



# Taking Action Against Hot-Dip Galvanizing Pollution

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# Galvanizing Process

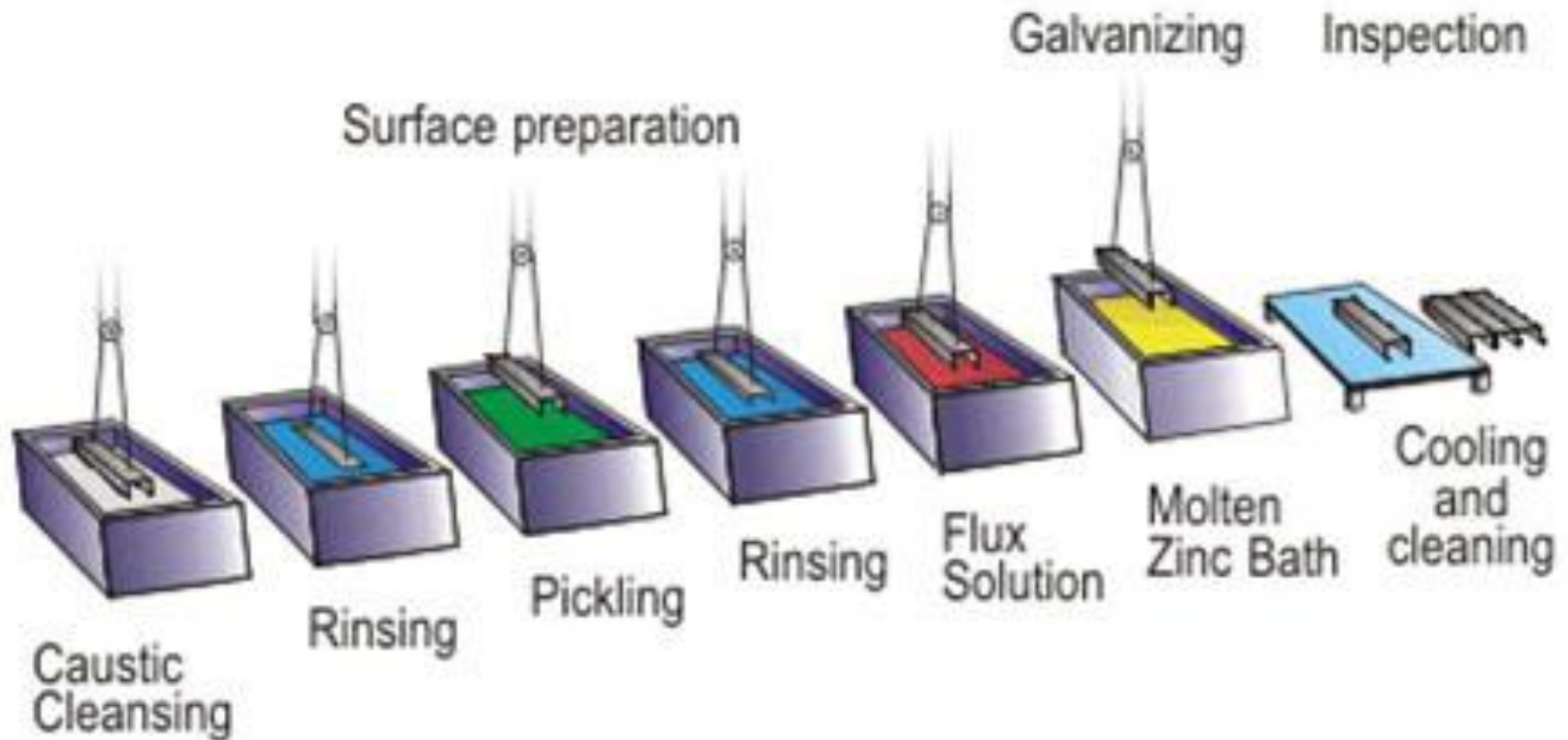
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- ▶ Galvanizing is the process of coating steel with a layer of zinc that protects the steel from rusting. Depending on the environment, items that have been galvanized can last between 20 and 80 years.
- ▶ There are three steps to the galvanizing process: preparation, galvanizing, and post-treatment.
- ▶ The preparation step is divided into degreasing, pickling, and fluxing. Each step consists of a cleaner, either basic or acidic, that cleans the steel of rust and dirt. After each step, the steel is then soaked in a water rinse bath.
- ▶ During the galvanizing step, the steel is immersed in a bath of molten zinc heated to a temperature of 850°F. It takes less than ten minutes for the chemical reactions to occur that bind the zinc to the steel and form the protective layer.
- ▶ Post-treatment varies by plant and is usually for aesthetic purposes such as ridding the steel of lumps or making it shinier.



# Picture of the Galvanizing Steps

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# Sources of waste

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- ▶ All of the different chemical baths used during the galvanizing process present multiple sources of waste.
  - ▶ The pickling bath used in the preparation process consists of hydrochloric acid (HCl). The acid becomes more dilute and less effective with use and must be dumped out and refilled once it becomes too dilute to be effective. Spent HCl is classified as hazardous waste and must be treated accordingly.
  - ▶ Zinc vaporizes off of the galvanizing bath and can escape into the air.
  - ▶ If the steel has not been cleaned enough or if there is carry-over from the previous flux solution, lead and other elements can precipitate out into the galvanizing bath. These contaminants are another source of waste, and they lower the effectiveness of the galvanizing solution. Eventually, there is too much precipitate for the solution to be effective, and it must be dumped out and refilled. Used galvanizing solution is also classified as hazardous waste.
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# South Atlantic, LLC

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- ▶ South Atlantic's corporate office is located in Wilmington, North Carolina.
- ▶ It was bought out by B.E.Wedge Holdings, a UK-based company, in 2004.
- ▶ Shortly after this, the company acquired the Virginia Galvanizing corporation.
- ▶ Now, South Atlantic has plants in North Carolina, South Carolina, Virginia, Georgia, and Tennessee.





Red = South Atlantic plants  
Blue = South Atlantic waste destinations

Detroit, MI

Vickery, OH

Ashland, VA

Graham, NC

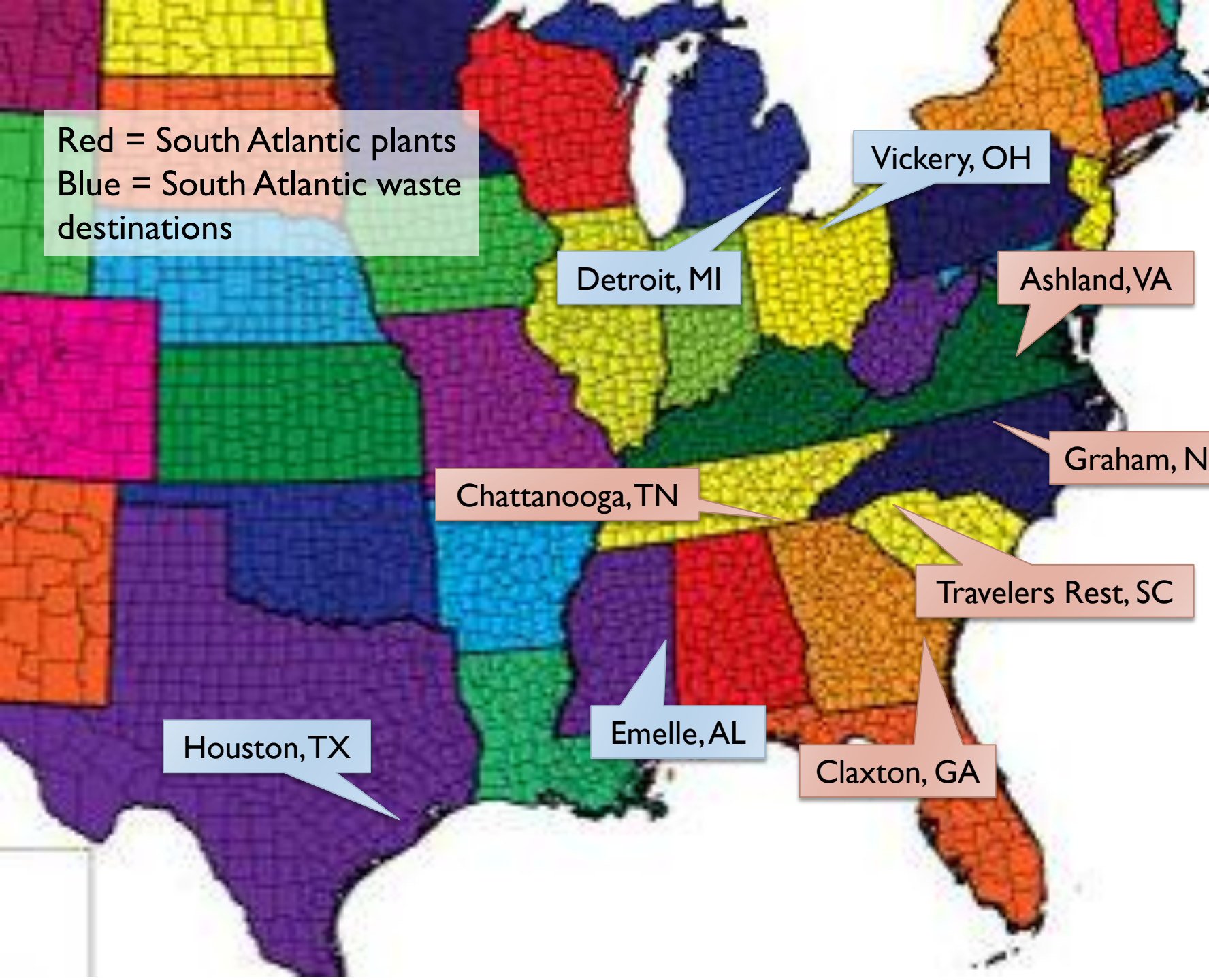
Chattanooga, TN

Travelers Rest, SC

Houston, TX

Emelle, AL

Claxton, GA



# How the Waste Was Tracked

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- ▶ The EPA's Toxic Release Inventory (TRI) was used to follow South Atlantic's waste.
- ▶ Each year companies self-report information to the TRI that includes what type of waste was emitted, how much was released on-site to air and water, how much was transferred off site, where it was transferred, and how transfers were processed.
- ▶ For the most recent year available (2010) South Atlantic reported releasing two types of pollutants: lead and zinc compounds.
- ▶ Waste was transferred to five different locations.



# Fate of the Waste

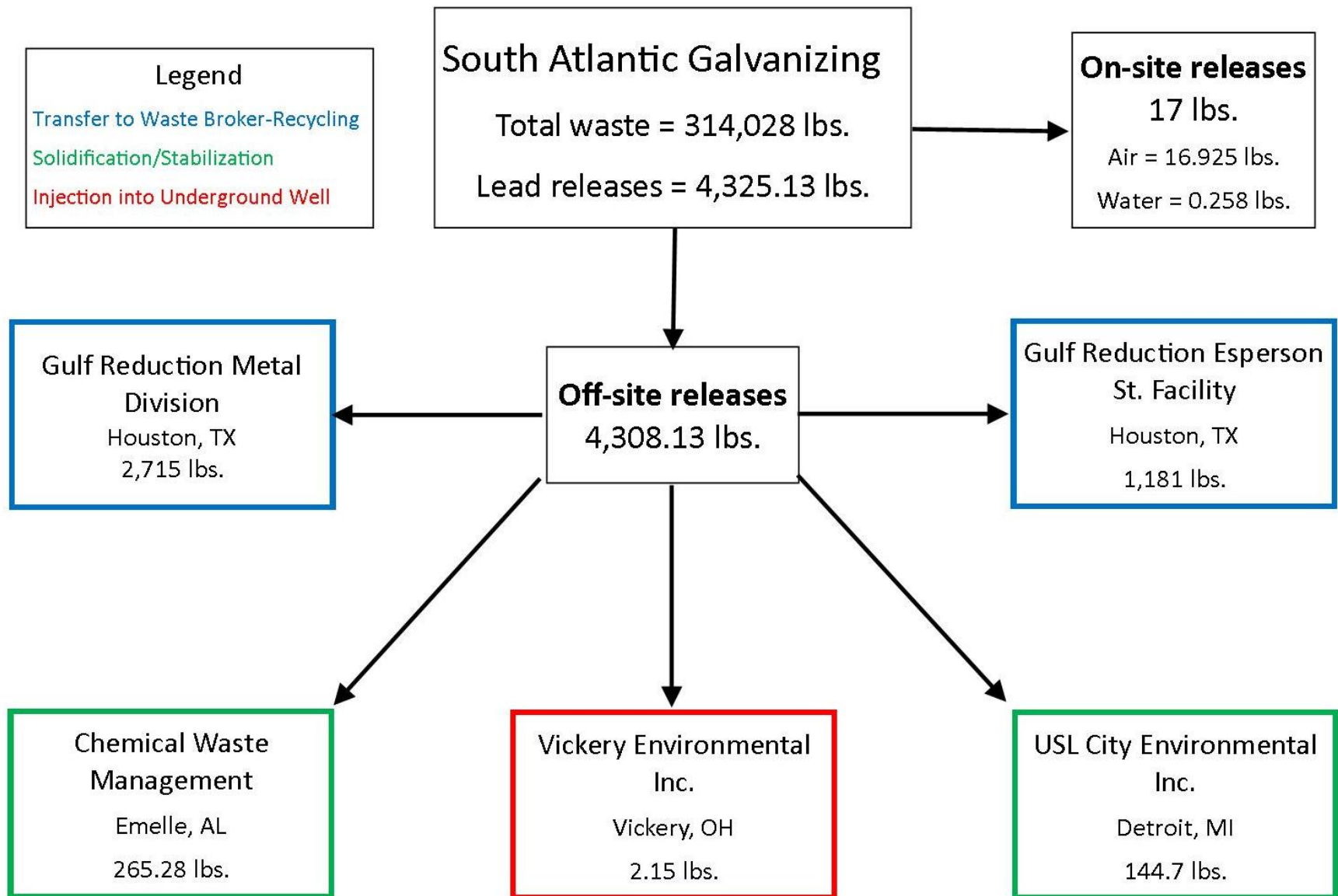
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- ▶ South Atlantic's off-site transfers included three different options for waste processing/storage.
- ▶ Waste sent off site to **waste broker-recycling** facilities is processed and later sold to other groups for reuse.
- ▶ **Solidification/stabilization** facilities treat waste for later disposal in a landfill, often by mixing hazardous material with cement.
- ▶ Hazardous waste can also be sent to an **underground injection well**, which is a well that is dug deep into the ground and designed with the aim of containing a vast mixture of dangerous material.

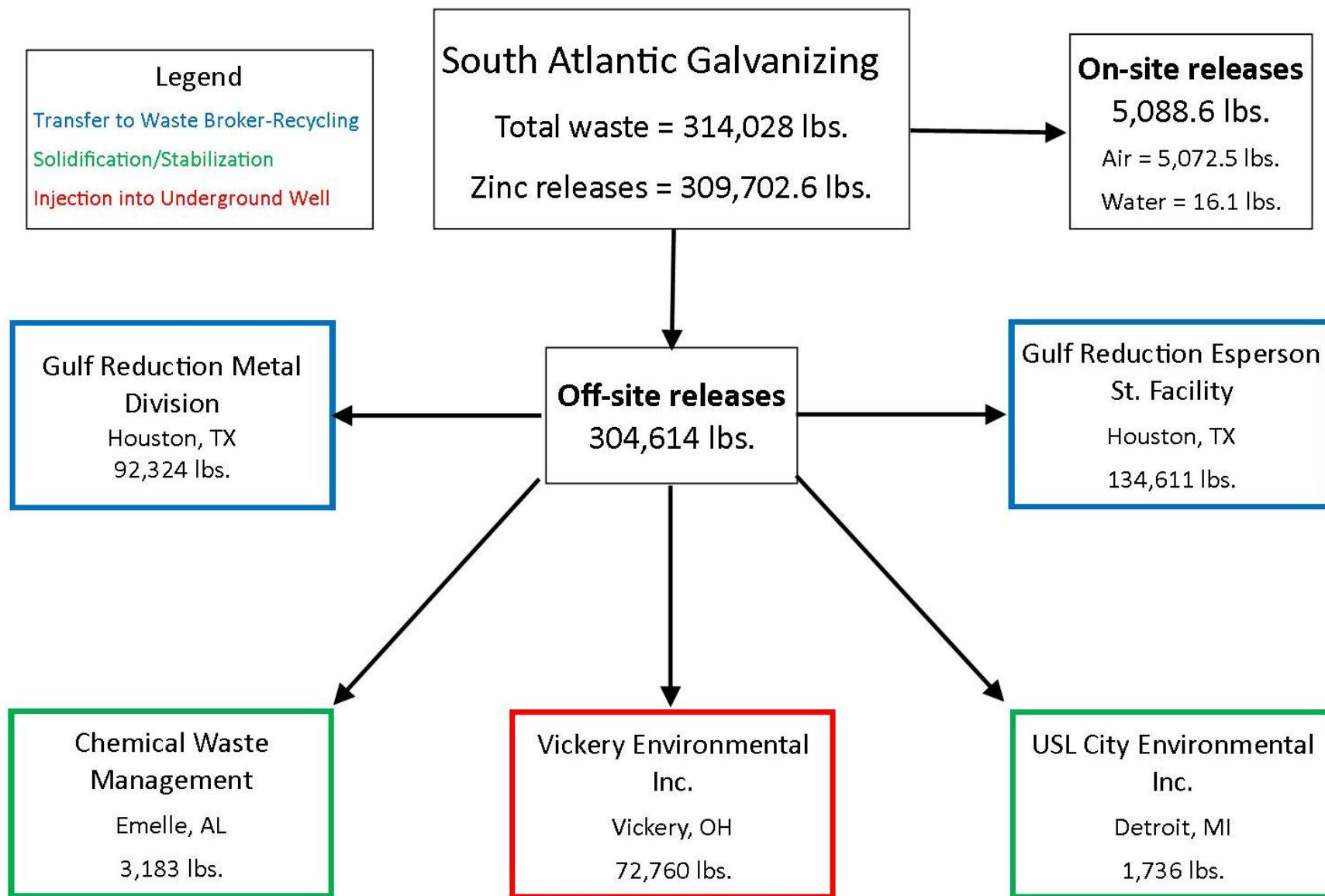




# Tracking the Waste: Lead (TRI 2010)



# Tracking the Waste: Zinc Compounds (TRI 2010)



# South Atlantic's Local Effect

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## Releases to Air



Zinc vapor has been known to cause metal fume fever. Symptoms of metal fume fever include fatigue, chills, muscle pain, fever, cough, and shortness of breath. Although metal fume fever is an occupational disease, Graham residents could feel some of the symptoms associated with it if they inhale too much contaminated air.

## Releases to Water



When released to water, zinc has a natural tendency to adsorb to solid matter rather than remain dissolved in solution. Small organisms living in the dirt alongside the river are especially sensitive to zinc, and decreases in their population could affect the wildlife on higher levels of the food chain.



# South Atlantic's Off-Site Transfers

- ▶ South Atlantic used to send some of their waste to **Environmental Quality (EQ) North Carolina**, an old solidification/stabilization facility in Apex, North Carolina. A chemical explosion caused the facility to burn down in 2006, and the resulting chemical haze was so hazardous that residents had to evacuate to Cary, North Carolina until the air was safe to breathe again.
- ▶ Once 2,700 acres of farmland, **Chemical Waste Management** in Emelle, Alabama is now one of the nation's largest hazardous waste dumps. One third of the people in the town live below the poverty line, and 90% of the people living directly near the dump are African-American.
- ▶ In 2004 and 2005, both the vice president and the plant manager of **US Liquids (USL) City Environmental Inc.** in Detroit, Michigan were sent to prison for conspiracy. The plant was charged with violating the Clean Water act for sending untreated waste into the Detroit River.
- ▶ The **Gulf Reduction Esperson Street** facility in Houston, Texas released 20,798 pounds of zinc into nearby Buffalo Bayou in 1994. Total waste released into the water was over 426,000 pounds.
- ▶ **Vickery Environmental Inc.** in Vickery, Ohio is located in the same county that is home the Clyde cancer cluster. Three dozen children in Sandusky County have been diagnosed with cancer since 1996.



# How South Atlantic Stacks Up

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- ▶ There are 13 galvanization plants located in North Carolina, South Carolina, Tennessee, Georgia, and Virginia. When their 2010 emissions were compared using the TRI, South Atlantic's Graham plant had the highest overall releases.
- ▶ South Atlantic provides no environmental information on their website. Other companies, however, are very open with how they are reducing their emissions to be more sustainable.
- ▶ Valmont Columbia in South Carolina and Galvan in North Carolina both run on a closed-loop process in which rinse bath water is constantly being filtered and reused.
- ▶ Tennessee Galvanizing uses an on-site recycling unit to eliminate the need for off-site waste transport.
- ▶ Wedge's UK plants get 30% of their zinc from recycled sources.
- ▶ These advancements in recycling have been encouraged by the cost of zinc, which is the largest outside cost for every galvanizer. Zinc prices have risen steadily over the past few decades and are likely to continue rising.





# Taking South Atlantic to Court

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- ▶ South Atlantic submitted air emissions information to the state in 2006. This information was marked confidential even though law required that air emissions be open to the public.
- ▶ North Carolina's Environmental Management Commission opened South Atlantic's emissions records to the public in November 2011.
- ▶ In January 2012, South Atlantic requested a judicial review, claiming that these emissions tests revealed "trade secrets."
- ▶ The case occurred in superior court on June 4. BREDL played a vital role in this court case so that South Atlantic's air emissions could remain public.
- ▶ The judge announced his ruling in favor of South Atlantic on July 3. For now, South Atlantic's emissions will remain a secret.



# Why should South Atlantic's emissions be made public?

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- ▶ Although it is the best record we have, the TRI is known not to be completely accurate. Companies usually estimate emissions instead of measuring them. Additionally, there are no penalties for under-reporting, which most companies do.
- ▶ It is against the law for any business to hide what pollution they are releasing into the air.
- ▶ Residents of Graham have a right to know what is in the air that they breathe. Making air emissions public knowledge would encourage South Atlantic to take more responsibility over their environmental impact- both locally and nation-wide.



# Thanks To

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- ▶ Beverly and Julius Kerr
- ▶ Blue Ridge Environmental Defense League
- ▶ Nicholas School of the Environment
- ▶ Fred and Alice Stanback



# **Taking Action Against Hot-Dip Galvanizing Pollution**

Blue Ridge Environmental Defense League

Duke University Stanback Intern, Summer 2012

Kelsey Behrens

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# Taking Action Against Hot-Dip Galvanizing Pollution

## About Galvanizing

Every year, steel corrosion costs the economy around \$2.2 million (1). Corrosion, also known as rust, is a natural process that occurs when steel is exposed to the environment. It can be slowed, however, with a protection technique called galvanizing, which is the coating of steel with a layer of zinc to slow the corrosion process. Zinc is used to protect steel because the zinc layer rusts more easily than steel but also rusts much more slowly than steel. Therefore, the underlying steel remains safe from rust for many years (2).

## Types of Galvanizing

There are two types of galvanizing: continuous and batch. Continuous galvanizing occurs when zinc is applied to a ribbon of steel as it passes through a bath. This steel passes through the bath at very high speeds and is only in the bath for two to four seconds. Once it has been galvanized, the steel is then shaped into the final product. Despite this high galvanization rate, continuous galvanizing is limited in the fact that only very thin, flexible sheets of steel are able to be galvanized in this way. This limitation is due to the fact that the steel needs to remain flexible so that it can be formed and shaped later. Objects that have been galvanized in this manner include items used for roofing sheets, automotive body panels, and culverts (3).

Batch galvanizing, also called after fabrication galvanizing, is different from continuous galvanizing in that the steel is first shaped into its final shape and then immersed in a bath of molten zinc. Although batch galvanizing is not as fast as continuous galvanizing, one advantage is that any shape of metal can be galvanized in this manner (3). Since this is the kind of galvanizing that South Atlantic's Graham plant uses, batch galvanizing will be discussed for the remainder of this paper.

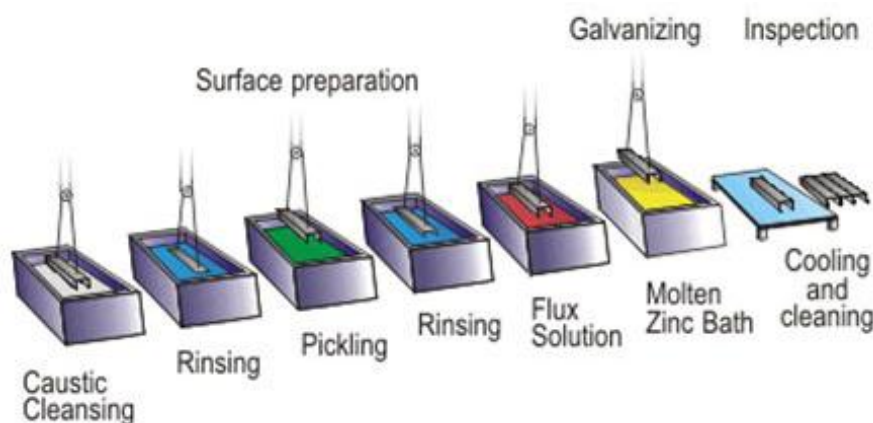
## The Galvanizing Process

Overall, the three steps in the galvanization process are preparation, galvanizing, and post-treatment (see Figure 1). The preparation step consists of immersing the steel in three different cleaning baths prior to galvanization. First, the steel is immersed in a caustic cleaner, which is an acid bath that removes all dirt and grease. After being rinsed in a water bath, the steel is then cleaned with a pickling acid (usually either hydrochloric or sulfuric acid) to remove rust and mill scale. The steel is again rinsed with water. The final step the preparation process is soaking the steel in a flux solution, which cleans the steel of any oxidation that has happened since the pickling step and protects it from further oxidation before it enters the galvanizing bath (4).



The galvanizing bath consists of a minimum of 98% molten zinc heated to a temperature of around 850°F. Once the steel reaches bath temperature, the zinc in the bath chemically reacts with the iron in the steel to form the layers that protect the steel. It usually takes less than ten minutes for the steel to reach bath temperature and to react with the zinc. The steel then undergoes a post-treatment process that varies with the facility. One of the most common post-treatment processes is quenching, which is when the steel is soaked in a quench tank to make a layer that protects steel during transportation. Another post-treatment process includes grinding off the zinc drips, or “icicles,” that form during the galvanization step (4).

Figure 1: Steps of the Galvanization Process



From <http://www.china-anbermachine.com/Wire-Galvanizing-Line/Hot-Dipped-Wire-Galvanizing-Line.htm>

### Sources of Waste

All of the different cleaning and rinse baths used during galvanizing present many opportunities for waste. With use, each cleaner used in the preparation step becomes more dilute and less efficient at cleaning the steel. Once efficiency is compromised, the cleaner is disposed of, usually off-site (5). A significant quantity of zinc waste occurs in the form of top dross and skimmings in the galvanizing tank. Skimmings, which float to the top, consist of iron and aluminum in the form of  $\text{Fe}_2\text{Al}_5$ , while dross, which sinks to the bottom, is made of iron and zinc in the form of  $\text{FeZn}_{10}$ . Accumulation of skimmings and dross interferes with the efficiency of the galvanizing tank, so they must be periodically removed. During the removal of these skimmings, however, a large amount of zinc is also removed. Although 80-95% of this removed zinc is still usable, it is transported off-site as waste (6).

The galvanization tank is also a significant source of air pollution due to the extremely high temperature of the bath. When the item to be galvanized is dipped into the tank, the liquid in the galvanizing bath volatilizes and escapes into the air as smoke. This smoke is primarily ammonium chloride, but it also contains zinc oxide (7).

## **South Atlantic, LLC**

South Atlantic Galvanizing is one of the largest galvanizers in the southeast. With its corporate offices located in Wilmington, North Carolina, South Atlantic has five manufacturing facilities located in North Carolina, South Carolina, Georgia, Tennessee, and Virginia (8). As of 2004, South Atlantic is a wholly owned subsidiary of B.E. Wedge, a galvanizing group located in the United Kingdom (9). South Atlantic's North Carolina plant is located in Graham and has a contentious history with the community since it began operations.

### **Tracking South Atlantic's Waste**

The Toxic Release Inventory (TRI) was used to track the releases of the South Atlantic Graham plant. The TRI is a website that companies report their emissions to so that the public can access this information. Each year, companies report the compounds released, amount released, where they were released, and (if applicable) where off-site waste was transported. For South Atlantic's Graham plant, the most recent year in the TRI database was 2011, and the only two types of releases reported were lead and zinc compounds (10). Information about these releases can be seen below in Figure 2 and Figure 3.

As it is possible to see in the figures below, South Atlantic releases a significant amount of both lead and zinc compounds. Most of South Atlantic's lead releases are processed off-site, while zinc compounds are released both on and off-site. The majority of the on-site releases were emitted into the air, but some also washed into the local water supply as stormwater. South Atlantic sent their waste to four different off-site locations for three different types of waste processing. Waste sent off for waste broker-recycling is recovered and then then sold again to other groups for reuse. Solidification/stabilization facilities condense waste and then physically encapsulate contaminants so that they can be disposed of later. One of the more common ways of doing this is injecting chemicals into cement or a cement mixture (11). An underground injection well is a hollow shaft bored deep underground into porous rock, such as sandstone or limestone. Toxic fluids are injected into these wells for long-term storage. There are six different classes of wells specified to contain a particular type of fluid. Class I wells, the class that South Atlantic's waste is sent to, are designated for hazardous waste storage (12).

Figure 2: Lead Releases from 2011 (in pounds)

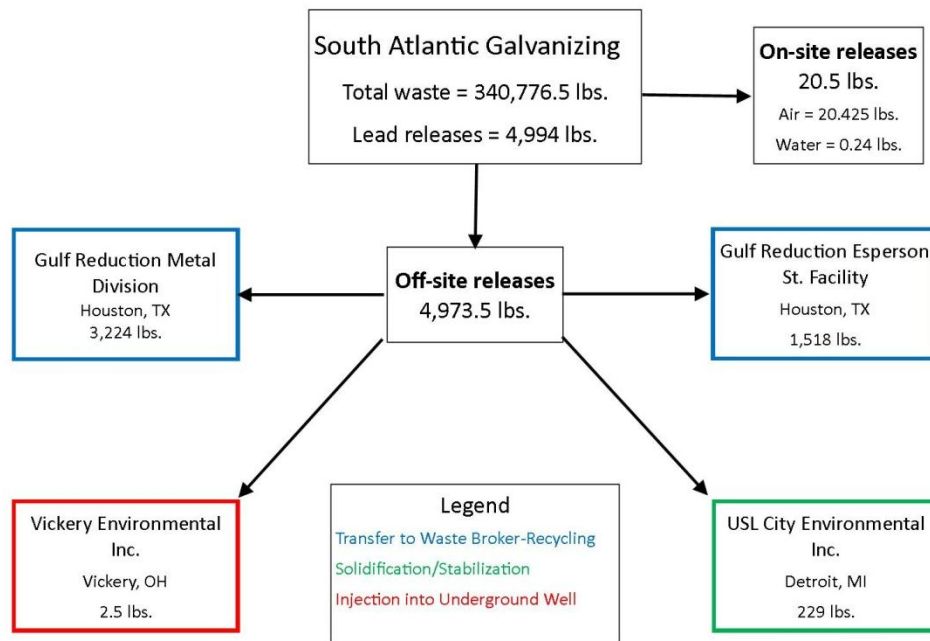
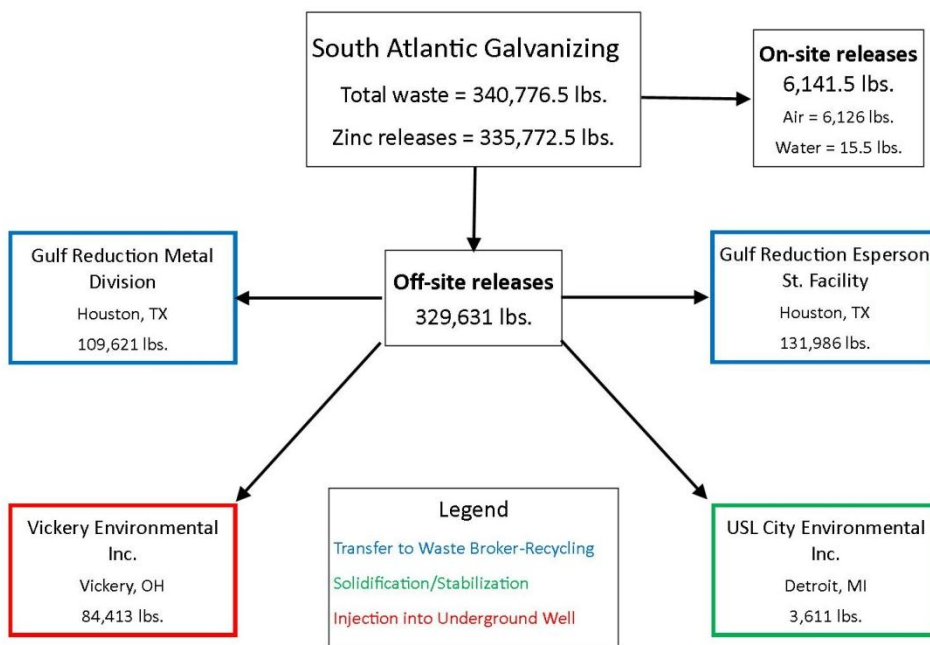


Figure 3: Zinc Compound Releases from 2011 (in pounds)



## South Atlantic's Local Impact

The TRI shows that South Atlantic's largest on-site releases are zinc compounds to the air, and this presents a hazard to residents living around South Atlantic's plant. One of the primary zinc compounds that residents living near South Atlantic are exposed to is zinc oxide, and zinc oxide's main effect on the human body is on the respiratory system. Inhalation of zinc oxide is already known to cause metal fume fever, whose most common symptoms include chest pain, cough, and shortness of breath. Risk of metal fume fever would be the highest in the galvanization workers, as they are the group with the highest exposure (13). Since we do not know the concentration of zinc oxide in the air around South Atlantic's plant, it is hard to predict levels of zinc oxide exposure for people who live near South Atlantic but they could suffer from similar symptoms if emissions were high enough. Similarly, vulnerable populations such as children, the elderly, and people who already suffer from respiratory problems (such as asthmatics) would be much more sensitive to South Atlantic's emissions. South Atlantic's lead releases to the air are much smaller, but elevated blood pressure is still a concern for lead exposure even at small levels (14). As with zinc oxide, lead risk to citizens affected by South Atlantic is still hard to predict because exact exposure levels are unknown.

The stream that runs by South Atlantic's plant could also be affected by the facility's lead and zinc releases. Due to its chemical nature, zinc released into the water is more likely to sink to the bottom and bind to the soil (15). Zinc does not accumulate in plants, but it does accumulate in fish and can be toxic to those fish (16). Like zinc, lead has a tendency to accumulate in soil, and ecosystems near sources of lead pollution have been shown to suffer from losses of biodiversity, decreases in growth and reproductive rates, and neurological effects (17).

While the metal concentrations in both the air and the water near South Atlantic are incredibly difficult to predict, Blue Ridge Environmental Defense League (BREDL) has already found metal concentrations in soil near South Atlantic to be higher than the national average (see Table 1). These samples make it clear that metals are already accumulating in the soil and could inflict serious ecological damage.

Table 1: Concentration (in parts per million) of Metals in Various Graham Soil Samples (31)

Pollutant	Sample A	Sample B	Sample C	Sample D	Typical us Level in Soil
Cadmium	1.0	2.3	8.6	8.0	0.06
Chromium	30.4	43.3	86.6	40.6	40
Lead	13.8	23.7	23.2	14.5	10
Zinc	84.9	181.0	30.1	258.0	50

## **South Atlantic's Off-Site Releases**

Although South Atlantic now sends all of their waste to be handled out of state, reports to the TRI show that they used to send waste to Environmental Quality (EQ) North Carolina in Apex, North Carolina for solidification/stabilization. In October of 2006, a series of explosions caused the plant to catch on fire and burn to the ground. The resulting smoke was so dangerous to public health that 17,000 residents had to be evacuated to nearby towns (18). US Liquids (USL) City Environmental Inc., the facility that South Atlantic currently sends their waste to for solidification/stabilization, has an equally poor track record with their community. In 2004, both the vice-president and plant manager of USL plead guilty to conspiracy and violations of the Clean Water Act and the Resource Conservation and Recovery Act. The pair was responsible for the illegal disposal of hundreds of thousands of gallons of hazardous waste (19). In 2002, the same company was also charged with releasing untreated hazardous waste into the Detroit River (20).

Another business contact of South Atlantic's, Vickery Environmental Inc., is located in the same area as a known childhood cancer cluster. Since 1996, there have been about three dozen cancer cases in this twelve mile wide circle known as the Clyde Cancer Cluster (21). The Environmental Protection Agency (EPA) is currently testing fourteen dump sites for contamination that could be causing the cluster, but Vickery Environmental is not among these locations being tested (22). Although South Atlantic is not directly responsible for any of the actions of these other companies, they are still contributing to this out-of-state pollution by continuing to send their waste to these companies.

## **How South Atlantic Compares to Other Galvanizers**

Based on reported emissions to the TRI, South Atlantic in Graham had the highest air emissions for the year 2011 (see Table 2). Given the fact that South Atlantic also had the highest number of off-site transfers, it makes sense to conclude that South Atlantic had the greatest local and long-range impact of any galvanizer in the southeast.

While South Atlantic has no information on their website about how they are trying to reduce their environmental impact, other companies are very open with the technologies they are using to lower their emissions. Valmont in Columbia, South Carolina and Galvan, North Carolina's other galvanizer, both run on a closed-loop process (23,24). In a closed loop process, water constantly flows through the rinse bath, which is continuously filtered. This reduces carry over from one bath to another, which in turn reduces the formation of solids in the galvanizing kettle (25). Tennessee Galvanizing invested \$750,000 to reduce their hazardous waste generation by constructing an on-site sulfuric acid recycling unit. With this system, they are able to sell recycled sulfuric acid as ferrous sulfate for use as livestock feed and fertilizer. Their waste minimization efforts won Tennessee Galvanizing an environmental award from the state of Tennessee (26). In the UK, Wedge has a system that reuses the "waste" heat that comes off of the furnaces. They also have a rainwater harvesting system at nine of their plants that collects, filters, and uses rainwater in the galvanizing process (27).



Waste reduction practices are largely driven by the rising cost of zinc. Zinc is the largest outside cost that galvanizers must deal with. Before 2000, the price of zinc was between 50 and 60 cents per pound, but as other metals increased in price during the 21st century, so did zinc. Prices of zinc peaked at two dollars per pound, and now they are just over a dollar a pound. While these waste minimization and recycling efforts are used to cut a company's outside zinc cost, they also reduce waste generated from the facility (28). Therefore, galvanizers can reduce their environmental impact with the same technologies that they use to cut costs.

Table 2: 2011 Releases (In Pounds) Of All Other Galvanizers in the Southeast

State	Plant	Environmental Releases				Waste Management: Recycling	
		Releases to Air	Releases to Water	Off Site Transfers	Total Releases	On- Site	Off-Site
North Carolina	South Atlantic	6,146	16	88,256	94,418	0	246,349
North Carolina	Galvan	5,723	-	-	-	17,681	673,649
South Carolina	South Atlantic	2,983	55	29,639	32,677	0	95,485
South Carolina	Valmont	840	120	29,000	29,960	0	105,000
South Carolina	Trinity Highway Products	1,777	8	62,845	64,630	0	766,431
Virginia	South Atlantic	4,138	69	54,923	59,130	0	164,269
Virginia	AZZ	900	86	45,505	46,491		
Virginia	Valmont	680	0	33,000	33,680	0	38,000
Georgia	South Atlantic	3,763	0	45,836	49,599	0	212,958
Tennessee	South Atlantic	5,125	45	64,677	69,847	0	190,925
Tennessee	Tennessee Galvanizing	5,401	-	-	5,401	0	589,528
Georgia	Metalplate	-	-	-	-	-	-
Tennessee	AZZ	-	-	-	-	-	-
Tennessee	Sure Built	-	-	-	-	-	-

## Recent Court Appearance

Although South Atlantic is not yet required to have an air permit, they submitted emissions tests results to the North Carolina Department of Environment and Natural Resources' (DENR) Division of Air Quality in 2006. This information was marked confidential when it was submitted, but the NC DENR appealed this decision in November of 2011 and made the emissions information open to the public. South Atlantic requested a judicial review the following January. On June 4, South Atlantic went to court against both the state and against BREDL. Both the state attorney general and the attorney for BREDL agreed that state law required that these documents be public information. Therefore, these documents never should have been marked confidential when they were first submitted. South Atlantic's attorneys, however, claimed that these documents contained "trade secrets" that must not be revealed amidst the competitive galvanizing industry (29). On July 3, however, the judge ruled to keep South Atlantic's emissions confidential.

Although the TRI gives us information regarding South Atlantic's emissions, it is important to note that information reported to the TRI has not always been correct in the past. A study conducted by the Environmental Integrity Project in 2004 found that many industries drastically underreport their air emissions to the TRI. They also note that their findings were consistent with the US General Accounting Office and the EPA's Office of Inspector General. Underreporting occurs because most facilities do not actually measure their emissions and instead give estimations to the TRI. They do this because it is less costly to estimate, and currently there are no negative consequences to underreporting (30).

## Conclusion

The TRI shows us that South Atlantic's waste releases affect multiple communities, both in North Carolina and in other states. However, it is crucial that South Atlantic's emissions records be made public in order to know the real exposures of those living near South Atlantic and the risks that the plant's waste poses to their health. With the accurate information provided by these emissions records, those affected by South Atlantic's pollution would be fully equipped with the knowledge they need to push South Atlantic towards more sustainable business practices. Many other galvanizing facilities have accepted their environmental responsibility and have implemented more sustainable business practices. These facilities show us that it is possible for South Atlantic to reduce their environmental impact, but they will never feel the need to if they are allowed to keep everything as it is now and hide the truth from the public.

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