Potassium Chloride

KCl (solid)

R Raw Material

Source of Raw Material: Naturally occurring mineral

% of Total Domestic Consumption Attributed to Water Sector: Less than 1%

Product Family: Potassium

CAS No.: 7447-40-7

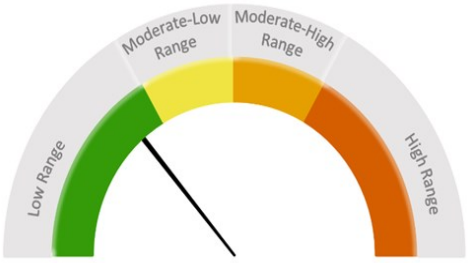
Derivative Water Treatment Chemicals: Potassium Hydroxide

Understanding Chemical Supply Chains

Shelf Life: 60+ Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Low



RISK DRIVERS

Agricultural use of fertilizer, trade disputes, and reliance on a small number of countries for imports add to risk for potential supply disruptions. Domestic production is largely intended for fertilizer, though there is dedicated production of potassium hydroxide as it is widely used.

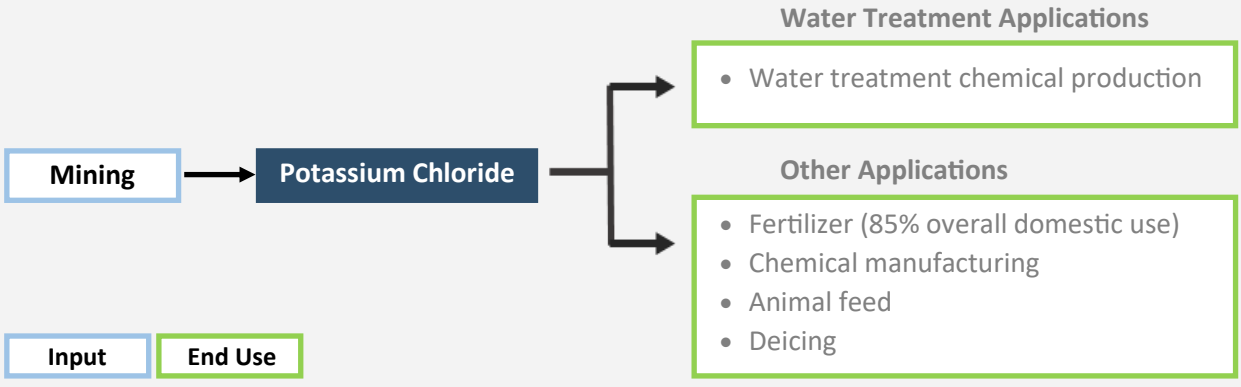
RISK PARAMETERS

Criticality: Moderate-High. Essential for the production of the input for potassium permanganate.

Likelihood: Low. No history of supply disruptions between 2000 and 2022.

Vulnerability: Moderate-High. The U.S. relies heavily on imports to meet domestic demand. The U.S. is a leading worldwide consumer of potassium chloride, the majority of which is used to produce fertilizer.

PRODUCTION PROCESS



DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

Domestic Production Locations (2019):
2, New Mexico and Utah.

International Trade (2019)
Primary Trading Partner (Imports): Canada
Primary Trading Partner (Exports): Mexico

Domestic Consumption (2018): 9,491 M kg

- Domestic Production (490 M kg)
- Imports for Consumption (9,380 M kg)
- Export of Domestic Production (379 M kg)

EPA

Product Description

Potassium chloride (KCl), also known as muriate of potash, is the most common form of potassium-bearing minerals, which are collectively referred to as potash. Though potassium chloride is not used directly in water treatment, it serves as an important raw material in the production of other water treatment chemicals. Potassium chloride is widely used in fertilizer, which is the single largest domestic and international application. In 2018 the U.S. Department of the Interior listed potash as a critical mineral.

Use in Water Treatment

Potassium chloride is not used directly in water treatment.

Use as a Precursor to Other Water Treatment Chemicals

Potassium chloride is used to manufacture potassium hydroxide. Though not widely used as a raw material, potassium chloride can be used to manufacture chlorine.

Other Applications

Potassium chloride has a wide range of applications. The leading use of potassium chloride is as a source of potassium in fertilizer. It is also used for chemical manufacturing, as a source of potassium in animal feed, ice melting applications, and industrial uses such as aluminum refining (USGS, 2021).

Primary Industrial Consumers

In 2019, approximately 85% of potassium chloride consumed in the U.S. was used in the production of fertilizer. Worldwide, in excess of 90% of global production is intended for fertilizer production. Approximately 6% of non-fertilizer potassium chloride is converted to other chemicals, primarily potassium hydroxide. Other applications, including animal feed, ice melting, and industrial use account for 2% of worldwide use (BHP, 2021; USGS, 2021).

Manufacturing, Transport, & Storage

Manufacturing Process

Potassium chloride is a naturally occurring mineral that is abundant throughout the earth, found in deposits and extracted from seawater. Potassium chloride may be produced by conventional underground mining, solution-mining of an underground deposit, or evaporation of brine. The dominant mineral source is sylvite (potassium chloride in natural mineral form) often mixed with halite (sodium chloride) (USGS, 2019; USGS, 2021).

Conventionally mined potassium chloride requires beneficiation, which often includes crushing, and grinding to separate out potassium chloride from other material. Further processing includes multiple steps of flotation, drying, sizing, compacting, and crystallization (DOE, 2013; PotashCorp, 2013). Solution mining relies on injection of a heated brine into an underground mine to dissolve deposits from the pillars and walls of an established mine. The brine is pumped into an evaporation pond where the potassium chloride crystals settle to the bottom and can be collected and processed. Solution mining uses significantly more energy and water than conventional mining (DOE, 2013; USGS, 2021).

Evaporation of a natural brine requires the brine is placed in an outdoor pond under conditions where evaporation outpaces precipitation. Crystals can be recovered after sufficient evaporation of water. This process yields a high purity potassium chloride (DOE, 2013; PotashCorp, 2013).

Product Transport

Many methods are used to transport potassium chloride, however transportation costs can add significantly to

the price of potassium chloride, as use is widespread throughout the world while production locations are not (USGS, 2021).

Storage and Shelf Life

Potassium chloride is stable and non-reactive over a wide range of temperatures and is highly soluble in water. When stored properly, potassium chloride can have a shelf life in excess of 60 months (Chemtrade Logistics, 2018).

Domestic Production & Consumption

Domestic Production

Production data was collected from U.S. Geological Survey (USGS), while trade data was collected from the U.S. International Trade Commission (USITC) Dataweb, as shown in Table 1. While trade data are specific to potassium chloride, production data was calculated as a percentage of total potash production.

Table 1. Potassium Chloride Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	U.S. Geological Survey	CAS No.: 7447-40-7	Potassium Chloride
Imports and Exports	U.S. International Trade Commission	HS Code: 3104.20	Potassium Chloride

Total U.S. domestic production of potassium chloride was approximately 490 million kilograms (M kg) in 2018. This estimate is based on total domestic potash production of 1,400 M kg in 2018, of which approximately 35% is estimated as production of potassium chloride. While potash is produced at two mines in New Mexico and three facilities in Utah, potassium chloride is produced by *Intrepid Potash, Inc*. at one facility each in New Mexico and Utah (USGS, 2019; USGS, 2021).

Domestic Consumption

U.S. consumption of potassium chloride in 2018 is estimated at 9,491 M kg. This estimate includes production of 490 M kg, import of 9,380 M kg, minus export of 379 M kg (USGS, 2020a), as shown in Figure 1.

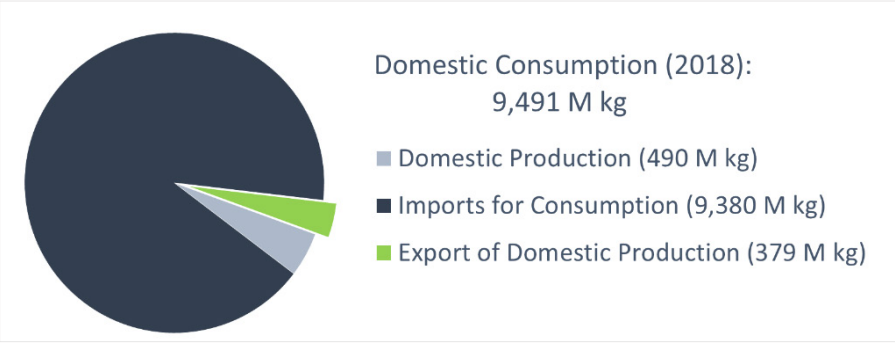


Figure 1. Domestic Production and Consumption of Potassium Chloride in 2018

Trade & Tariffs

Worldwide Trade

Worldwide import and export data for potassium chloride are reported through the World Bank's World

Integrated Trade Solutions (WITS) software, as a category specific to potassium chloride. In 2018, the U.S. ranked fourth worldwide in total exports and first in total imports of potassium chloride. In 2018, Canada ranked first worldwide in total exports (WITS, 2022), as shown in Table 2. Exports from Belarus, one of the most significant potassium chloride producers, were not reported in 2021.

Table 2. WITS Worldwide Export and Import of Potassium Chloride in 2021

2021 Worldwide Trade Potassium Chloride (HS Code 3104.20)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
Canada	21,625 M kg	**United States**	**13,454 M kg**
Russian Federation	11,835 M kg	Brazil	12,780 M kg
Germany	3,455 M kg	China	7,673 M kg
United States	**3,120 M kg**	Indonesia	4,016 M kg
Spain	760 M kg	Malaysia	1,863 M kg

Domestic Imports and Exports

Domestic import and export data are reported by USITC in categories specific to potassium chloride. Figure 2 summarizes imports for consumption[1] and domestic exports[2] of potassium chloride between 2015 and 2020. During this period, the overall quantity of imports and exports remained relatively steady, with imports for consumption significantly outpacing domestic exports. Over this five-year period, Mexico was the primary recipient of domestic exports while the primary source of imports was Canada (USITC, 2021). One of the largest potash deposits is found in Saskatchewan, Canada.

It is noteworthy that total exports, as recorded by WITS, are significantly greater than domestic exports as recorded by USITC. Total exports represent goods produced or modified in the U.S. in addition to exports of goods of foreign origin that have passed through U.S. customs.

[1] Imports for consumption are a subset of general imports, representing the total amount cleared through customs and entering consumption channels, not anticipated to be reshipped to foreign points, but may include some reexports.
[2] Domestic exports are a subset of total exports, representing export of domestic merchandise which are produced or manufactured in the U.S. and commodities of foreign origin which have been changed in the U.S.

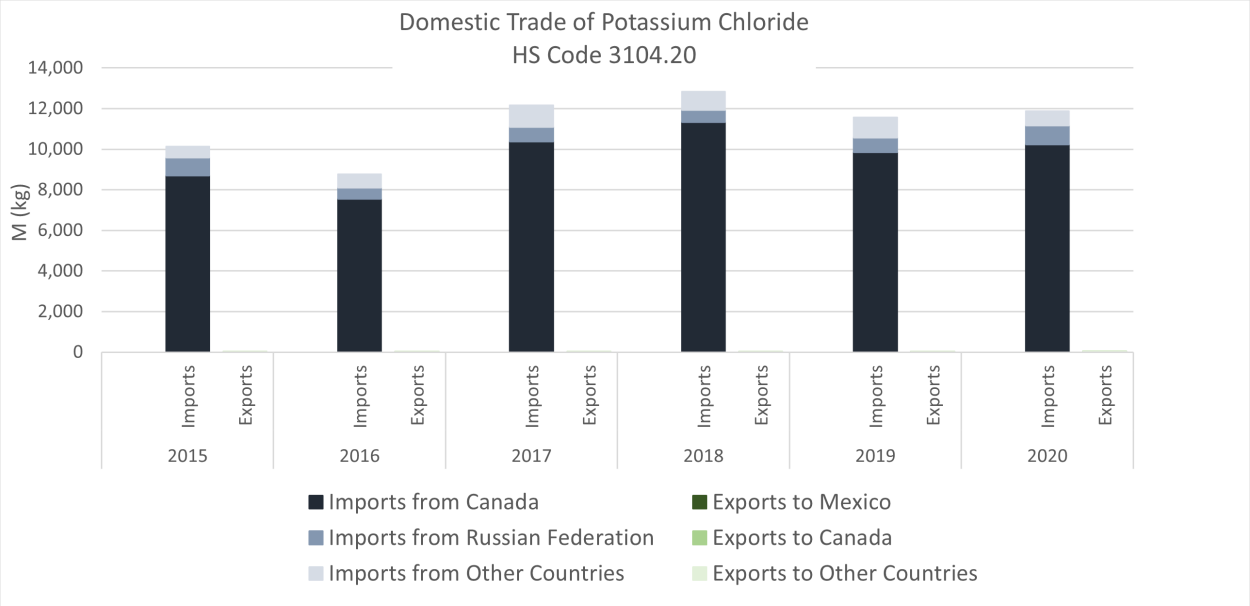


Figure 2. USITC Domestic Import and Export of Potassium Chloride between 2015 and 2020

Tariffs

Imports of potassium chloride are primarily supplied from Canada. There is no general duty for import of potassium chloride, however there is an additional 25% duty on imports from China (USITC, 2022), as summarized in Table 3.

Table 3. 2021 Domestic Tariff Schedule for Potassium Chloride

HS Code	General Duty	Additional Duty – China (Section 301 Tariff List)	Special Duty
3104.20	None	25%	None

Market History & Risk Evaluation

History of Shortages

Canada, Russia, Belarus, and China accounted for 80% of world potash production in 2019, and global supply and demand from these select countries have historically dictated price and availability. The U.S., which imports approximately 17% of worldwide production, relies heavily on Canadian production to meet domestic demand, and supply is heavily reliant on rail transport from Saskatchewan. Use in fertilizer dominates global and domestic demand for potassium chloride, and as potassium is a vital nutrient for crop growth, it plays a key role in determining crop yields. Though historically the price of potassium chloride has fluctuated, there was no identified history of potassium chloride shortages between 2000 and 2022.

In 2022, the World Bank recognized worldwide potash supply shortages due to challenges in bringing potash from Belarus and Russia to market, noting a 178% price increase in potash from April 2021 to April 2022 (Baffes and Koh, 2022).

Risk Evaluation

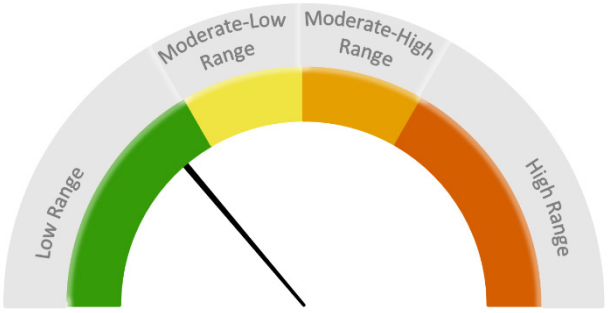
The complete risk evaluation methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022). The risk rating is calculated as the product of the following three risk parameters:

Risk = Criticality x Likelihood x Vulnerability	
Criticality	Measure of the importance of a chemical to the water sector
Likelihood	Measure of the probability that the chemical will experience a supply disruption in the future, which is estimated based on past occurrence of supply disruptions
Vulnerability	Measure of the market dynamics that make a chemical market more or less resilient to supply disruptions

The individual parameter rating is based on evaluation of one or more attributes of the chemical or its supply chain. The ratings and drivers for these three risk parameters are shown below in Table 4.

Table 4. Supply Chain Risk Evaluation for Potassium Chloride

Risk Parameter Ratings and Drivers		
Criticality Moderate-High	**Likelihood** Low	**Vulnerability** Moderate-High
Potassium chloride is essential to the water sector as a raw material in the production of potassium hydroxide, which is used to manufacture potassium permanganate.	There have been no notable domestic potassium chloride supply disruptions between 2000 and 2022.	The U.S. relies heavily on imports from Canada, and to a lesser degree Russia, to meet domestic demand. The U.S. is a leading worldwide consumer of potassium chloride, the majority of which is used to produce fertilizer.
Risk Rating: Low		



References

Baffes, J., Koh, W. C., 2022. Fertilizer prices expected to remain higher for longer, *World Bank Blogs*, May 11, 2022, retrieved from https://blogs.worldbank.org/opendata/fertilizer-prices-expected-remain-higher-longer

BHP, 2021. *Potash Outlook and Fundamentals 101*, retrieved from https://www.bhp.com/-/media/project/bhp1ip/bhp-com-en/documents/investors/presentations/2021/210617_potashoutlookbriefing.pdf

Chemtrade Logistics, 2018. Potassium Chloride Product Profile, retrieved from https://www.chemtradelogistics.com/wp-content/uploads/2020/10/PDS-Potassium_Chloride_Product_Profile.pdf

EPA, 2022. *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions*, retrieved

from https://www.epa.gov/waterutilityresponse/risk-disruptions-supply-water-treatment-chemicals

The Potash Corporation of Saskatchewan (PotashCorp), 2013. The Potash Journey, retrieved from https://minedocs.com/20/PotashCorp_brochure_2012.pdf

U.S. Department of Energy (DOE), 2013. *Energy and Environmental Profile of the U.S. Mining Industry*, retrieved from https://www.energy.gov/sites/prod/files/2013/11/f4/potash_soda_borate.pdf

U.S. Geological Survey (USGS), 2019. *Mineral commodity Summaries for Potash*, retrieved from https://www.usgs.gov/centers/national-minerals-information-center/potash-statistics-and-information

U.S. Geological Survey, 2021. *2018 Minerals Yearbook: Salt*, retrieved from https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/atoms/files/myb1-2018-potas.pdf

U.S. International Trade Commission (USITC), 2021. USITC DataWeb, retrieved from https://dataweb.usitc.gov/

U.S. International Trade Commission (USITC), 2022. Harmonized Tariff Schedule (HTS) Search, retrieved from https://hts.usitc.gov/

World Integrated Trade Solutions (WITS), 2022. Trade Statistics by Product (HS 6-digit), retrieved from https://wits.worldbank.org/trade/country-byhs6product.aspx?lang=en#void