MARINE HIGHWAY TRANSPORT OF TOXIC INHALATION HAZARD (TIH) MATERIALS

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Objective

- Investigate possibility of transporting greater volumes of chlorine and anhydrous ammonia via the marine highway system
- Implemented research recommendation of initial st
  Highwa

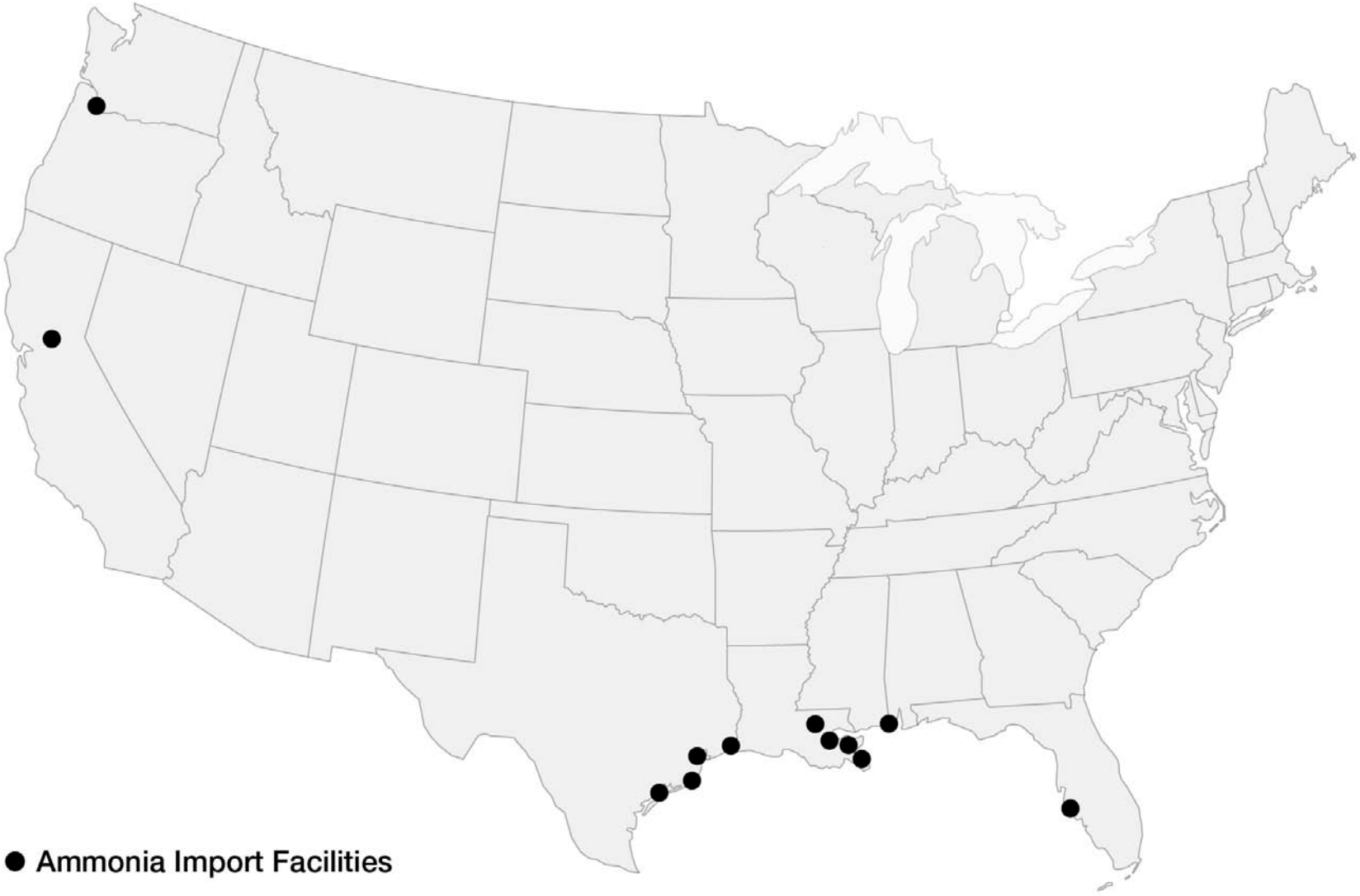
Motivation

- Public safety
  - Low frequency but high severity of large releases → high risk
  - e.g. several high profile railroad incidents
- Environmental concerns
- Eliminate rail TIH shipments (industry support)
- Marine highways are most efficient mode by several measures

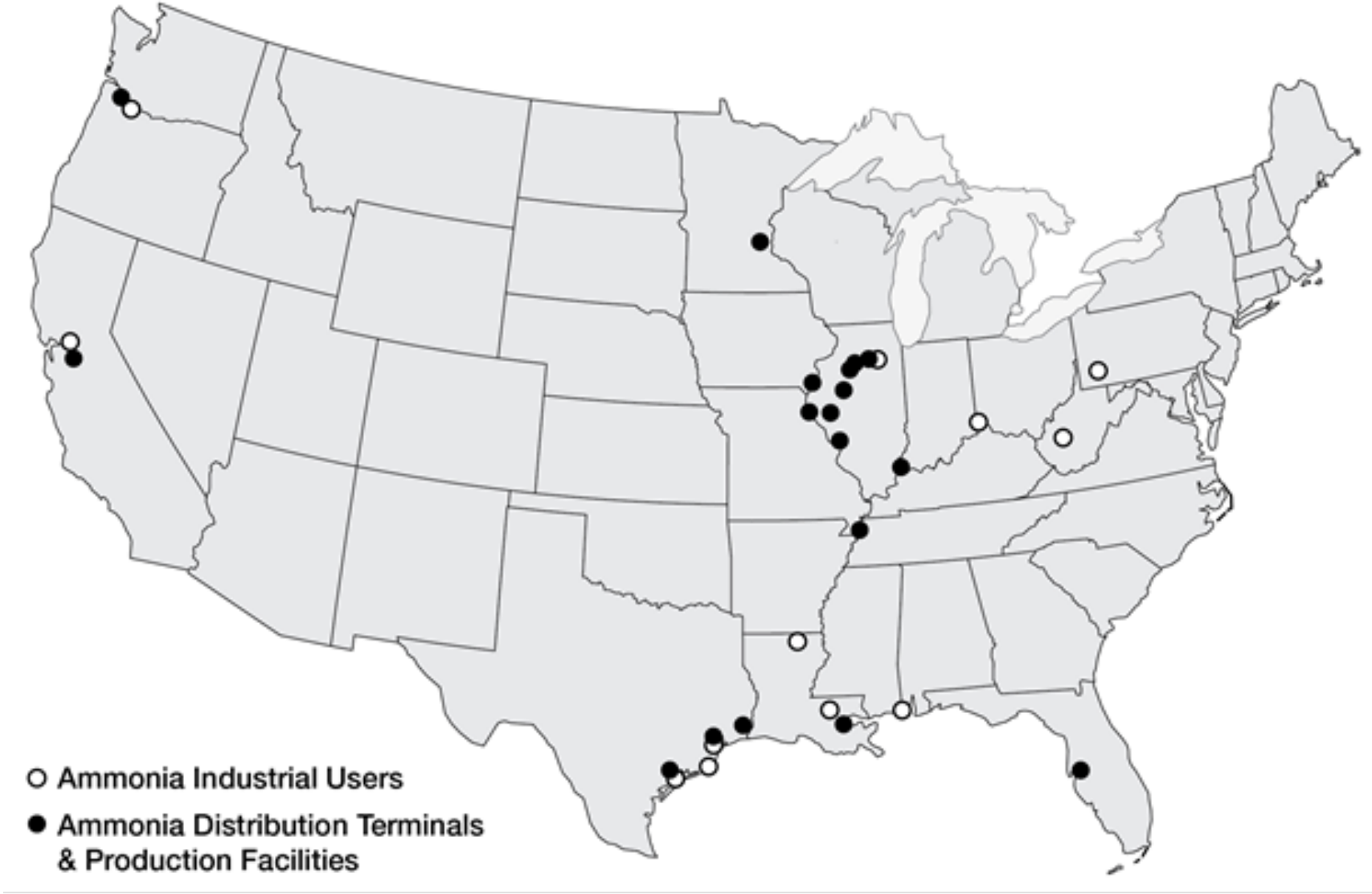
Project Overview

- Limited literature; data & information “mining”
  - Operating environment
    - Market, logistics, regulations
  - US, Europe, Canada
  - Vessel requirements
    - Existing barge, rail, truck
  - Economics of expanded operations
    - Market conditions, transportation rates, capital requirements, risk
  - Obstacles
  - Potential courses of action
- Confidential interviews with broad spectrum of industry experts

Import terminals



Users, producers, distributors



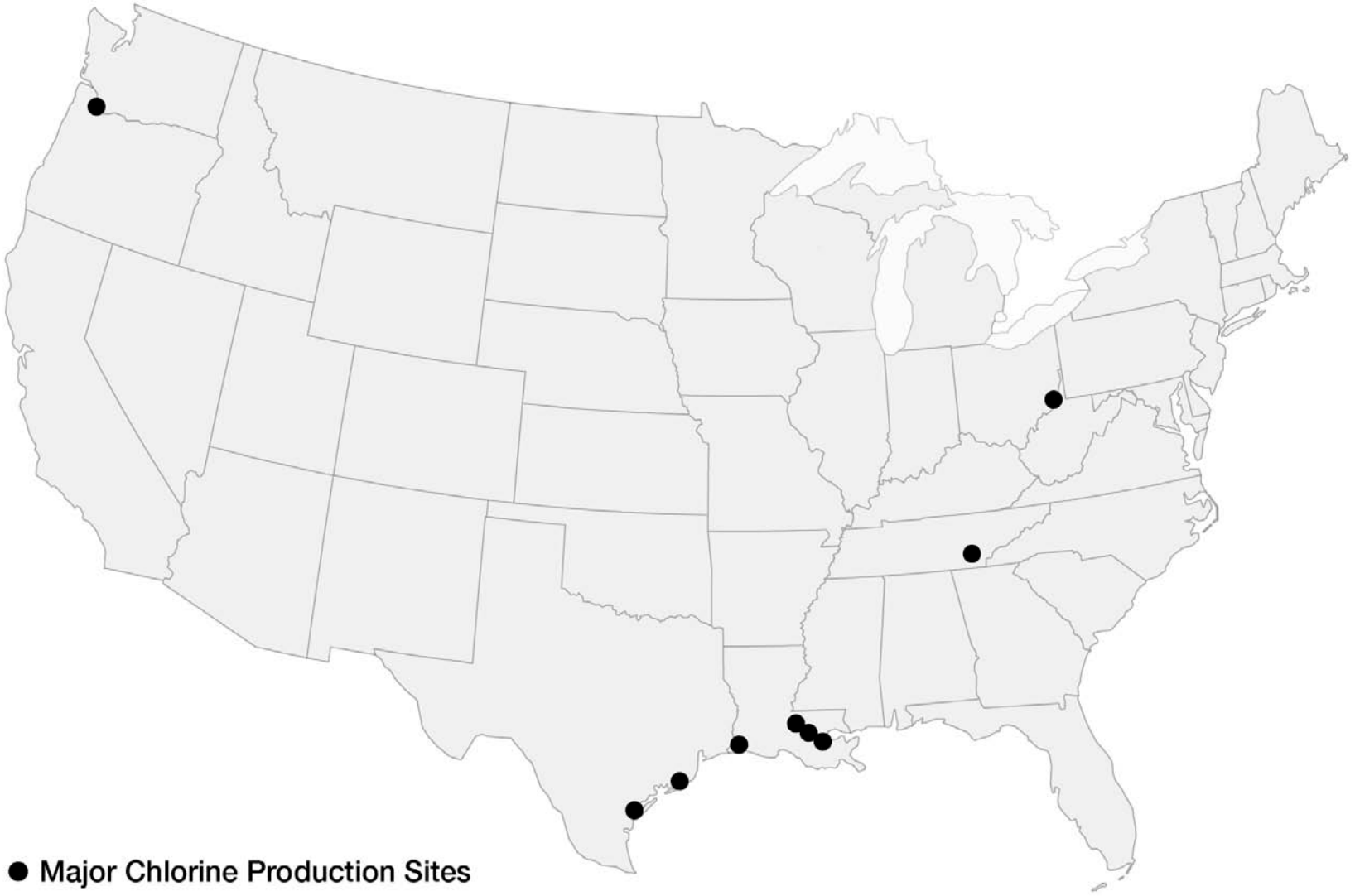
Marine transport

- ~1.5 M tons of ammonia (anhydrous & solution) transported by barge in 2007; ~1.1M by rail
- Domestic production & imports↑
- Current fleet 33 vessels
- Average distance 795 miles
- Typical shipment size 5,000 tons
- Few retail/mfg facilities on water
- Barge cost approximately $14 million
- ~100K tons of chlorine in 2007; only 1 major receiving marine terminal; ~3.2M tons by rail

Ammonia facility & equipment costs

Capital Item	Cost
Conventional Production Facility 1500 tons/day with storage	$300 million
Pipeline 12″ Diameter—1000 mi	$240 million
Large Refrigerated Storage Terminal 30,000-ton capacity	$20 million
Pressure Storage Tanks—30,000 gal $5/gallon installed	$150,000
Ammonia Rail Tank Car Current design: 340 psi Proposed design: 500 psi	 $118,000 $135,000–$150,000

Chlorine Producers



Findings – Obstacles

1. No coastwise movements exist (no Jones Act vessels)
2. Little water shipment of chlorine (2 operators)
3. Geographical dispersion works against marine shipment
4. Mature markets—no expansion opportunity
5. Rail competes on price along water routes
6. Capital requirements are high for new vessels/terminals; permit process is lengthy
7. Risk is high, even for water; no liability limits
8. Manufacturers are seeking substitutes
9. Co-location emphasized (eliminate transportation)
10. Lock and dam infrastructure condition is a concern

Potential Courses of Action

1. Limit liability to carriers & shippers; establish emergency funds e.g.
   - Oil Spill Liability Trust Fund
   - IMO Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea
   - “Price-Anderson” protections in transportation of nuclear energy waste
2. Government incentives
   - Grants/tax credits for acquisition of equipment or modification of infrastructure, facilities, supply chains
   - e.g. encourage plant/facility location near marine terminals

Potential Courses of Action

3. Dilute ammonia
   - Would multiply actual volume by 5
4. Restrict movements through High Urban Threat Areas
5. Require safer equipment & technology
6. Repair & maintain marine infrastructure
7. Integrate marine component into national transportation planning
   - System resiliency, redundancy (national security)

Conclusion

Geographical, market, and risk issues are insurmountable.

Further expansion is unlikely.

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