Material Research L3C
Methodology for research
Toxic Cargo report
For Toxic Free Future
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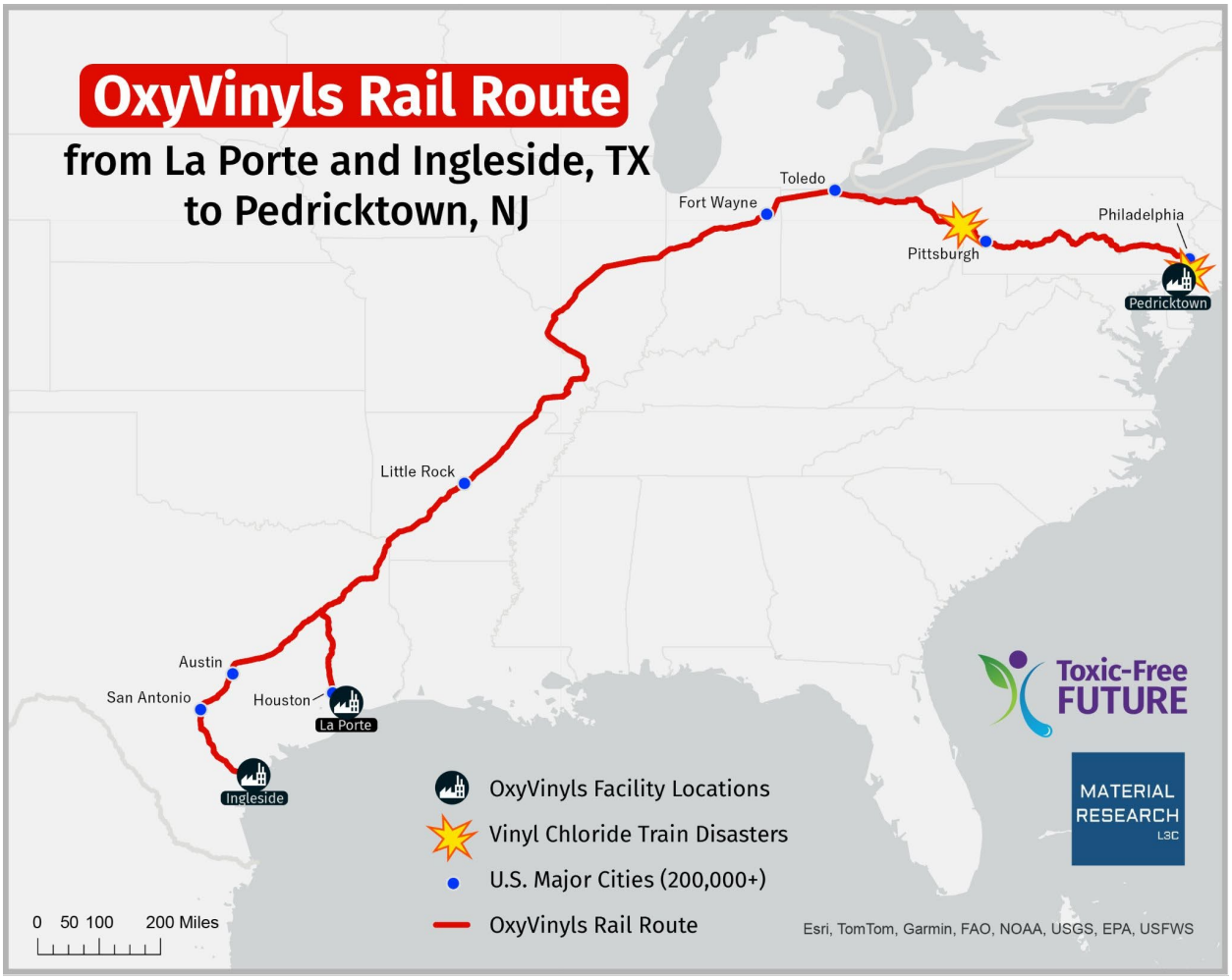

Mapping Methodology

Five factories in the U.S. and Canada manufacture PVC resins distant from vinyl chloride factories. Each depends on rail shipments. OxyVinyls plants in Pedricktown, N.J. and Niagara Falls, Ontario (Canada), and Orbia/Mexichem plants in Pedricktown and Henry, Illinois, receive vinyl chloride by rail from OxyVinyls' VCM factories in La Porte and Ingleside, Texas. Westlake's Aberdeen, Mississippi, factory depends upon VCM by rail from Westlake's operations in Lake Charles, Louisiana.

This case study focuses on the OxyVinyls supply chain, which is responsible for the two recent toxic chemical disasters in East Palestine, OH and Paulsboro, NJ highlighted in this report.

The rail route displayed from Ingleside and La Porte, TX to Pedricktown, NJ was identified through a series of steps in ArcGIS pro. The main layer used to determine these specific routes comes from the Bureau of Transportation Statistics, specifically the North American Rail Network Lines (NARN) layer, which was last updated on October 13th, 2023.

The process of identifying the most probable route for vinyl chloride rail transportation from Texas to New Jersey involved visual confirmation and the aid of news reports, rail company (Norfolk Southern, Union Pacific, Conrail) network and routes maps and reports, railcar photos, previous derailment locations, and tank car repair reports. Often, the team at Material Research confirmed the origin and destination along the route through rail photos and news reports, and visual analysis of the shortest route using the North American Rail Network Lines layer would confirm a section of the route.

Through meticulous selection of rail segments, the specific route layers were created in sections, using geolocated way points that were identified through railcar photos, news articles, tank car repair reports, and locations of vinyl chloride disasters. These sections were then compiled into one complete layer.

Once this polyline layer was created, a buffer tool was used to create a one-mile radius along the entire route. Public and private schools were identified within this buffer zone. The public school and private school data were accessed through the National Center for Education Statistics, which collects their data from the U.S. Census Bureau's American Community Survey. The public school data is from the school year of 2020 - 2021 and the private school data is from the school year of 2019-2020. Read here for documentation of how this data is collected.

Note: the identified route is the most likely route followed by OxyVinyls based on photographs, manifests, incident reports, and manifest train schedules. Other routes are possible depending upon conditions and scheduling. For example, OxyVinyls railcars have been located in northern New Jersey, in the Newark area, according to Railcar fan photos and OTMA car repair reports. The route through Little Rock to East St. Louis, followed in this investigation, is paralleled by another manifest train's route through Pine Bluff, Arkansas. In such cases, the chosen route is based on the currency and frequency of

reports showing OxyVinyls tank cars on a given route. Variations from the identified route would likely increase the number of rail cars en route at any moment.

Estimated OxyVinyls VCM shipments to stranded PVC Plants

PVC Plant Location	Max. VCM Demand pounds per day	Max. VCM tank cars demand per day	Travel Time from La Porte	Max. tanks en route
Pedricktown, NJ (OxyVinyls)	1,353,425	7.64	9.9 days	75.64
Pedricktown, NJ (Orbia)	408,000	2.30	9.9 days	22.77
Henry, IL (Orbia)	293,479	1.66	5.0 days	8.32
Niagara Falls, ON (OxyVinyls)	2,116,438	11.95	8.4 days	100.38
TOTAL	**4,171,342**	**23.55**	**-**	**207.11**

Citations and calculations provided below.

Destination	Max. No. of VCM Tank Car deliveries per year (a)	Pounds VCM on tracks at any moment (b)
Pedricktown (OxyVinyls)	2,788.60	13,398,907
Pedricktown (Orbia)	839.50	4,039,200
Henry (Orbia)	605.90	1,466,479
Niagara Falls (OxyVinyls)	4,361.75	17,778,076
TOTAL	**8,595.75**	**36,681,458**

(a) Maximum demand per year divided by 365 days, further divided by 177,111 lb (avg weight of vinyl chloride per tank based on nine bills of lading[1] for OxyVinyl tanks in the East Palestine and Paulsboro disasters)

[1] https://www.maersk.com/logistics-explained/shipping-documentation/2023/10/02/what-is-bill-of-lading

(b) Number of cars en route (see above table) multiplied by 177,111 lb.

As much as 1,522,253,980 (1.5 billion) pounds of vinyl chloride move by rail each year from OxyVinyls to the four PVC plants that rely upon these deliveries. This is based on maximum permitted demand of 772,500,000 lb (Niagara Falls), 494,000,000 lb (Oxy in Pedricktown), and 148,920,000 lb (Orbia in Pedricktown), and estimated demand of 107,120,000 lb in Henry.

The average tank car, as measured by manifests for deliveries in the East Palestine and Paulsboro disasters, carries 177,111 pounds of vinyl chloride.[2]

Calculating the number of rail cars carrying vinyl chloride at any time requires understanding supply requirements per location and the time it takes to reach the destination from the source plant.

OxyVinyls ships VCM from its Texas operations to four PVC plants. Calculations are based upon sourcing from its La Porte/Deer Park complex near Houston. However, OTMA car repair records, visual evidence, and other reports show that OxyVinyls' other Texas VCM plant in Ingleside also supplies stranded PVC plants, though less frequently than La Porte. The Ingleside plant is near Corpus Christi, more than 200 miles southwest of La Porte. Therefore, the estimated maximum number of tank cars carrying OxyVinyls VCM at any time is likely lower than the actual number

- **Tanks per day**

The average tank car, as measured by manifests for deliveries in the East Palestine and Paulsboro disasters, carries 177,111 pounds of vinyl chloride.[3]

State air permits provide upper limits for the amount of vinyl chloride that can be received by PVC resin manufacturers. These maximums provide the upper end basis for how many rail cars are required to fulfill that demand.

Maximums allowed by permit are consistent measures, unlike figures provided in company websites and news reports regarding production capacity. "Production capacity is a vital statistic for describing the performance of a chemical plant, but there is no universally accepted definition or means to evaluate

[2] The National Transportation Safety Board published four bills of lading from the Paulsboro disaster. The cars carried 175,050, 175,950, 176,500, and 179,100 pounds of VCM. https://data.ntsb.gov/Docket/?NTSBNumber=DCA-13-MR-002 (exhibit 222) EPA's East Palestine records list five tank cars carrying 178,150, 178,300, 177,250, 177,600, and 176,100 pounds VCM. https://www.epa.gov/system/files/documents/2023-02/02%2021%2023%20Norfolk%20Southern%20Removal%20UAO%20-%20Signature%201-508checked.pdf

[3] The National Transportation Safety Board published four bills of lading from the Paulsboro disaster. The cars carried 175,050, 175,950, 176,500, and 179,100 pounds of VCM. https://data.ntsb.gov/Docket/?NTSBNumber=DCA-13-MR-002 (exhibit 222) EPA's East Palestine records list four tank cars carrying 178,150, 178,300, 177,250 and 177,600 pounds VCM. https://www.epa.gov/system/files/documents/2023-02/02%2021%2023%20Norfolk%20Southern%20Removal%20UAO%20-%20Signature%201-508checked.pdf

it," Engineers have noted that, "Capacity is often expressed in vague, imprecise, and inconsistent terms."[4]

Pedricktown NJ (Orbia and OxyVinyls)

Summary:

- **Pedricktown (OxyVinyls and Orbia)**
  VCM Demand: 642,920,000 pounds/year
  Distance from La Porte: 1,979 miles
  Max. number of VCM tank cars (@177,111 lb each): 3,628.1
  Max. tank cars per day: 9.94
  Max. tank cars en route (@9.9 day travel time): 98.41

Two companies own co-located PVC resin manufacturing units in Pedricktown. BF Goodrich opened the plant in 1950. In 1998, Occidental Petroleum, and its new subsidiary, OxyVinyls, took control of most of the facility. A smaller section of the plant was spun off into the ownership of what became PolyOne, which is now part of Orbia.

According to New Jersey Dept. of Environment permits, the maximum amount of vinyl chloride that the two plants can receive, combined, is 642,920,000 pounds.

The OxyVinyls plant is permitted to produce a maximum of 480 million pounds of PVC resin, according to a 2022 permit modification.[5] Using the standard conversion rate of 1.03:1, maximum production would demand 494 million pounds of vinyl chloride.

Orbia's plant is permitted to receive up to 148,920,000 pounds per year of vinyl chloride, as stated in a 2020 permit modification.[6] This indicates a design capacity (72,291 tons PVC/year) that is higher than what Orbia reports on the Vestolit website. Orbia says in Pedricktown, "Approximately 100 employees produce roughly 51 kt/ year."[7] However, it is likely that Orbia is using metric tons rather than U.S. tons in this statement (see Henry discussion).

Henry IL (Orbia)

Summary:

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[4] https://www.aiche.org/sites/default/files/cep/20140859.pdf

[5] https://njems.nj.gov/DataMiner/Report/ReportCriteria?APIKEY=DEP123&showheader=y&isExternal=y&getCriteria=y&BOReportName=Community%20Corner%20-%20Effective%20Permits&Enter%20PI%20Number:=65530

[6] Mexichem Specialty Resins Inc (65494), Air permit modification, January 30, 2020. NJ DEP DataMiner https://njems.nj.gov/DataMiner/Report/ReportCriteria?APIKEY=DEP123&showheader=y&isExternal=y&getCriteria=y&BOReportName=Community%20Corner%20-%20Effective%20Permits&Enter%20PI%20Number:=65494 (downloaded Jan. 4, 2024)

[7] https://www.vestolit.com/about-us-2/region-sites/us/

Maximum Permitted VCM Demand: 107,120,000 pounds/year
Distance from La Porte: 1,087 miles
Max. number of VCM tank cars (@177,111 lb each): 605.90
Max. tank cars per day: 1.66
Max. tank cars en route (@ 5 days travel time): 8.32

Summary: 52,000 tons of PVC production is used as a conservative basis for estimating maximum demand for vinyl chloride.

The Illinois Environmental Protection Agency's Document Explorer database does not have the full air permit for the Henry, only modifications. The full air permit, which would have details such as vinyl chloride input or PVC output limits, likely predates the agency's online system capabilities.

Estimating the Henry plant's VCM demand must rely upon other sources.

In 2017, Mexichem's website stated that "the two plants [Henry and Pedricktown] have a combined capacity of 225M pounds.[8] This is equivalent to 112,500 tons of PVC resin. This is slightly higher than capacities reported by the Independent Commodity Intelligence Services (ICIS) in 2006 (50,000 tons for Pedricktown, 52,000 tons for Henry).[9]

ICIS' 52,000 ton figure corresponds with data provided on Orbia's current website, if it is assumed Orbia's figure is for metric rather than U.S. tons. The site under the brand name Vestolit, states, "Henry produces approximately 48 kt/year and has around 90 employees."[10] 48,000 metric tons is equivalent to 52,900 tons.

Therefore, 52,000 tons of PVC is used as a conservative basis for estimating maximum demand for vinyl chloride monomer: 53,560 tons or 107,120,000 pounds, based on the 1.03:1 ratio).

Niagara Falls, Ontario (OxyVinyls)

Maximum Permitted VCM Demand: 772,500,000 pounds
Distance from La Porte: 1,664 miles
Max. number of VCM tank cars (@177,111 lb each): 4,361.75
Max. tank cars per day: 11.95
Max. tank cars en route (@ 8.4 days travel time): 100.38

[8] https://web.archive.org/web/20170609212038/http://www.mexichem.us/MSR/mexichem-specialty-resins-inc
[9] Feliza Mirasol. "Chemical Profile: Polyvinyl Chloride." ICIS Chemical Business, May 11, 2009.
[10] https://www.vestolit.com/about-us-2/region-sites/us/

In 2006, the Ontario Ministry of Environment approved an amended certificate of approval, in which OxyVinyls' PVC production was limited with the objective of reducing vinyl chloride air emissions. "The plant polyvinyl chloride (PVC) production capacity will be limited to 341 kilotonnes of PVC resin per year," it states.[11] This figure, equivalent to 375,000 U.S. tons, forms the basis for the maximum permitted VCM demand.

- **Tanks between locations**

Vinyl chloride tank cars run on "manifest trains." In these operations, stock with varied origins and destinations roll together between car marshaling yards.[12] There are dedicated manifest trains between Houston and New Jersey. Manifest trains with daily departures that lead to Camden include:

1. Union Pacific's (UP) MEWNL manifest train from the Englewood Yard (Houston) to the Jenks Yard (North Little Rock).
2. UP's MNLAS manifest train from the Jenks Yard (North Little Rock) to the Gateway Yard in East St. Louis.
3. Norfolk Southern's 32N manifest train from Madison (near East St. Louis) to Decatur and on to the Conway yard in Pennsylvania.
4. NS's 38G manifest train runs from the Conway yard to the Abrams yard in King of Prussia, Pa., and onward to the Camden Povonia yard in New Jersey.

The number of vinyl chloride tanks in manifest trains at any moment is determined here by:

1. Distance
2. Average miles per hour (when moving between yards)
3. Time spent in yards

Other factors such as crew shifts are not accounted for in the calculations for this case study.[13] The time estimates in this case study are likely understated. A trains.com reporter, for example, tracked two tank cars' journey from Houston to Connecticut, which took more than 13 days.[14]

Distance:

As noted above, the calculations assume the shortest route where there are options.

Average mph:

[11] https://www.accessenvironment.ene.gov.on.ca/instruments/3366-6HYSJN-14.pdf

[12] https://railtec.illinois.edu/wp/wp-content/uploads/2019/01/Lovett-et-al-2015-IAROR.pdf

[13] See https://web.archive.org/web/20190107194003/http://www.nscorp.com/content/dam/nscorp/maps/2016-system-map-print.pdf for examples of other situations.

[14] https://www.trains.com/wp-content/uploads/2020/10/trnm0707_a4cars.pdf

The federal Surface Transportation Board (STB) maintains rail service data including average speeds by rail operator.[15] Averages for 2017 to 2023 are used for segments by operator, then divided by distance, to estimate time between yards.

La Porte to Pedricktown - Avg Time between Yards[16]

Segment	**Distance (miles)**	**Avg mph (operator)**	**Time moving**
La Porte to Pedricktown			
Houston to Madison IL	888	25.3 (Union Pacific)	35 hours
Madison IL to Philadelphia	1025	20.66 (Norfolk Southern)	50 hours
Philadelphia to Pedricktown	45	23.97 (CSX)	2 hours
Total moving time	**1969 miles**	**22.5 mph**	**87 hours moving**

Yard "dwell time":

Rail cars reliant upon manifest trains spend more time stationary in yards than moving toward their destinations.[17] Manifest train cars are re-positioned in terminals at several points in their journeys.

Rail operators report average "dwell times" for their most frequented terminals.[18] The following table lists known terminals along manifest train routes between Houston and Camden. OxyVinyl VCM cars commonly follow these lines.

Weekly reports to the Surface Transportation Board, from 2017 to 2023, were averaged as the basis for calculating total dwell time. Railroads report dwell times for their 10 most frequented terminals and an overall service average for the rest.

Terminal Dwell Times per Route

Rail Yard	**Dwell Time (hours)**	**En route to Pedricktown**	**En route to Henry**	**En route to Niagara Falls**
Englewood (Houston), Texas (UP)	26.53	x	x	x

[15] https://www.stb.gov/reports-data/rail-service-data/

[16] based on avg system speed reported by NS, 2017 to 2023 https://www.stb.gov/reports-data/rail-service-data/

[17] https://rosap.ntl.bts.gov/view/dot/32572/dot_32572_DS1.pdf

[18] https://www.stb.gov/reports-data/rail-service-data/

North Little Rock, Ark. (UP)	25.32	x	x	x
E. St. Louis / Madison, Ill. (UP)	25.32	x	x	x
Decatur, Indiana	23.83	x		x
Conway, Pennsylvania	28.5 hours	x		x
Camden, New Jersey	20.93	x		
Total of above		**150.43**	**77.17**	**129.5**

Total travel time

Estimated travel times are then calculated using these industry averages for dwell times and miles per hour between terminals.

"Manifest traffic is operationally more complex than point-to-point service. It requires frequent switching, repeated assembly of cars into trains, and multiple transfers among carriers as the traffic traverses the national rail system." - Pennsylvania State Rail Plan 2020[19]

[19] https://www.penndot.pa.gov/Doing-Business/RailFreightAndPorts/Planning/Documents/2020%20Pennsylvania%20State%20Rail%20Plan/2020%20Pennsylvania%20State%20Rail%20Plan.pdf

Table. OxyVinyls Rail Deliveries of Vinyl Chloride Monomer

PVC factory	Max. VCM daily demand (pounds)	VCM tank cars needed per day	VCM tank cars needed per year	Distance from La Porte (miles)	Avg speed	Hours moving	Terminal wait hours	Total Hours - origin to destination	Days, origin to destination	Maximum number of tank cars en route
OxyVinyls - Pedricktown, NJ	1,353,425	7.64	2,788.60	1,979	22.50	87.9	150.43	238.4	9.9	75.64
Orbia - Pedricktown, NJ	408,000	2.30	839.50	1,979	22.50	87.9	150.43	238.4	9.9	22.77
Orbia - Henry, Illinois	293,479	1.66	605.90	1,087	24.89	43.7	77.17	120.9	5.0	8.32
OxyVinyls - Niagara Falls, Ontario	2,116,438	11.95	4,361.75	1,664	22.92	72.6	129.5	202.1	8.4	100.38
OxyVinyls totals	**4,171,342**	**23.55**	**8595.75**	**-**	**-**	**-**	**-**	**-**	**-**	**207.11**

As many as 98 tank cars are en route to Pedricktown from Texas at any moment. Another hundred or so may be destined for Niagara Falls, Ontario, and Henry, Illinois, if the plants are running near capacity.

Location References for OxyVinyl VCM rail route

Material Research pieced together the most common and likely routes for vinyl chloride shipments using a combination of community and official sources. These include:

Official Sources

- One-time movement approvals (OTMA), U.S. Department of Transportation, downloaded spreadsheets.[20]
- Accident Data as Reported by Railroads to the Federal Railroad Administration.[21]

In addition, National Transportation Safety Board and U.S. Environmental Protection Agency investigators published manifest information for the East Palestine and Paulsboro disasters, which included further identifications, and are cited below:

Community Sources

- Manifest Train schedules. Railroad fan sites provide details on manifest train routing between the Englewood Yard in Houston and the Pavonia Yard in Camden, N.J.

- Railcar photos. The primary source is the fansite, www.railcarphotos.com. Photographs are organized by location and codes. Some codes are related to specific producers, including OxyVinyls and Westlake. Other codes are related to leased cars. Photos of vinyl chloride rail cars were identified and mapped to aid in identifying known locations. These are linked in the table below.

- News reports. News reports confirm locations of hazardous cargo on identified routes.

- Google Street View and User Photos. Visual confirmation is also found in Google Street Views and Google user photos of factories and other locations as found in maps.google.com.

From Ingleside and La Porte, TX to Pedricktown, NJ

Location, State	Source	Hyperlink	Confirmation

[20] https://railroads.dot.gov/sites/fra.dot.gov/files/2022-01/CURRENT%20OTMA%20DATA_.xlsx (spreadsheet) January 2022.
[21] https://safetydata.fra.dot.gov/officeofsafety/publicsite/on_the_fly_download.aspx

Texas			
FROM OXYVINYLS LA PORTE TO PALESTINE, TEXAS			
La Porte/Deer Park, Texas	NTSB; EPA		Manifests of tank cars in train disasters
La Porte/Deer Park, Texas	Rail Car Photo (David Casdorph)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=6902	Photo of OxyVinyls tank car (2002)
La Porte/Deer Park to Union Pacific Englewood Yard (Houston)	Port Terminal Rail Association (PTRA); manifest	https://www.ptra.com/index.php/about-us/ptra-rail-network-map.html; https://www.houstonchronicle.com/business/article/east-palestine-houston-waste-vinyl-chloride-17814509.php ; https://digitalscholarship.tsu.edu/cgi/viewcontent.cgi?article=1057&context=theses	A PTRA map shows routing from OxyVinyls in Deer Park to Englewood Rail Yard in Houston. The routing code for the manifest of vinyl chloride tank cars in the 2012 Paulsboro disaster reads, "PTRA (SWG) UP-SALM CSXT" PTRA is the Port Terminal Rail Association, which connects the Houston Ship Channel area chemical industry to the Englewood Rail Yard. "Authorities have identified higher rates of cancer than expected in Fifth Ward around the rail yard," reported the Houston Chronicle in 2023.
Englewood yard (Houston) to Jenks Yard (North Little Rock), Arkansas	Manifest; Railroad fan site.	https://railroadfan.com/wiki/index.php/UP_Train_Symbols	The routing code for the manifest of vinyl chloride tank cars in the 2012 Paulsboro disaster reads, "PTRA (SWG) UP-SALM CSXT" (SWG) is shorthand for the Southwest Gulf line now run by Union Pacific between Englewood and Arkansas.[22] UP Train manifest train MEWNL "Works Lloyd Yard - Spring, TX, Longview, TX, & Texarkana, AR" en route to North Little Rock,

[22] https://www.historictexasmaps.com/collection/search-results/93287-map-of-the-southwest-railway-system-general-map-collection

			according to a railcar fan website.
Spring, Texas	Rail Car Photo (Randy Smith); Railroadfan site.	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=51434, https://www.railcarphotos.com/PhotoDetails.php?PhotoID=51433, https://www.railcarphotos.com/PhotoDetails.php?PhotoID=51437 ; https://railroadfan.com/wiki/index.php/UP_Train_Symbols	Photos of OxyVinyls tank cars (2009). On UP Manifest Train MEWNL route.
Spring, Texas (between Englewood and Palestine)	Rail Car Photo (Randy Smith)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=51434, https://www.railcarphotos.com/PhotoDetails.php?PhotoID=51433, https://www.railcarphotos.com/PhotoDetails.php?PhotoID=51437	Photos of OxyVinyls tank cars (2009)
FROM OXYVINYLS INGLESIDE TO PALESTINE			
Ingleside to Palestine, Texas	Planning for Container growth along the Houston Ship Channel	https://library.ctr.utexas.edu/ctr-publications/0-5068-1.pdf	Congested rail lines in Houston lead planners to direct rail traffic from Corpus Christi toward inland terminals.
Austin, Texas (between Ingleside and Palestine)	Is vinyl chloride shipped through Austin?	https://www.kxan.com/news/local/austin/is-vinyl-chloride-shipped-through-austin/	“The federal mandate is the “Common Carrier Obligation of Railroads.” It establishes railroad companies must provide “transportation or service on reasonable request” and cannot refuse service because it would be inconvenient or unprofitable for the company.”
Palestine, Texas to			OxyVinyl tank cars from La Porte

East Little Rock, Arkansas			and Ingleside meet at the intersection of rails in Palestine, Texas. This main line continues from Palestine through Little Rock, Arkansas and onward to St. Louis, Missouri.
Arkansas			
Jenks Yard, Little Rock, Arkansas	Rail Car Photo (Robin Thomas); Maps, Railroad fan site.	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=139383, https://www.railcarphotos.com/PhotoDetails.php?PhotoID=132511, https://www.railcarphotos.com/PhotoDetails.php?PhotoID=111764 ; https://railroadfan.com/wiki/index.php/UP_Train_Symbols	Photos of OxyVinyls tank cars (2022 and 2023). UP Train manifest train MEWNL "works Lloyd Yard - Spring, TX, Longview, TX, & Texarkana, AR" en route to North Little Rock, according to a railcar fan website.
Missouri			
Little Rock AR to St. Louis MO to East St. Louis IL			The main rail line from Texas to Illinois continues from LIttle Rock AR through Missouri (via Poplar Bluff and Bismarck junctions) and crosses the Mississippi River in St. Louis, to the Madison, Illinois yard, near East St. Louis.
Illinois			
Madison, Illinois to Conway, Pennsylvania	EPA investigation of East Palestine; Railroad fan site.	EPA cited below; https://railroadfan.com/wiki/index.php/UP_Train_Symbols	The East Palestine train was located in the UP Madison yard prior to derailing. Norfolk Southern Manifest Train 32N runs from Madison to Conway, Pa. Norfolk Southern Manifest Train 30N runs from Madison to

			Decatur. Train 34N runs from Decatur to Conway, Pa.
Alorton, Illinois	Railcar Photos (Keith Belk)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=39918	Photo of OxyVinyls tank car (2008)
East St. Louis, Illinois	Railcar Photo (Skip Gatermann)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=26532	Photo of OxyVinyls tank car (2007)
Decatur, Illinois (East Yard)	"Derailed Ohio train had problems after leaving Decatur." Origin point for manifest train to Conway, Pa. ; Railroad fan site.	https://www.wandtv.com/news/derailed-ohio-train-had-problems-after-leaving-decatur/article_987812c2-edb5-11ed-9748-1b3017648653.html ; https://railroadfan.com/wiki/index.php/NS_Train_Symbols#300_Series_-_Manifest	"A large freight train which derailed in Ohio in early February stopped in Decatur the previous day." Norfolk Southern Manifest Train 32N runs from Madison to Conway, Pa. Norfolk Southern Manifest Train 30N runs from Madison to Decatur. Train 34N runs from Decatur to Conway, Pa.
Champaign, Illinois	Railcar Photo (Donnie Lee)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=102017	Photo of OxyVinyls tank car (2016)
Danville, Illinois	Senators propose tighter regulations for railroad hazmat shipments	https://www.trains.com/trn/news-reviews/news-wire/senators-propose-tighter-regulations-for-railroad-hazmat-shipments/	Photograph in news report of VCM tank car in Danville, Illinois
Indiana			
Lafayette, Peru, and Fort Wayne Indiana	Indiana communities at risk for train disasters like the one that devastated Ohio town	https://www.indystar.com/story/news/environment/2023/02/27/indiana-communities-at-risk-for-train-disasters-like-the-one-in-ohio/69925253007/ ;	"The Norfolk Southern train departed from Madison, Ill. and crossed Indiana on a route taking it through Lafayette, Peru and Fort Wayne and several other smaller towns before heading into Ohio —– all the while carrying the same chemicals

		https://railroadfan.com/wiki/index.php/NS_Train_Symbols#300_Series_-_Manifest	responsible for the ongoing disaster." NS Manifest Train 32N runs through Lafayette.
Ohio			
Madison, Illinois, to Pennsylvania via Toledo, Ohio	Train carrying toxic chemicals traveled through many northern Ohio cities before derailing	https://www.beaconjournal.com/story/news/local/2023/02/16/norfolk-southern-train-route-northern-ohio-cuyahoga-hudson-kent-ravenna-hartville-salem/69906508007/	"a federal agency investigating the disaster confirmed on Wednesday that the train, which started its journey on the Illinois/Missouri state line, was piloted by a crew it picked up in Toledo." Article also confirms preceding route of train from Madison, Illinois
Greenwich, OH	Railcar Photo (Mike Rujak)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=66108	Photo of OxyVinyls tank car (2011)
Lorain, OH (Fairlane Yard)	Railroad fansite	https://railroadfan.com/wiki/index.php/NS_Train_Symbols#300_Series_-_Manifest	NS Manifest Train 32N runs through the Fairlane Yard on Lake Erie.
East Palestine, Ohio	Unilateral Administrative Order for Removal Actions	https://www.epa.gov/system/files/documents/2023-03/Unilateral%20Administrative%20Order%20for%20Removal%20Action-First%20Amendment%20-%2020230327.pdf	Site of 2023 disaster. Precise latitude/longitude from EPA records.
Pennsylvania (Conway to Philadelphia)			
Conway, Pennsylvania	OTMA - FRA Defect Reports; EPA investigation of East Palestine disaster; Rail fan sites and	https://railroads.dot.gov/sites/fra.dot.gov/files/2022-01/CURRENT%20OTMA%20DATA_.xlsx (spreadsheet);	Location of overloaded OxyVinyls tank car as reported on Nov. 24, 2021. Conway was the destination yard for the train that derailed in East

	videos[23]	https://railroadfan.com/wiki/index.php/NS_Train_Symbols#300_Series_-_Manifest	Palestine in 2023. NS Manifest Train 32N runs between Madison, Illinois, and Conway, Pennsylvania. NS Manifest Train 38G runs from Conway to the Abrams Yard in King of Prussia and on to the Pavonia Yard in Camden, NJ.
Baden, Pennsylvania	Railcar Photos (Donnie Lee)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=118249; https://www.railcarphotos.com/PhotoDetails.php?PhotoID=121273	Photos of OxyVinyls tank cars (2020 and 2021)
Johnstown, Pennsylvania	Railpictures.net	https://www.railpictures.net/photo/834543/	"NS 1008 brings up the rear of manifest 38G as the train heads over the Arch Stone Bridge that traverses over the Conemaugh River."
Cresson, Pennsylvania	Railcar Photo (Collin Reinhart); Youtube video	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=134415; https://www.youtube.com/watch?v=vlObIx9R9ys	Photo of OxyVinyls tank cars (2022). YouTube video of Manifest Train 39G. This is the return manifest train from Abrams Yard outside Philadelphia to Conway.
Gallitzin, Pennsylvania	Railcar Photo (Collin Reinhart)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=125680	Photo of OxyVinyls tank cars (2022)
Bennington Curve, Pennsylvania	Railcar Photos (Collin Reinhart)	https://www.railcarphotos.com/PhotoDetails.php?PhotoID=117522	Photo of OxyVinyls tank car (2020)
Altoona,	Railcar Photos	https://www.railcarph	Photos of OxyVinyls tank cars

[23] References include https://www.youtube.com/watch?v=vlObIx9R9ys , https://railroadfan.com/wiki/index.php/NS_Train_Symbols#300_Series_-_Manifest

Pennsylvania	(Collin Reinhart); Youtube video	otos.com/PhotoDetails.php?PhotoID=109103; https://www.railcarphotos.com/PhotoDetails.php?PhotoID=140214 https://www.youtube.com/watch?v=sYs0absEYJg	(2015 and 2019). Youtube video shows NS manifest train 38G.
Reading, Pa.	Railroad fansite	http://www.rrpicturearchives.net/showPicture.aspx?id=96050	"Work at Spring Yard has been completed by the crew of NS manifest 39G" 39G is the return route from Abrams to Conway..
Abrams Yard, King of Prussia, Pa.	Youtube videos; railroad fansite	https://www.youtube.com/watch?v=vlObIx9R9ys ; https://railroadfan.com/wiki/index.php/NS_Train_Symbols#300_Series_-_Manifest	Manifest Train 38G runs daily from between the Conway and Abrams Yards; 39G is the return route from Abrams to Conway.
Philadelphia, Pennsylvania, including North Philadelphia station	The Grid (2013 news article); railroad fansites	https://gridphilly.com/blog-home/2023/10/05/phillys-worst-possible-transportation-disaster-a-train-derailment-in-center-city-experts-say/ https://railpace.com/railfan-hot-spot-north-philadelphia-station/ http://trainweb.org/rpotw/RPOTW200112.htm	A Pa. DOT map "shows two large Norfolk Southern lines passing through the region. Entering from the west, one loosely follows the path of the Pennsylvania Turnpike from Norristown, across Montgomery County, and into Bucks. The other follows the Schuylkill River into East Falls. From there, it connects with CSX lines: **one cuts northeast across the city loosely following Route 1** and the other continues to follow the Schuylkill River, becoming the 25th Street viaduct before looping around South Philly." "...NS 38G led by AC44C6M NS 4160 (rebuilt from Dash 9-44CW N 8968) passes North Philadelphia Tower…"

New Jersey (Camden to Pedricktown)			
Delair Bridge (Philadelphia to New Jersey)	Railpictures.net	https://www.railpictures.net/photo/715916/	"38G was running a little earlier than usual… the NS 8098 (ES44AC, Conrail Heritage) was leading as it made its way over the Delair Bridge to the CSAO Pavonia Yard in Camden, NJ."
Pavonia Yard, Camden, New Jersey	Conrail Freight Train Derailment with Vinyl Chloride Release. https://www.youtube.com/watch?v=NFCuXSYfXew	https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR1401.pdf	NTSB's report says the train that derailed in Paulsboro in 2012 had been in the Conrail Pavonia Yard before its morning run to OxyVinyls. A CSX bridge in Philadelphia brings hazardous cargo across the Delaware River to the Pavonia Yard. YouTube video shows NS Manifest Train 39G in the yard.
Pavonia Yard, Camden, to OxyVinyls, Pedricktown		Cited above	In addition to the NTSB report on the Paulsboro disaster, a manifest for the cars that derailed in East Palestine list the route as "PTRA (SWG) UP-SALM CSXT" SALM CSXT is short for the CSX Camden line that runs from the Pavonia Yard through Pedricktown.
Paulsboro, NJ	Conrail Freight Train Derailment with Vinyl Chloride Release	Cited above	Location of the 2012 derailment that injured hundreds of people from exposure to vinyl chloride gas. Located on the CSX Camden line to Pedricktown
Swedesboro, NJ	OTMA - FRA Defect Reports	https://railroads.dot.gov/sites/fra.dot.gov/files/2022-01/CURRENT%20OTMA%20DATA_.xlsx (spreadsheet)	Location of fully loaded OxyVinyls tank car when reported in need of repairs on Jan. 25, 2018. Located to the side of the Camden line.
Pedricktown, NJ			PVC factories run by OxyVinyls and Orbia. Destination as cited above.

Overall Sources			
Norfolk Southern detailed system map		https://web.archive.org/web/20190107194003/http://www.nscorp.com/content/dam/nscorp/maps/2016-system-map-print.pdf	

Community Demographics (schools; EJScreen; population estimates)

- **Schools:**

Public: In 2020, there were 98,469 elementary and secondary public schools[24] and 49,375,000 students in the United States.[25] This is an average of 501 students per public school.

Private: In 2012, there were 26,230 elementary and secondary private schools with 4,479,500 students in the United States.[26] (Most recent available dataset from the National Center for Education Statistics). This is an average of 170 students per private school.

There are 1,249 public and 276 private schools within a mile of the OxyVinyls vinyl chloride rail routes from Ingleside and La Porte to New Jersey. Using the above averages, there are about 650,000 K-12 students within one mile of the train route.

Estimated students within 1 mile of rail route
1249 schools x 501 students = 625,749 public school students
276 schools x 170 students = 46,920 private school students
Total = Estimated 672,660 K-12 students in schools within a mile of vinyl chloride rail route.

- **Number of People**

Three methods were used to estimate the number of people living along the rail routes. These yielded results within 107,000 people, a margin of 3.1%, from low to high.

Method	Result (estimated number of people living within a

[24] https://nces.ed.gov/programs/digest/d21/tables/dt21_216.10.asp
[25] https://nces.ed.gov/programs/digest/d21/tables/dt21_105.20.asp
[26] https://nces.ed.gov/programs/digest/d21/tables/dt21_205.50.asp

	mile of the route)
1. Proportion of census blocks along route	3,453,486
2. Census block centroids	3,396,627
3. Extrapolation of estimated student population	3,503,437

Methods:

1) The sum population of the EJScreen Block Group Level Data (data from the Census Bureau's American Community Survey between 2017-2021) within a one-mile radius of the rail route, reduced by proportional number of people within a given census block outside the one-mile radius (assuming equal distribution of population within the block). For example, if the one-mile buffer from the rail route covers 30% of a given census block group and the population of this census block group is 100 people, the tool used to generate the summary population will account only for 30% of the total population of the block group, which would be 30 people. There is room for error in this calculation as the tool assumes equal distribution of population. This method yields an estimated total population of 3,453,486 people that live within one mile of the mapped train route.

2) Population only of census block groups in which the centroid of the polygon lies within the one-mile radius. The workflow of this analysis began with the EJScreen Block Group Level Data . Using Feature to Point, a centroid point was created for each census block group. This centroid point holds all the data included in the EJScreen Block GroupLevel Data for the related polygon All center points that were within the one-mile buffer of the rail route were selected and made into a new layer. The total population for each of these census block center points were summarized to find a total number. This number is less accurate than the above method, as it does not account for census blocks that the route buffer intersects with, if it does not intersect with the center point. This method yields an estimated total population of 3,396,627 that live within one mile of the mapped train route.

3) Extrapolation of K-12 student estimates. In 2017 (latest available data), the U.S school-age population (5 to 19 years-old) as a percentage of total population was 19.2%.[27] Applying this proportion to the above estimated 672,660 student population yields an estimated total population of 3,503,43 that live within one mile of the mapped train route.

Note: The total U.S. population in 2023 was 334,914,895.[28] Therefore, roughly 1 in 100 U.S. residents live within one mile of this route.

[27] https://nces.ed.gov/programs/digest/d19/tables/dt19_601.30.asp

[28] https://www.census.gov/newsroom/press-releases/2023/population-trends-return-to-pre-pandemic-norms.html

- **EJScreen**

Demographic information obtained via Environmental Protection Agency's EJScreen using a 1.0 mile radial search from locations frequented by OxyVinyls tank cars.

Houston:
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-95.306371,29.78776

Philadelphia:
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-75.188024,39.978056

San Antonio
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-98.505873,29.430101

Austin
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-97.754646,30.264786

Pittsburgh
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-79.996274,40.448354

Toledo
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-83.53256,41.632635

Fort Wayne
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-85.161193,41.060912

Little Rock
https://ejscreen.epa.gov/mapper/demogreportpdf.aspx?feattype=point&radius=1.0&coords=-92.2818,34.754382