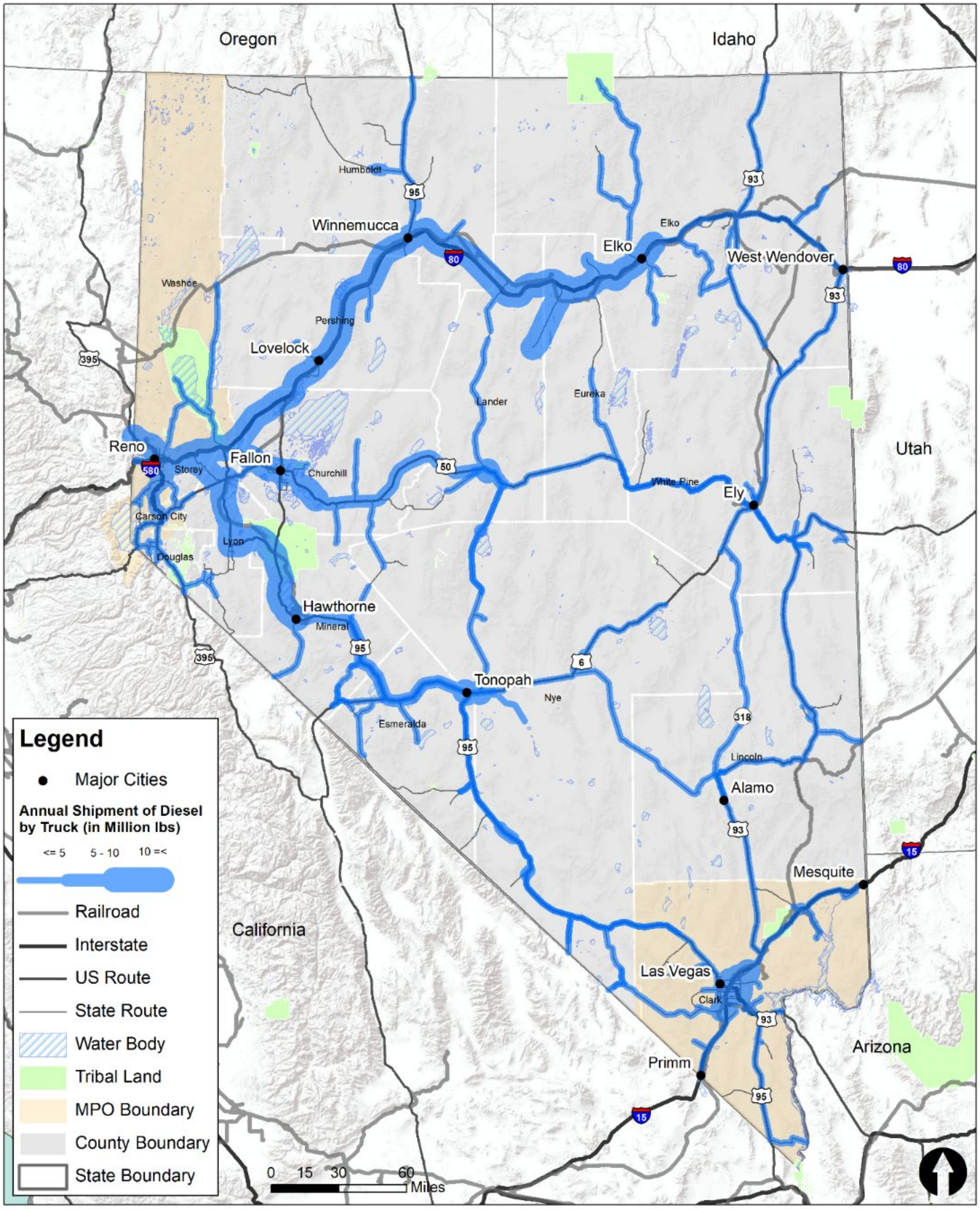
In an effort reduce the use of 100-LL fuel in the U.S., the FAA recently selected two unleaded aviation fuels, developed by Shell and Swift Fuels, for further testing as part of its effort to qualify and deploy an unleaded aviation gasoline to replace the 100 low-lead avgas currently used in the piston aircraft fleet.

In conclusion, a small supply chain supplying avgas to GA airports in Nevada likely results in truck shipments from a limited number of avgas refineries to Nevada each year. This represents a small volume of the gasoline transported in the state.

[11] U.S. Energy Information Administration, “Refinery Net Production.” Release data March 29, 2019. Accessed April 4, 2019 https://www.eia.gov/dnav/pet/PET_PNP_REFP2_A_EPPV_YPY_MBBL_A.htm

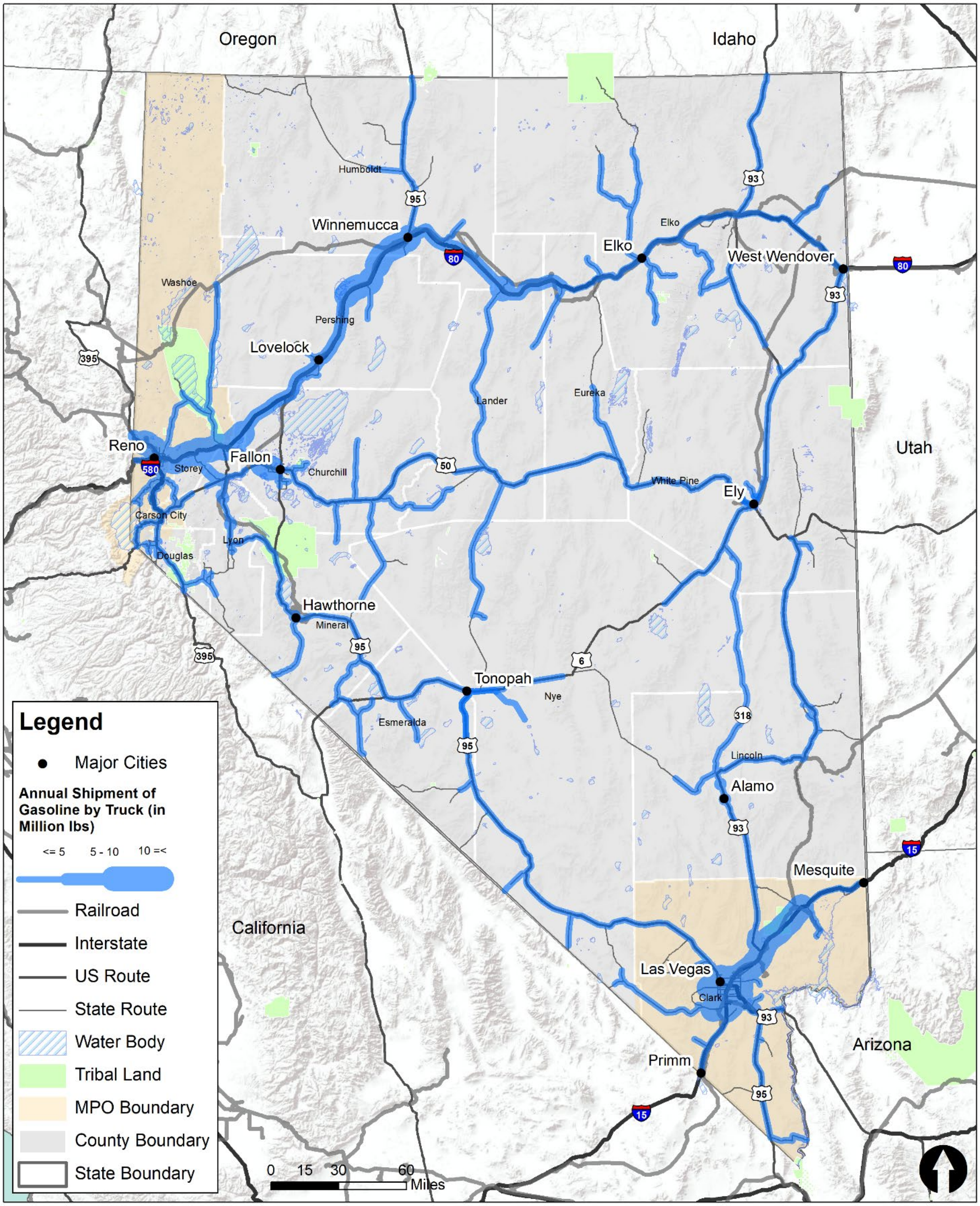
[12] EPI Inc. Web Site accessed April 4, 2019. http://www.epi-eng.com/aircraft_engine_products/demise_of_avgas.htm

Figure 5.1 Nevada Petroleum Distribution, Diesel



Source: Cambridge Systematics. Statewide Hazmat Database.

Figure 5.2 Nevada Petroleum Distribution, Gasoline



Source: Cambridge Systematics. Statewide Hazmat Database.