# MEA Clean Fuels Technical Assistance Program:

# City of Baltimore Biodiesel Feasibility Report

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Submitted to:

Maryland Energy Administration

*and the*

City of Baltimore

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ICF

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# I. Executive Summary

The Maryland Energy Administration (MEA) Clean Fuels Technical Assistance (CFTA) Program has provided this fleet advisory service for the City of Baltimore (City), through a partnership with ICF. ICF analyzed Baltimore's on-road vehicle fleet, reviewing 996 medium- and heavy-duty diesel vehicles to evaluate a transition from fueling fleet vehicles with diesel to a biodiesel blend of 20% (B20) year-round. Biodiesel is a drop-in fuel, allowing short-term gains in greenhouse gas (GHG) emissions reductions and fuel cost savings. The conversion to B20 can take place as soon as the City secures a B20 fuel contract; no vehicle replacements or conversions needed.

**Based on our analysis, converting 996 diesel vehicles to operate on B20 is estimated to produce the following short-term benefits[1]:**

**$340,000** fuel cost savings annually

**3,411** metric tons of GHG eliminated annually

**400,000** gallons of diesel displaced annually

Emissions savings equivalent to **5,640** trees planted in a year

Equivalent to emissions from **975,117** round trips across the Bay Bridge

[1] U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

# II. Introduction

## Program Description

The State Fiscal Year 2021 (FY21) CFTA Program is a new pilot, test-of-concept program which aims to provide eligible local government and municipal fleets with technical assistance as they consider alternative transportation fuel options. This program is complementary to MEA's FY21 Clean Fuels Incentive Program. Through CFTA, a technical assistance contractor (ICF) employed by MEA was tasked to work directly with eligible fleets, selected via an application process, for the purpose of developing potential alternative fuel fleet strategies. Possible alternative fuels for evaluation include electric, ethanol, hydrogen, natural gas, propane, and other biofuels, with the selected local government or municipal fleet choosing their preferred technical for evaluation, after discussions with ICF.

## Biodiesel Overview

Biodiesel offers a variety of benefits for fleets and is one of the most accessible to obtain and implement. Benefits include:

- **GHG Emissions:** Replacing diesel with biodiesel can offer significant reductions in GHG emissions. B100 can reduce GHG emissions by up to 74% compared to diesel while B20 can reduce total GHG emissions by approximately 15%.[2,3]
- **Air Quality:** Using biodiesel can reduce hydrocarbon, carbon monoxide, and particular matter emissions. The total emissions reductions achieved depends on the blend of biodiesel used, feedstock, and any additives included in the blend.
- **Safety:** Biodiesel can benefit human health because of the reduction in particulate matter emissions that it offers. Biodiesel blends also have a higher flashpoint than their diesel alternative, making the fuel safer to handle, store, and transport.[4]
- **Compatibility:** Low-level biodiesel blends (e.g., B20) is fully compatible with diesel vehicles and infrastructure, making it one of the easiest short-term solutions to emissions reductions.
- **Performance:** Biodiesel blends of B20 or lower should not negatively impact engine performance. Higher biodiesel blends can impact engine performance, particularly in colder temperatures.

[2] Alternative Fuels Data Center. Biodiesel Vehicle Emissions. Retrieved from: https://afdc.energy.gov/vehicles/diesels_emissions.html
[3] U.S. Department of Energy. Biodiesel Basics. 2011. Retrieved from: https://www.nrel.gov/docs/fy11osti/47504.pdf
[4] Alternative Fuels Data Center. Biodiesel Benefits and Considerations. Retrieved from: https://afdc.energy.gov/fuels/biodiesel_benefits.html

# III. Overview of Motivations and Priorities

The City of Baltimore's Department of General Services (DGS) is developing a plan to reduce the City fleet's carbon footprint and petroleum use. This plan focuses on electrification but relies on transitioning medium- and heavy-duty diesel-powered vehicles to B20 for short-term emissions reductions.

The City has the following goals and objectives:

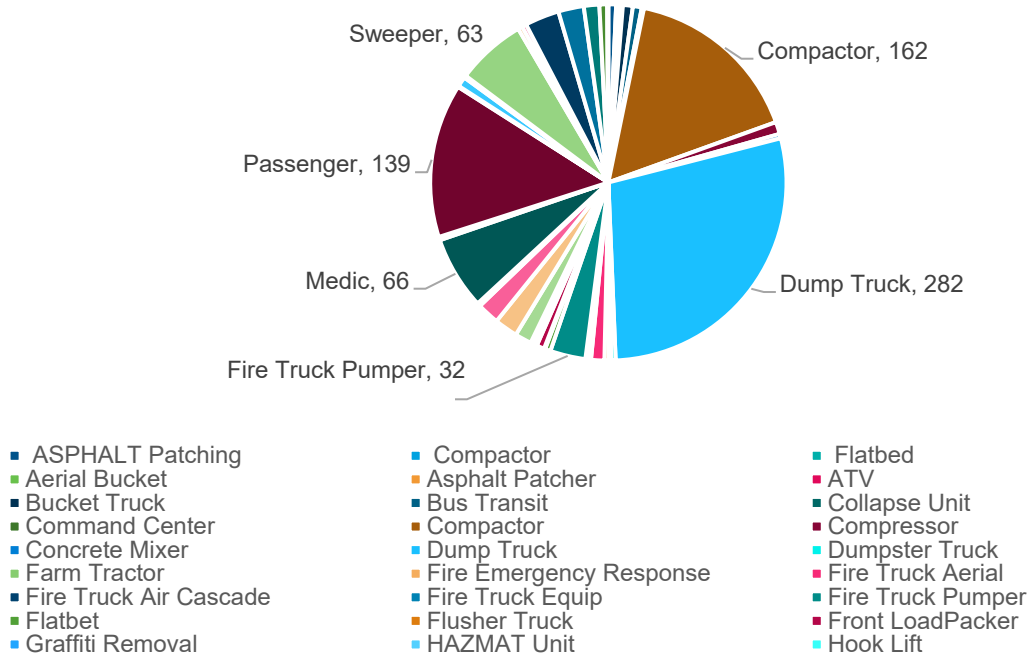
1. Determine if a switch to B20 year-round is viable for the City's fleet
2. Determine the barriers and opportunities associated with transitioning from diesel to B20
3. Provide proof of concept for the City to bring to leadership

The City's 2010 Sustainability Plan aimed to reduce petroleum use by 20% by 2017. In 2013, the City set a new goal of reducing GHG emissions by 15% by 2020 in their Climate Action Plan. However, the City increased petroleum consumption since setting these goals, and DGS is exploring a new goal of replacing 20% of fleet vehicles with alternative fuel vehicles (AFVs) beginning in the City's FY22. While the City is primarily relying on transitioning from diesel to B20 to achieve rapid, short-term reductions in GHG emissions and petroleum consumption, in the long-term the City plans to also consider electrification options as electric vehicles and infrastructure become increasingly cost competitive.

# IV. Current Fleet Inventory

The City owns and operates approximately 5,600 on- and off-road vehicles, 996 of which are on-road diesel-powered vehicles. The City's fleet includes police vehicles, sedans, trash trucks, and more. The bulk of the City's current diesel fleet consists of crew trucks, dump trucks, street sweepers, refuse trucks, aerial bucket trucks, and additional equipment such as portable air compressors. Fleet diesel vehicles consume approximately 2 million gallons of diesel.

Figure 1. Medium- and Heavy-Duty Diesel Vehicle Fleet Composition




The DGS Fleet Maintenance Division operates and maintains 10 battery electric vehicles (BEVs) and 2 plug-in hybrid electric vehicles (PHEVs), including Nissan Leaf, Chevrolet Volt, Hyundai Kona and Ford Escape models. The City is planning to purchase 19 more BEVs in FY2021. The City is also pending an award from the Maryland Department of the Environment to purchase two electric load-packers.

The DGS staff has significant experience operating and maintaining AFVs, including biodiesel-powered vehicles. The Fleet Chief, Christopher Lyons has over 30 years of experience developing and implementing alternative fuel strategies for both municipal and utility operations for companies including Sempra Energy and Exelon Utilities. Additionally, Mr. Lyons oversaw the implementation of Alternative Fuel Transit operations for such Southern California organizations as Los Angeles MTA and Los Angeles DOT.

# V. Fuel Pricing

The City's current fuel pricing structure is based on the OPIS daily average rack price plus an additional charge per gallon based on a pay scale that decrease as delivery size increases.

The October 2020 Alternative Fuel Price Report notes that the average cost of B20 in the Central Atlantic region for fleets is $0.17 per gallon less than diesel fuel. Assuming the City is able to secure a fuel contract that mirrors the fuel cost savings, the City has the opportunity to achieve fuel cost savings of approximately $340,000 annually.

**Recommendation:** As the City begins negotiating fuel contracts, use the average cost savings per gallon of biodiesel as a baseline for negotiations.

# VI. B20 Considerations and Recommendations

## Feedstock Variations

There are several types of feedstocks that are manufactured from plant oils and animal fats, which serve as the base for the creation of biodiesel. Feedstocks include:

- Canola oil
- Safflower oil
- Sunflower oil
- Corn oil
- Olive oil
- Soybean oil
- Peanut oil
- Cottonseed oil
- Yellow grease
- Lard
- Beef tallow
- Palm oil
- Coconut oil

Feedstock characteristics are detailed in Appendix A Figure 2. Each feedstock has unique properties that result in some performance variations across biodiesel blends. Different feedstocks can cause biodiesel to gel at different temperatures, ranging from 0°C to 15°C (32°F to 60°F) or higher. Similarly, feedstock influences biodiesel cetane number, cloud point, and stability. The amount of saturated fatty acids in a feedstock influences the cloud point of the final fuel. Biodiesel made with feedstocks that have higher amounts of saturated fatty acids (e.g., beef tallow, yellow grease, etc.) have higher cloud points.

**Recommendation:** The City should select a biodiesel blend that uses a feedstock with a low amount of saturated fats (e.g., soybean oil) to ensure the fuel has a naturally lower cloud point than blends made from feedstocks with high amounts of saturated fats.

In the Central Atlantic, soybean oil is one of the most common feedstocks used for biodiesel production. While B20 can be purchased and transported from almost any fuel provider, the availability of biodiesel with soybean oil feedstock means the City can source B20 from the Central- and North-Atlantic regions.

## Regional Climate

Biodiesel performance is strongly influenced by regional climate. Baltimore's annual weather conditions are outlined in Table 1. The coldest recorded temperature in Baltimore was -7°F or -22°C.

Table 1. Baltimore Weather Averages[5]

| Season | Daily Average | Average High | Average Low |
|---|---|---|---|
| **Hot Season** | 79°F / 26°C | 89°F / 32°C | 74°F / 23°C |
| **Cold Season** | 52°F / 11°C | 43°F / 6°C | 30°F / -1°C |

## Cloud Point

To ensure biodiesel does not negatively impact engine operability, the City should select a B20 blend with a cloud point—the temperature at which solid crystals form in the fuel—appropriate for the climate. ASTM specifications recommend biodiesel blends that are capable of operating in the 10th percentile minimum ambient temperature of the region the fuel will be used. This temperature range, detailed in Table 2, varies from October to March.

Table 2. 10th Percentile Temperatures for Maryland by Month[6]

| | Oct | Nov | Dec | Jan | Feb | Mar |
|---|---|---|---|---|---|---|
| **10th Percentile Temperature** | 2°C / 35.6°F | -3°C / 26.6 °F | -10°C / 14°F | -12°C / 10.4°F | -10°C / 14°F | -4°C / 24.8°F |

**Recommendations:**

- From October through March, the City should use a biodiesel blend that is operable in the 10th percentile minimum ambient temperature for a given month.
- If possible, the City should consider using fuel that is capable of operating in lower temperatures to account for weather variability.
- The City should confirm the 10th percentile ambient temperatures on an annual basis.
- If the City cannot obtain a B20 blend with at least a cloud point at or below the 10th percentile minimum ambient temperature, the City should switch to a lower biodiesel blend in winter months.

## Petroleum Diesel Fuels

There are two types of petroleum diesel fuels that can act as the base diesel fuel that is blended with B100 to create different variations of B20: No. 1 and No. 2 diesel.

- No. 1 petroleum diesel performs better in winter months because of its lower viscosity and cloud point. The cloud point of No. 1 petroleum diesel is approximately -40°C.

[5] National Weather Service. Baltimore, Maryland Temperatures. March 2021. Retrieved from: https://www.weather.gov/media/lwx/climate/bwitemps.pdf
[6] ASTM Biodiesel B20 Specification D7467.13

- No. 2 petroleum diesel, while typically more affordable and fuel efficient than No. 1, it has higher viscosity and is less suitable for cold weather. The cloud point of No. 2 petroleum diesel is approximately -10°C.

While No. 2 petroleum diesel alone has a cloud point low enough to function at -1°C, adding biodiesel with a higher cloud point will raise the cloud point of the final B20 product. Best practices suggest switching to No. 1 petroleum diesel blends (or "winter blends") when the weather drops to 15°F above cloud point.[7] For example, while a No. 2 petroleum diesel fuel with a cloud point of -3°C (26°F) may be suitable for winter use in Texas, a No. 1 petroleum diesel with a cloud point of -29°C (-20°F) would be better suited for winter use in Minnesota.[8]

**Recommendations:**

- Use No. 1 petroleum diesel in B20 blends during the winter months.
- The City should switch to a winter blend at 45°F or 7°C.
- The City should look for a supplier that offers a B20 blend with No. 1 petroleum diesel in the winter months.
- If available, the City should choose fractionated B20, as it improves operability in cold weather.

## Feedstock and Weather

Different feedstocks have different cloud points, making the feedstock of the B20 an important consideration for Baltimore. Feedstock cloud points are summarized in Table 3 in Appendix A. Soybean and canola oil feedstocks are two of the most common biodiesel feedstocks in the United States.[9] Tallow, yellow grease, and white grease are also popular feedstocks, but are not suitable for winter use in the Central Atlantic due to their high cloud point.[10]

**Recommendation:** To limit the number of additives needed to make biodiesel operable in cold weather and be compatible with Baltimore's climate year-round, the City should choose a B20 blend with soybean or canola oil feedstock, with a cloud point at or below -1°C. Soybean oil has a cloud point of -1°C and canola oil has a cloud point of -3°C. Do not purchase a B20 blend that uses an animal fat-based feedstock.

## Optimal Cold Weather Blends

Baltimore's average winter temperatures are warm enough to not require a 100% No. 1 petroleum diesel base, so the City can look for fuel suppliers that offer No. 1 and No. 2 petroleum base blends in their B20. Blends of No. 1 and No. 2 diesel are frequently used to

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[7] Jessen, R. 2014. Avoid Cold Weather Diesel Problems. Cenex. Retrieved from: https://www.cenex.com/about/cenex-information/cenexperts-blog-page/fuel-efficiency/cold-weather-diesel-problems.
[8] U.S. Department of Energy. 2016. Biodiesel Handling and Use Guide. Retrieved from: https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf
[9] U.S. Energy Information Administration. 2018. Biodiesels produced from certain feedstocks have distinct properties from petroleum diesel. Retrieved from: https://www.eia.gov/todayinenergy/detail.php?id=36052
[10] See Appendix A.

meet customer cold flow specifications.[11] Adjusting the blend of No. 1 diesel in the diesel fuel alone can modify the cloud point of B20 to a level suitable for winter use.[12]

> **Recommendation:** As temperatures drop, the fleet should work with its fuel supplier to ensure enough No. 2 diesel has been replaced with No. 1 diesel for optimal winter operability, keeping the cloud point of the B20 at least 15°F below the current temperature.[13]

Once biodiesel is added to the petroleum diesel base, it will raise the cloud point above the original diesel fuel. The amount biodiesel will raise the cloud point varies based on the cloud point of the diesel fuel and feedstock of the biodiesel. For example, soy biodiesel has a cloud point of 1°C, and No. 1 diesel has a cloud point of -40°C, resulting in a B20 blend with a cloud point of -31.8°C.[14]

> **Recommendation:** Work with fuel supplier to ensure the biodiesel will not accidentally raise the cloud point above the 10$^{th}$ percentile minimum ambient temperature of Baltimore.

An accurate estimate of how B20 will perform in the winter months requires mixing the biodiesel with the winter diesel typically delivered in the fleet's region and testing the mixture.[15] Figures 3, 4, and 5 in Appendix B details different cloud points based on biodiesel blends.

> **Recommendation:** Ask fuel suppliers to provide results of their fuel performance in winter months that they deliver to Central Atlantic fleets to ensure it is compatible with Baltimore's climate.

If there are no fuel suppliers that offer a No. 1 and No. 2 base diesel blend that produces suitable cold weather operability for Baltimore, the City can search for a supplier that adds a cold flow to protect diesel against cold-weather gelling and filter plugging.[16] To accommodate biodiesel in cold climates, low-cloud point petroleum diesel or low-temperature flow additives, or both, are necessary.

> **Recommendations:**
>
> - Work with fuel supplier to determine the different pricing options for each cold weather blend of B20.

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[11] U.S. Department of Energy. 2008. Biodiesel Handling and Use Guide. Retrieved from: https://www.canr.msu.edu/uploads/files/Fuels/Handling%20and%20Use%20Guidelines.pdf
[12] *Ibid.*
[13] *Ibid.*
[14] National Cooperative Extension. 2019. Biodiesel Cloud Point and Cold Weather Issues. Farm Energy. Retrieved from: https://farm-energy.extension.org/biodiesel-cloud-point-and-cold-weather-issues/#:~:text=1%20diesel%20has%20a%20cloud%20point%20of%20%2D40%C2%B0C.&text=1%20diesel%20would%20therefore%20have,%3D%20%2D31.8%C2%B0C).
[15] U.S. Department of Energy. 2008. Biodiesel Handling and Use Guide. Retrieved from: https://www.canr.msu.edu/uploads/files/Fuels/Handling%20and%20Use%20Guidelines.pdf
[16] Jessen, R. Diesel Gelling and How to Stop it This Winter. Cenex. Retrieved from: https://www.cenex.com/about/cenex-information/cenexperts-blog-page/agriculture-and-farming/diesel-gelling-and-how-to-stop-it-this-winter

- While an additive may not be required to allow B20 to be operable year-round in Baltimore, it might be the more financially viable option. Work with the fuel provider to determine cost differential.

If No. 1 diesel and additives are not available or affordable, another option for winter operability is to reduce the percentage of biodiesel in the blend: from B20 to B10 or B5 in winter months. Generally speaking, with the same biodiesel and diesel fuel, a B10 will have better cold weather operability properties than a B20.

**Recommendation:** If the City cannot obtain a B20 blend that is suitable for Baltimore's winter weather or the options are not financially feasible, the City can still run biodiesel blends in the winter months but should reduce the blend to B10 or B5.

It is important to consider the cost trade-offs of using less expensive biodiesel that might be higher in saturates but require extra No. 1 diesel or additives for low-temperature operability in colder weather, versus more unsaturated biodiesel and No. 2 diesel. A biodiesel supplier may be willing to switch from more highly saturated feedstocks in the summer to a more unsaturated feedstock in the winter. Most commonly, B20 users require their fuel supplier to ensure adequate low-temperature operability through contractual language.

A purchase contract could specify that a fuel must remain crystal free at temperatures as low as -26°C (-14°F) (cloud point lower than -26°C) for December, January, and February. Then the blender will work independently with the biodiesel and diesel suppliers and the additive firms to address these issues.

**Recommendations:** When selecting a B20 blend, the City should:

- Know the cold weather specifications for the base diesel fuel in the B20 blends it is considering;
- Confirm that fuel suppliers can provide cold weather specifications at all times; and,
- Ask fuel suppliers to verify the cloud point of samples of their B20 with additives to determine effectiveness.

Similarly, to ensure optimal cold weather vehicle performance, the City should:

- Use fuel tank, filter, and line heaters to improve cold weather operability;
- Park vehicles indoors when they are not in use; and,
- Prepare to meet cold weather performance ahead of time.

## Additives

Fuel additives can improve and support the suitability of biodiesel for long-term storage and cold weather. To ensure B20 is viable for winter use, the City should winterize their B20 and consider the use of a cold flow improver additive. Cold flow improvers lower the cloud point of the biodiesel blend to prevent filter plugging by preventing the growth of wax crystals in the fuel.[17] It

[17] National Biodiesel Board & Advanced Fuel Solutions. 2007. Biodiesel Fuel Management Best Practices for Transit. Retrieved from: https://rosap.ntl.bts.gov/view/dot/16246/dot_16246_DS1.pdf

is important to note that the National Biodiesel Board does not endorse the performance of any fuel additives, but additives are generally more affordable than No. 1 diesel.[18]

A few types of cold flow improvers are available, including ethylene vinyl acetate, polyalpha olefin, polyalkyl methacrylate, and others. The most popular is ethylene vinyl acetate, accounting for 40% of the market in 2017.[19] If the City chooses to rely solely on cold flow improvers for winter fleet operation, it is important to note that if, for some reason, the additive is absent in the fuel or fails to function, vehicles will shut down.

Additives need to be blended with the biodiesel well before the ambient temperature drops otherwise there might be fuel without additives still in the tank, increasing the chance that the additive will be diluted to a point it is no longer effective.

**Recommendations:**

- Make sure all vehicles that are running on B20 are fueled with the proper cold weather blends before the temperature drops. The City needs to monitor the amount of B20 that is not suitable for winter use that is in vehicle fuel tanks as the weather gets colder and during cold spells.
- The City should not rely solely on additives to ensure cold weather performance. Instead, the City should look for a B20 blend that has both No. 1 diesel and an ethylene vinyl cold flow improver.
- If the City chooses a fuel supplier that will add cold flow improvers to B20, the City should discuss the timeline for transition to winter B20 blends.

List of additives can be found on the U.S. Environmental Protection Agency's website.

## Performance

B20 typically performs equivalently to diesel. However, issues with performance can arise if the biodiesel blend is not appropriate for cold weather. NBB does not endorse the performance capabilities of any additives, but industry literature indicates there are no serious performance issues associated with any cold flow improvers.

A common concern with transitioning to biodiesel and vehicle performance, is if using biodiesel blends will void the vehicle warranty. Many original equipment manufacturers (OEMs) have stated that using biodiesel blends up to B20 will not void their warranty.[20] Some OEMs specify that the biodiesel blends must meet ASTM D-6751 specifications to not void their warranty.

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[18] Illinois Soybean Association. 2018. Biodiesel Specialist Shares Five Steps to Better Cold Weather Fuel Performance. Retrieved from: https://www.ilsoy.org/press-release/biodiesel-specialist-shares-five-steps-better-cold-weather-fuel-performance

[19] Cold Flow Improvers Market by Type (Ethylene Vinyl Acetate, Polyalpha Olefin, Polyalkyl Methacrylate), Application (Diesel Fuel, Lubricating Oil, Aviation Fuel), End-Use Industry (Automotive, Aerospace & Defense) and Region - Global Forecast 2023. 2019. Retrieved from: https://www.globenewswire.com/news-release/2019/04/10/1802081/0/en/Cold-Flow-Improvers-Ethylene-Vinyl-Acetate-Polyalpha-Olefin-Polyalkyl-Methacrylate-Market-Global-Forecast-2023.html

[20] Statements made by OEMs are available at: https://www.nbb.org/

**Recommendation:** The City should review whether the use of B20 in their fleet vehicles will void the OEM's warranty.

## Emissions

Biodiesel emissions is dependent on feedstock, meaning the emissions of a B20 blend can change based on what the biodiesel component of the fuel is made of. However, while there are variations across biodiesel blends, fleets can expect to see emissions benefits across the board. The following emissions estimates are provided by the U.S. Department of Energy Biodiesel Handling Use Guide and based on national averages.[21]

- **Carbon dioxide:** Biodiesel produces up to 78% less carbon dioxide than traditional petroleum diesel[22]
- **Hydrocarbons:** Emissions decrease by approximately 20% for B20 blends
- **Carbon monoxide:** Emissions decrease by approximately 15% for B20 blends
- **Particulate matter:** Emissions decrease by approximately 15% for B20 blends
- **NOx:** Emissions tend to increase with biodiesel, especially in biodiesel produced by feedstocks containing larger amounts of unsaturated fatty acids (e.g., soybean oil, canola oil, etc.)[23]

By transitioning diesel vehicles to B20, the City has the opportunity to reduce emissions by the following amounts, and equivalencies:

- **Carbon dioxide:** 7,520,816 pounds (lbs.), or 3,411 metric tons, per year, reducing the fleet's carbon dioxide emissions by 15.3%[24]
- **Hydrocarbons:** 3,356.24 lbs. per year, reducing the fleet's emissions by 20.1%
- **Carbon monoxide:** 28,433 lbs. per year, reducing the fleet's emissions by 12.3%
- **Particulate matter:** 2,561.1 lbs. per year, reducing the fleet's emissions by 12%

***5,640*** *trees planted in a year*

***975,117*** *round trips across the Bay Bridge*

[21] The most common feedstocks used in the United States are soybean and canola oil. Because this report recommends soybean oil as a potential feedstock for the City's biodiesel fuel, these estimates provide a useful baseline for potential emissions reductions.
[22] U.S. Department of Energy. 2005. Biodiesel—Clean, Green Diesel Fuel. Retrieved from: https://afdc.energy.gov/files/pdfs/30882.pdf
[23] ICCT. 2012. Biodiesel carbon intensity, sustainability and effects on vehicles and emissions. Retrieved from: https://theicct.org/sites/default/files/publications/ICCT_biodiesel%20briefing_Jan12.
[24] Biodiesel provides a lifecycle reduction in greenhouse gas emissions of 76.4% relative to average 2005 petroleum diesel fuel. average reduction of emissions comparing USEPA approved diesel fuel with biodiesel. The results are compiled from engine testing on diesel engines without diesel particulate filters equipped engines. Results may vary by engine type and model years. Calculations based on the fleet's annual diesel consumption of 2,000,000 gallons as noted in their gasoline and diesel fuel procurement contract scope of work.

See Figures 6 and 7 and Table 4 in Appendix C for emissions reductions estimates based on biodiesel blends. Transitioning to B20 will help limit county employee and community member exposure to GHG emissions and hazardous tailpipe pollutants.

## Infrastructure Evaluation

Biodiesel blends up to B20 have few compatibility issues with diesel infrastructure. A list of compatible infrastructure is available in Appendix D. The Alternative Fuel Data Center (AFDC) Station Locator lists five biodiesel stations, two of which are located in Baltimore.

> **Recommendations:** The City crosschecked existing tank compatibility with Appendix D. The City was only able to confirm 3 of their tank locations[25] that are compatible with biodiesel. The rest of the tanks did not have manufacturer information available.
>
> Before storing biodiesel in the unconfirmed tanks, the City should take every effort to confirm compatibility. If the City cannot confirm any additional storage tanks are compatible with biodiesel, the City should only rely on the tanks that are confirmed as compatible. Biodiesel stored in tanks that may be incompatible with the fuel poses risks related to corrosion, leaking, fuel spills, equipment damage (e.g., clog filters, damage fuel pumps, etc.), erosion, and fuel degradation.[26]

Improper or lengthy storage of B20 can result in oxidation and the formation of corrosive materials, and the B20 may degrade faster than regular diesel if infrastructure has oxidizing metals found in lead solders, zinc linings, copper pipes, and brass and copper fittings. If possible, ensure that infrastructure materials are made of stainless steel, carbon steel, or aluminum.[27]

## Maintenance and Mechanic Training

Biodiesel is a drop-in fuel and does not require changing any vehicle parts for fleet use. However, the City should take a few steps to prepare their mechanics.

> **Recommendations:**
>
> - Hold mandatory general biodiesel training for all mechanics with special training on complications associated with biodiesel in winter months. The training should cover fuel filters, nozzle coking, and fuel stability.
> - If the fleet is finding that filters clog more frequently with B20 than they do with petroleum diesel, the fueling system should be checked for these materials and they should be replaced with biodiesel-compatible parts.
>
> Training and educational resources include:
>
> - National Biodiesel Board's Biodiesel Training Toolkit

[25] Northwest, Central, and Education Yard
[26] U.S. Department of Energy. 2008. Biodiesel Handling and Use Guide. Retrieved from: https://www.canr.msu.edu/uploads/files/Fuels/Handling%20and%20Use%20Guidelines.pdf
[27] *Ibid.*

- ASTM International's Biodiesel eLearning Bundle
- Advanced Biofuels USA's Online Courses resource
- U.S. Department of Energy National Renewable Energy Lab's Biodiesel Handling and Use Guide
- U.S. Department of Energy's Office of Science and Technical Information's biodiesel resources
- West Virginia University's National Alternative Fuels Training Consortium

## Fuel Suppliers

A list of fuel suppliers is available in Appendix E.

**Recommendation:** As the City secures a purchase contract with a fuel supplier, they should:

- Include a cloud point requirement in the purchase contract. The requirement should be that the cloud point during winter months is no higher than the 10$^{th}$ percentile of the minimum ambient air temperature of Baltimore.
- If the City is not intending to monitor cold flow properties at all, include contractual requirements to have their distributors make sure low-temperature operability is manageable for their location.

# VII. Case Studies

**New York City –** New York City began using B20 year-round in 2017 and slowly expanded use to 11,000 fleet vehicles. The New York City Department of Citywide Administrative Services noted that the fleet has experienced virtually no fuel-related problems and consider the fuel transition successful. Some lessons learned include:

- Discuss fuel options with the fuel supplier to guarantee the biodiesel fuel is blended after both diesel and biodiesel components meet ASTM specifications;
- Develop a fuel management plan that includes cold flow improvers;
- Test biodiesel fuel frequently in winter months;
- Have fuel handling and storage plans in place before adopting the fuel; and,
- Maintain tank cleanliness and maintenance year-round.

**City of Seattle** – Seattle's Green Action Fleet Plan has a goal of reducing carbon emissions by more than 40 percent by 2020, and biodiesel is helping. Seattle now uses nearly 200,000 gallons of biodiesel per year in a 20 percent blend.

**Jackson Hole Mountain Resort, Wyoming** – Uses biodiesel blends power its fleet of snow cats and plows even when temperatures plunge to 30 below.

**G&D Integrated** – Carbon dioxide emissions by the equivalent of 230,000 gallons of gasoline annually and more than 2,800 pounds of particulate matter. No drop in fleet performance compared with petroleum diesel. Uses up to a B20 blend in cold weather.

**Metropolitan Sewerage District, Ashville, NC** – MSD transitioned their diesel vehicles to B20 but experienced some gelling problems during the winter months. To solve this problem, they partnered with a fuel provider that produces biodiesel to ASTM standards and meets the voluntary industry wide quality assurance requirements of BQ-9000 certification. MSD also conducted regular fuel quality and performance assessments to ensure optimal fleet operation.

# VIII. Conclusion

The City of Baltimore has the opportunity transition fleet vehicles from diesel to B20 year-round. To successfully transition, the City should follow these recommendations:

**Fuel Contracts and Prices:**

- Use the average cost savings per gallon of biodiesel compared to diesel ($0.17 per gallon) as a baseline for price comparison.
- While an additive may not be required to allow B20 to be operable year-round in Baltimore, it might be the more financially viable option. Work with the fuel provider to determine cost differential.
- Include a cloud point requirement in the purchase contract. The requirement should be that the cloud point during winter months is no higher than the 10$^{th}$ percentile of the minimum ambient air temperature of Baltimore.
- Include contractual requirements to have the fuel supplier make sure low-temperature operability is manageable for their location.
- Discuss the timeline for transition to winter B20 blends with the fuel supplier.
- Ask fuel suppliers to provide results of their fuel performance in winter months that they deliver to Central Atlantic fleets to ensure it is compatible with Baltimore's climate.

**Fuel Composition:**

- The City should select a biodiesel blend that uses a feedstock with a low amount of saturated fats. This means a B20 blend with a feedstock of soybean or canola oil. Do not purchase a B20 blend that uses an animal fat-based feedstock.
- Use No. 1 petroleum diesel in B20 blends and, if available, a fractionated B20 blend during the winter months
- As temperatures drop, the fleet should work with its fuel supplier to ensure enough No. 2 diesel has been replaced with No. 1 diesel for optimal winter operability, keeping the cloud point of the B20 at least 15°F below the current temperature.
- The City should not rely solely on additives to ensure cold weather performance. Instead, the City should look for a B20 blend that has both No. 1 diesel and an ethylene vinyl cold flow improver.

**Cold Weather Considerations:**

- From October through March, the City should use a biodiesel fuel that is operable in the 10$^{th}$ percentile minimum ambient temperature for a given month, switching to a winter blend at 45°F or 7°C.
- Confirm the 10$^{th}$ percentile ambient temperatures on an annual basis.

- Work with fuel supplier to ensure the biodiesel will not accidentally raise the cloud point above the 10th percentile minimum ambient temperature of Baltimore.
- If the City cannot obtain a B20 blend that is suitable for Baltimore's winter weather or the options are not financially feasible, the City can still run biodiesel blends in the winter months but should reduce the blend to B10 or B5.
- Use fuel tank, filter, and line heaters to improve cold weather operability.
- Park vehicles indoors when vehicles are not in use.
- Make sure all vehicles that are running on B20 are fueled with the proper cold weather blends before the temperature drops. The City needs to monitor the amount of B20 that is not suitable for winter use that is in vehicle fuel tanks as the weather gets colder and during cold spells.

**Additive Considerations:**

- Know the cold weather specifications for the base diesel fuel in the B20 blends the fleet is considering and if additives will be necessary for winter months.
- Ask fuel suppliers to verify the cloud point of samples of their B20 with additives to determine effectiveness.

**Infrastructure and Maintenance Considerations:**

- Hold mandatory general biodiesel training for all mechanics with special training on complications associated with biodiesel in winter months. The training should cover fuel filters, nozzle coking, and fuel stability.
- If the fleet is finding that filters clog more frequently with B20 than they do with petroleum diesel, the fueling system should be checked for these materials and they should be replaced with biodiesel-compatible parts.

# Appendices

## Appendix A. Feedstock

Figure 2. Feedstock Characteristics[28]

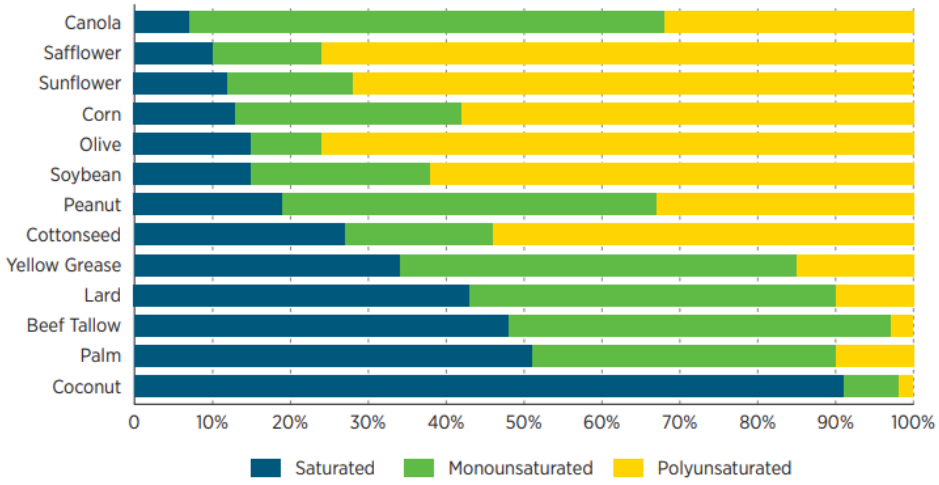



Table 3. Feedstock Cloud Points[29]

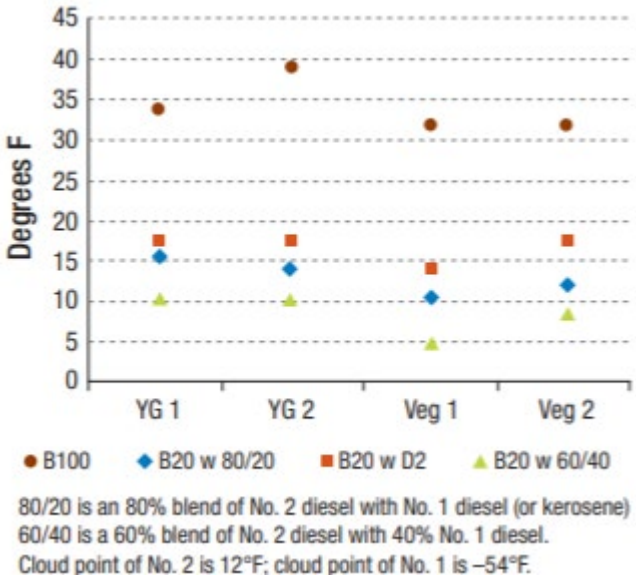
| Biodiesel | Cloud Point (°C) | Biodiesel | Cloud Point (°C) |
|---|---|---|---|
| Algae 1 | -5.2 | Hepar, Low IV | 6.7 |
| Algae 2 | 3.9 | Jatropha | 2.7 |
| Babassu | 4.0 | *Lesquerella fendleri* | -11.6 |
| Beef Tallow | 16.0 | Linseed | -3.8 |
| Borage | -1.3 | *Moringa oleifera* | 13.3 |
| Camelina | 1.5 | Mustard | 3.2 |
| Canola | -3.3 | Neem | 14.4 |
| Castor | -13.4 | Palm | 13.0 |
| Choice White Grease | 7.0 | Perilla Seed | -8.5 |
| Coconut | 0.0 | Poultry Fat | 6.1 |
| Coffee | 0.2 | Rice Bran | 0.3 |
| Corn, Distiller's | -2.8 | Soybean | 0.9 |
| *Cuphea viscosissima* | Not enough sample | Stillingia | -8.5 |
| Evening Primrose | -7.5 | Sunflower | 3.4 |
| Fish | 3.2 | Tung | -10.0 |
| Hemp | -1.3 | Used Cooking Oil | 2.4 |
| Hepar, High IV | 16.0 | Yellow Grease | 6.0 |

[28] U.S. Department of Energy. 2016. Biodiesel Handling and Use Guide. Retrieved from: https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf

[29] Sanford, S., et al. 2009. Feedstock and Biodiesel Characteristics Report. Renewable Energy Group. Retrieved from: https://biodieseleducation.org/Feedstock/documents/Feedstock%20and%20Biodiesel%20Characteristics%20Report%20(1).pdf

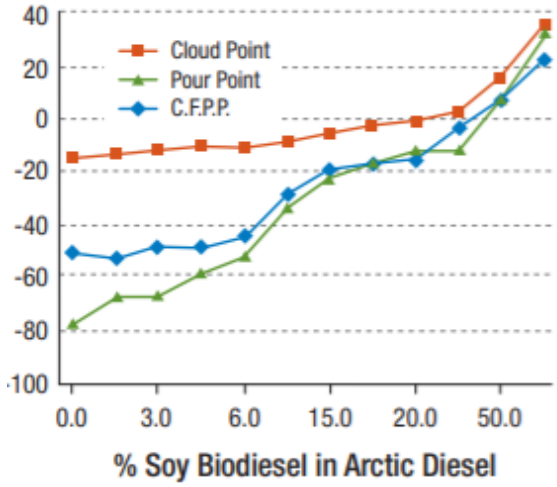
# Appendix B. Biodiesel Blends and Cloud Point[30]

Figure 3. Biodiesel Blend Variations and Cloud Points



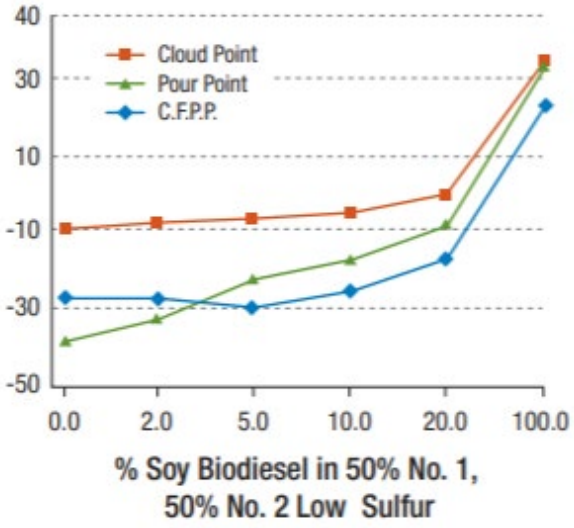

80/20 is an 80% blend of No. 2 diesel with No. 1 diesel (or kerosene)
60/40 is a 60% blend of No. 2 diesel with 40% No. 1 diesel.
Cloud point of No. 2 is 12°F; cloud point of No. 1 is –54°F.

Figure 4. Soy Biodiesel Impacts on Arctic Diesel Cloud Point




[30] U.S. Department of Energy. 2008. Biodiesel Handling and Use Guide. Retrieved from: https://www.canr.msu.edu/uploads/files/Fuels/Handling%20and%20Use%20Guidelines.pdf

Figure 5. Soy Biodiesel Impacts on B20 Blend with 50% Diesel Blend Base



# Appendix C. Biodiesel Emissions

Figure 6. Biodiesel Blend Impacts on Emissions[31]

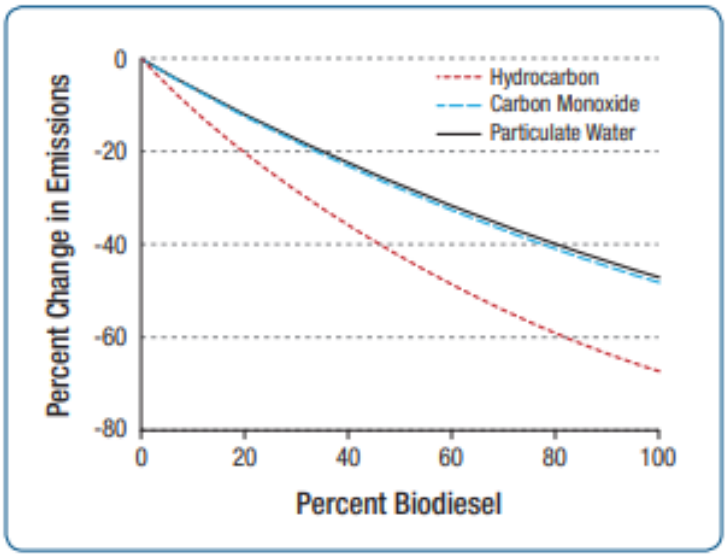
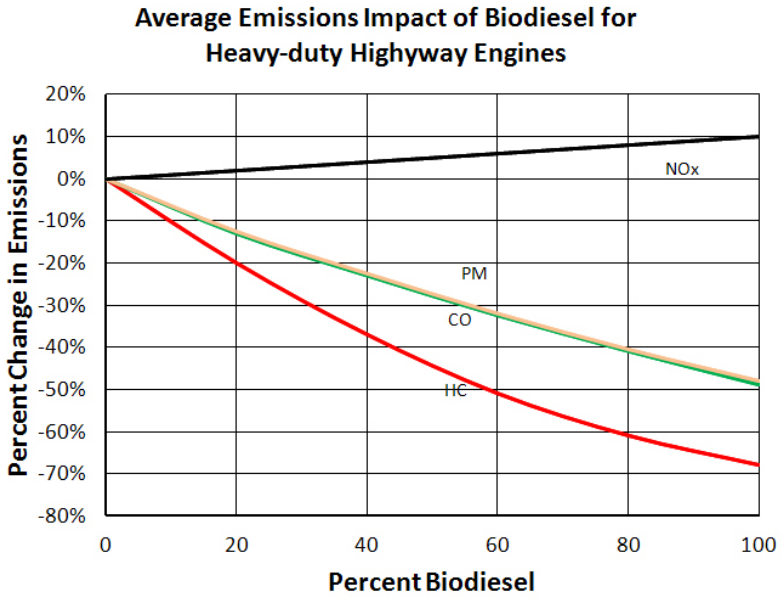



*Figure 2. Average Emission Impacts of Biodiesel Fuels in CI Engines[32]*

Figure 7. Biodiesel Blend Impacts on Emissions in Heavy-Duty Vehicles[32]




[31] U.S. Department of Energy. 2008. Biodiesel Handling and Use Guide. Retrieved from: https://www.canr.msu.edu/uploads/files/Fuels/Handling%20and%20Use%20Guidelines.pdf
[32] U.S. Department of Energy. 2016. Biodiesel Handling and Use Guide. Retrieved from: https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf

Table 4. B100 and B20 Emissions Compared to Diesel Fuel[33]

| BIODIESEL REDUCES EMISSIONS | | |
|---|---|---|
| EMISSION | B100 | B20 |
| Carbon monoxide | -43.2% | -12.6% |
| Hydrocarbons | -56.3% | -11.0% |
| Particulates | -55.4% | -18.0% |
| Nitrogen oxides | +5.8% | +1.2% |
| Air toxics | -60%-90% | -12%-20% |
| Mutagenicity | -80%-90% | -20% |

[33] U.S. Department of Energy. 2005. Biodiesel—Clean, Green Diesel Fuel. Retrieved from: https://afdc.energy.gov/files/pdfs/30882.pdf

# Appendix D. Infrastructure Compatible with Biodiesel[34]

Table 5. Manufacturers with B100 Compatible Diesel Tanks

| Table C-3. Tank Manufacturer Compatibility with Biodiesel Blends | |
|---|---|
| **Manufacturer** | **B100** |
| Fiberglass | |
| Containment Solutions | ✓ |
| Owens Corning | ✗ |
| Xerxes | ✓ |
| Steel | |
| Acterra Group Inc. | ✓ |
| Caribbean Tank Technologies Inc. | ✓ |
| Eaton Sales & Service LLC | ✓ |
| General Industries | ✓ |
| Greer Steel, Inc. | ✓ |
| Hall Tank Co. | ✓ |
| Hamilton Tanks | ✓ |
| Highland Tank | ✓ |
| J.L. Houston Co. | ✓ |
| Kennedy Tank and Manufacturing Co., Inc. | ✓ |
| Lancaster Tanks and Steel Products | ✓ |
| Lannon Tank Corporation | ✓ |
| Mass Tank Sales Corp. | ✓ |
| Metal Products Company | ✓ |
| Mid-South Steel Products, Inc. | ✓ |
| Modern Welding Company | ✓ |
| Newberry Tanks & Equipment, LLC | ✓ |
| Plasteela | ✓ |
| Service Welding & Machine Company | ✓ |
| Southern Tank & Manufacturing Co., Inc. | ✓ |
| Stanwade Metal Products | ✓ |
| Talleres Industriales Potosinos, S.A. de C.V. | ✓ |
| Tanques Antillanos C. x A. | ✓ |
| Watco Tanks, Inc. | ✓ |
| We-Mac Manufacturing Company | ✓ |

[34] U.S. Department of Energy. 2016. Biodiesel Handling and Use Guide. Retrieved from: https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf

Table 6. Manufacturers with Biodiesel Compatible Underground Equipment[35]

| Table C-4. Underground Equipment | | | |
|---|---|---|---|
| **Company** | **Product** | **Model** | **Biodiesel Compatibility** |
| Manufacturers introduce and discontinue models over time. If you do not see your equipment on this list, please contact the manufacturer. Note, "X" in these lists can be substituted for any value. | | | |
| Federal code requires compatibility of this equipment with specific fuels. This is achieved through either third-party listing or a letter from the manufacturer stating compatibility. If a specific manufacturer or model is not in the list, please contact the manufacturer directly to determine compatibility. Compatibility letters are available at: *pei.org/ust-component-compatibility-library*. | | | |
| Bravo Systems | Fiberglass fittings | Series F, FF, FPE, FR, Retrofit-S, D-BLR-S, D-INR-S, FLX, FLX-INR, FPS, TBF | B100 |
| Bravo Systems | Spill buckets | B3XX | B100 |
| Bravo Systems | Tank Sumps & covers | B4XX | B100 |
| Bravo Systems | Transition sumps | B5XX, B6XX, B7XX, B8XX | B100 |
| Bravo Systems | Under dispenser containment sumps | B1XXX, 7XXX, B8XXX, B9XXX | B100 |
| Brugg | Piping | FLEXWELL-HL, SECON-X, NITROFLEX, LPG | B100 |
| Cimtek | Filter | 200, 250, 260-10, 260-30, 260AHS, 260HS, 300-02, 300-10, 300-30, 300HS, 400-02, 400-10, 400-30, 400HS, 800-02, 800-10, 800-30, 800HS | B20 |
| Cimtek | Filter | 260BHG, 260BMG, 300BHA, 300BMG, 300MB, 400BHA, 400BMG, 400MB, 450-10, 450-30, 475XL-10, 475XL-30, 450HS-10, 450HS-30, 475XLHS-10, 475XLHS-30, 800BHA, 800BHG, 800BMG | B100 |
| Franklin Fueling | Other UST equipment | Franklin has third-party certified equipment compatible with biodiesel blends. Contact manufacturer for specific part numbers. | |
| Franklin Fueling | Piping | Franklin has third-party certified equipment compatible with biodiesel blends. Contact manufacturer for specific part numbers. | |
| Husky | Pressure vacuum vents | 4620, 4885, 5885, 11730, 11735, 11740, 450MG-10, 475XLMB-10 | B20 |
| Morrison Bros. | Overfill prevention valve | 9095S | B20 |
| Morrison Bros. | Anti-syphon valve | 912 | B100 |
| Morrison Bros. | AST adaptor | 927 | B100 |
| Morrison Bros. | Ball valves | 691BSS | B100 |
| Morrison Bros. | Clock gauges | 818 | B100 |

[35] Compatible at time of report publication.

| | | | |
|---|---|---|---|
| Morrison Bros. | Clock gauge with alarm | 918 | B100 |
| Morrison Bros. | Combination vent/overfill alarm | 922 | B100 |
| Morrison Bros. | Drop tubes | 419A, 539TO, 539TC | B100 |
| Morrison Bros. | Emergency vents | 244 | B100 |
| Morrison Bros. | Expansion relief valve | 076DI, 078DI | B100 |
| Morrison Bros. | External emergency valves | 346DI, 346FDI, 346SS, 346FSS | B100 |
| Morrison Bros. | Flame arrestor | 351S | B100 |
| Morrison Bros. | Frost proof drain valve | 128DIS | B100 |
| Morrison Bros. | In-line check valve | 958 | B100 |
| Morrison Bros. | Internal emergency valves | 272DI, 72HDI | B100 |
| Morrison Bros. | Overfill alarm | 918TCP | B100 |
| Morrison Bros. | Overfill prevention valve | 9095A-AV, 9095SS | B100 |
| Morrison Bros. | Series cap | 305C | B100 |
| Morrison Bros. | Solenoid valves (3", must be all-Teflon version) | 710SS | B100 |
| Morrison Bros. | Spill containers | 515/516/517/518 | B100 |
| Morrison Bros. | Swing check valves | 246ADI, 246DRF | B100 |
| Morrison Bros. | Vapor recovery adaptor | 323 | B100 |
| Morrison Bros. | Vapor recovery caps | 323C | B100 |
| Morrison Bros. | Vent-pressure vacuum | 548, 748, 749 | B100 |
| Morrison Bros. | Vent-updraft | 354 | B100 |
| National Environ-mental Fiberglass | Sumps and accessories | all | B100 |
| NOV Fiberglass | Piping | RedThread IIA, Ameron Dualoy | B100 |
| NUPI | Piping | Smartflex | B100 |
| OMEGAFLEX | Piping | DoubleTrac (stainless steel fittings) | B100 |
| OPW | AST anti-siphon valve | 199ASV | B20 |
| OPW | AST check valve | 175, 1175 | B20 |
| OPW | AST emergency shut off valve | 178S | B20 |
| OPW | AST emergency vent | 201, 301 | B20 |

| | | | |
|---|---|---|---|
| OPW | AST mechanical gauge | 200TG | B20 |
| OPW | AST spill container | 211-RMOT, 331, 332 | B20 |
| OPW | AST swing check valve | all | B20 |
| OPW | AST tank alarm | 444TA | B20 |
| OPW | AST vapor adaptor | 1611AVB-1625 | B20 |
| OPW | AST vapor cap | 1711T-7085-EVR, 1711LPC-0300 | B20 |
| OPW | Ball float vent valve | 53VML, 30MV | B20 |
| OPW | Check valve | 70, 70S | B20 |
| OPW | Dispenser sumps & accessories | FlexWorks | B20 |
| OPW | Drop tube | 61FT | B20 |
| OPW | Extractor fittings and plug | 233, 233VP | B20 |
| OPW | Face seal adaptor (threaded riser adaptor) | FSA | B20 |
| OPW | Fill adaptor-side | 61AS | B20 |
| OPW | Fill adaptor-top | 633T, 633TC | B20 |
| OPW | Fill Cap | 634TT-7085-EVR, 634LPC, 634TT-4000 | B20 |
| OPW | Fill cap-side | 62TT | B20 |
| OPW | Fill-swivel adaptor | 61SALP-MA, 61SALP-1020-EVR | B20 |
| OPW | Flexible connectors | FCxx | B20 |
| OPW | Jack screw | 61JSK, 71JSK | B20 |
| OPW | Manhole | Conquistador, Fiberlite, 104A, 104FG, 104C, 6110,6120 | B20 |
| OPW | Monitoring well cap kit | 634TTM | B20 |
| OPW | Monitoring well probe cap | 62M, 116M, 62M-MA | B20 |
| OPW | Multi-port spill containment | 6511, 6421, 6511, 6521, 6561, 6571, Fiberlite | B20 |
| OPW | Piping | FlexWorks | B20 |
| OPW | Piping | FlexWorks, KPS, Pisces (discontinued) | B20 |
| OPW | Pressure vacuum vent | 523V, 623V | B20 |
| OPW | Spill container (bucket) | 1-2100, 1SC-2100, 1C-2100,1C-2200, EDGE (1-3100), '1-2105, 101-BG2100 | B20 |
| OPW | Tank sumps & accessories | Fiberlite, FlexWorks | B20 |
| OPW | Transition sumps & accessories | FlexWorks | B20 |
| OPW | Vapor adaptor | 1611AV, 1611AVB | B20 |

| | | | |
|---|---|---|---|
| OPW | Vapor cap | 1711T-7085-EVR, 1711LPC | B20 |
| OPW | Vapor-swivel adaptor | 61VSA-MA, 61VSA-1020-EVR | B20 |
| Veeder-Root | Ground water monitoring | P/N 794380-621, 794380-622, 794380-624 | B20 |
| Veeder-Root | Interstitial and secondary containment monitoring | P/N 794380-XXX, 794390-XXX, 847990- 00X, 857080-XXX, P/N 794380-321, 794380-323, 794380-333, 794380-344, 794380- 345, 794380-351, 794380-430 | B20 |
| Veeder-Root | Continuous interstitial tank system | P/N 857280-100, 857280-200, 857280-30X | B100 |
| Veeder-Root | Electronic line leak detector | Series 8484, 8590 | B100 |
| Veeder-Root | Interstitial and secondary containment monitoring | 794380-344, 794380-345, 794380- 321, 794380-351 | B100 |
| Veeder-Root | Magnetostrictive Probe | Mag Plus Series 8463XX, Mag Series 8473XX | B100 |
| Veeder-Root | Red Jacket Maxxum Pump | 410763-XXX (MXP300JX-XXX or MXP500JX-XXX) | B100 |
| Veeder-Root | Tall tank probe | Mag-FLEX 889560-XXX, MAGXL-XXX | B100 |
| Veeder-Root | Vapor monitoring | P/N 394390-700 | B20 |
| Western Fiberglass | Co-flex piping | all | B100 |
| Western Fiberglass | Co-flow hydrostatic monitoring systems | all | B100 |
| Western Fiberglass | Cuff fittings | all | B100 |
| Western Fiberglass | Sumps (dispenser, tank, transition, vapor, vent) | all | B100 |

Table 7. Baltimore Diesel Tank Compatibility[36]

| Location | Status |
|---|---|
| **Midtown** | Unknown |
| **Northwest** | Compatible with Biodiesel |
| **Central** | Compatible with Biodiesel |
| **Northeast** | Unknown |
| **Patapsco WWTP** | Unknown |
| **Liberty Dam** | Unknown |
| **Loc Raven Dam** | Unknown |
| **Prettyboy Dam** | Unknown |
| **Montebello Plant** | Unknown |
| **BackRiver WWTP** | Unknown |
| **Northwest Yard SW** | Unknown |
| **Western Yard SW** | Unknown |
| **Carroll Park** | Unknown |
| **Clifton Park** | Unknown |
| **Gwynn Falls Park** | Unknown |
| **Druid Hill** | Unknown |
| **Education Yard** | Compatible with Biodiesel |
| **Pine Ridge** | Unknown |
| **Mount Pleasant** | Unknown |

[36] Only 3 of Baltimore's diesel tanks are confirmed as compatible with B20. The rest of the tanks should not be used to store biodiesel until compatibility can be confirmed.

# Appendix E. Fuel Suppliers

Table 8. Fuel Suppliers

| Business Name | Address | City | State | ZIP | Phone | Blends | B20 |
|---|---|---|---|---|---|---|---|
| **Apex** | 1622 South Clinton | Baltimore | MD | 21224 | 410-342-7800 | All | Yes |
| **Tevis Energy, Inc** | 82 John St | Westminster | MD | 21157 | 866-838-4764 | B2, B5 | |
| **Buckeye** | 6200 Pennington Ave | Baltimore | MD | 21226 | 410-355-0700 | All | Yes |
| **Tri-Gas & Oil Co., Inc.** | 3941 Federalsburg Hwy | Federalsburg | MD | 21632 | 800-638-7802 | All Blends | Yes |
| **Ascent Aviation Group. Inc.** | 115 Farrell Rd | Syracuse | NY | 13209 | 315-625-7299 | All | |
| **John Ray & Sons** | 2900 Sixth Ave | Troy | NY | 12180 | 518-272-4432 | | |
| **Metro Fuel Oil** | 500 Kingsland Ave | Brooklyn | NY | 11222 | 718-383-1400 | b1-b100 | Yes |
| **Mirabito Fuel Group** | 10 Carbon St | Oneonta | NY | 13820 | 607-432-5100 | ANY | Yes |
| **New Hyde Park Oil Terminal** | 1900 Plaza Ave | New Hyde Park | NY | 11040 | 516-352-4245 | all | Yes |
| **Sprague Energy** | 540 Riverside Dr | Rensselaer | NY | 12144 | 800-225-1560 | B2, B5, B20 | Yes |
| **Suma Energy, LLC** | 303 Park Ave S #1281 | New York | NY | 10010 | 917-464-3841 | B2-B100 | Yes |
| **TMT Biofuels LLC** | 3792 Hunkins Rd | Port Leyden | NY | 13433 | 315-348-5338 | B99.9 | |
| **Tri-State Biodiesel** | 531 Barretto St | Bronx | NY | 10474 | 718-860-6600 | All | Yes |
| **Windsor Fuel** | 80 Windsor Ave | Mineola | NY | 11501 | 516-746-5900 | B5, B10, B20, B100 | Yes |
| **American Biodiesel Energy Inc** | 4680 Iroquois Ave | Erie | PA | 16511 | 814-899-0621 | B99.9 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Americans Energy Supply** | 1704 Chichester Ave | Upper Chichester | PA | 19061 | 610-494-4874 | B2, B5, B20 | Yes |
| **Barnes Petroleum Products, Inc** | 12802 Dunnings Hwy | Claysburg | PA | 16625 | 814-239-8161 | B2 | |
| **Beck Fuels, Inc.** | 4655 Susquehanna Trail | Turbotville | PA | 17772 | 570-538-1833 | B5-B20 | Yes |
| **Bernville Quality Fuels, Inc.** | 330 Blair Ave | Reading | PA | 19601 | 610-372-2709 | B2, B5, B20 | Yes |
| **Drescher Fuel Oil, Inc.** | 193 Greble Rd | Myerstown | PA | 17067 | 717-933-4368 | B2 | |
| **Eagle Bio Diesel** | 99 Wetmore Ave | Kane | PA | 16735 | 814-837-1093 | B100 | |
| **Francis L Werley, Inc.** | 16527 Pottsville Pike | Hamburg | PA | 19526 | 610-562-2236 | B3, B100 | |
| **Glassmere Fuel Service, Inc.** | 1967 Saxonburg Blvd | Curtisville | PA | 15032 | 724-265-4646 | B2 | |
| **Independence BioFuels** | 55 Doe Run Rd | Manheim | PA | 17545 | 717-665-1402 | B100 | |
| **K.E. Weaver** | 144 Church St | Lititz | PA | 17543 | 717-626-7169 | B2-B99 | |
| **Keystone Biofuels, Inc.** | 2850 Appleton St | Camp Hill | PA | 17011 | 717-761-3511 | B100 | |
| **Moyer Plumbing and Heating Co.** | 105 East Main St | Kutztown | PA | 19530 | 610-683-7364 | B-5 Off-Road +Heating | |
| **Shipley Energy** | 415 Norway St | York | PA | 17403 | 717-848-4100 | Bioheat | |
| **Sprague Philadelphia** | 6310 Passyunk Ave | Philadelphia | PA | 19153 | 914-328-6770 | B2, B5 | |
| **United Oil Company** | 1800 North Frankin St | Pittsburgh | PA | 15233 | 412-231-1270 | B100 | |
| **Vincent R. Boltz, Inc.** | 45 Guilford St | Lebanon | PA | 17046 | 717-272-4881 | B2 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Culpeper Petroleum Cooperative** | 15297 Brandy Rd | Culpepper | VA | 22701 | 540-825-9651 | B5 | |
| **Foster Fuels, Inc.** | 16720 Brookneal Hwy | Brookneal | VA | 24528 | 434-376-2322 | All | Yes |
| **James River Petroleum** | 10487 Lakeridge Pkwy Suite | Ashland | VA | 23005 | 800-825-5599 | B2, B5, B20 | Yes |
| **Northern Neck Oil Company** | 11549 History Land Hwy | Warsaw | VA | 22572 | 804-333-3835 | B2, B5, B10, B20 | Yes |
| **PAPCO, Inc.** | 4920 Southern Blvd | Virginia Beach | VA | 23462 | 757-499-5977 | B2, B5, B10, B20 | Yes |
| **Phillips Energy Incorporated** | 2586 George Washington Memorial Hwy | Hayes | VA | 23072 | 804-642-2166 | B5, B10, B20 | Yes |
| **Woodfin Watchcard** | 1625 N Hamilton St | Richmond | VA | 23230 | 804-355-7104 | All | Yes |
| **Emerald Circle Fuel Manufacturing** | 1344 N West Blvd | Vineland | NJ | 8360 | 610-737-8731 | B100 | |
| **EPDS GROUP INC** | 85-34 167TH St | Jamaica | NJ | 11432 | 917-423-3959 | | |
| **Innovation Fuels** | 126 Passaic St | Newark | NJ | 7104 | 917-699-8877 | B100, B99.9 | |
| **Medford Fuel** | 188 Route 70 | Medford | NJ | 8055 | (609) 654-2188 | B2, B5, B10, B20 | Yes |
| **Mitchell Supreme Fuel** | 532 Freeman St | Orange | NJ | 7110 | 973-678-1800 | B5, B10, B20 | Yes |
| **Ross Enterprise - Vineland Shell** | 1955 N Main Rd | Vineland | NJ | 8360 | 609-965-6800 | B2-b5 | |
| **Sprague Newark** | 436 Doremus Ave | Doremus | NJ | 7105 | 914-328-6770 | B2, B5, B10, B20 | Yes |
| **Taylor Oil Co., Inc.** | 77 Second St | Somerville | NJ | 8876 | 908-725-7737 | All | Yes |
| **TransMontaigne** | 78 Lafayette St | Carteret | NJ | 7008 | 303-860-5304 | B99.9 | |