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## North Korea's Chemical Facilities: Site Profile 1

Lennie Phillips, Giangiuseppe Pili and Sean Corbett

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RUSI Special Resources, May 2023


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# Project Background

NORTH KOREA HAS long been assessed by many countries as having a chemical weapons (CW) programme. In 2006 a South Korean defence ministry white paper[1] estimated that between 2,500 and 5,000 tons of chemical warfare agents (CWAs) were stored in facilities across the country. This figure is often quoted, although it is now almost 20 years out of date.

In 2017 Kim Jong-nam was assassinated with the nerve agent VX, in an attack that was widely accepted as being orchestrated[2] by North Korea. This both served as a reminder of the longstanding North Korean CW programme and to highlight that very little is known about it, in contrast to the international attention paid to North Korea's missile[3] and nuclear programmes.[4]

In an attempt to identify means to bridge that gap, RUSI published[5] a feasibility study in partnership with Dstl in March 2022 which concluded that open source tools could help to understand North Korea's chemical industry, allowing hypotheses about CW production to be developed and refined. The study formed part of a multi-year project on North Korean WMD in cooperation with VERTIC and the James Martin Center for Nonproliferation Studies.

One of the conclusions of the feasibility study was that:

> Future work will need to consider industrial capability as a network; looking at single sites in isolation will leave knowledge gaps. Although this approach as applied to a single site will help inform assessments of activity taking place there, it will not support a holistic understanding of a CW capability. This is because it is unlikely that an individual facility is responsible for start-to-finish production of CW.

Based on the feasibility study and with the support of Global Affairs Canada, RUSI has initiated a three-year project to use open source tools and remote-sensing technologies to provide a networked overview of North Korea's chemical industry initially by profiling sites and seeking

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1. South Korean Ministry of Defense, '2006 Defense White Paper', <https://www.files.ethz.ch/isn/155726/SouthKorea_English2006.pdf>, accessed 23 February 2023.
2. Hannah Ellis-Petersen and Benjamin Haas, 'How North Korea Got Away with the Assassination of Kim Jong-nam', *The Guardian*, 1 April 2019.
3. NTI, 'The CNS North Korea Test Database', 28 April 2023, <https://www.nti.org/analysis/articles/cns-north-korea-missile-test-database/>, accessed 7 May 2023.
4. Hans M Kristensen and Matt Korda, 'Nuclear Notebook: How Many Nuclear Weapons Does North Korea Have in 2022?', *Bulletin of the Atomic Scientists*, 8 September 2022.
5. Cristina Varriale and Sarah Clapham, 'Remote Assessment of North Korea's Chemical Weapons: Feasible or Not?', *RUSI Occasional Papers* (March 2022).

to understand their role in North Korea's chemical industry as well as any links they might have to CW production.

CW production programmes have always had their roots in the chemical industry, from research into new pesticides to the supply of raw materials and intermediates. Many chemicals which have formed part of historic worldwide CW programmes have been included in the Annex on Chemicals,[6] which forms part of the Chemical Weapons Convention (CWC). This annex defines the basis for allocating one of three schedules to some chemicals. The basis of the three schedules depends on aspects such as toxicity, quantity of use for purposes not prohibited by the CWC, whether it has been used as a chemical weapon or identified as a precursor. For completeness, it should be noted that a chemical can be classed as a chemical weapon without being in any of the schedules.

Additional background can be found at: <https://rusi.org/explore-our-research/projects/assessing-north-koreas-chemical-weapons-capability/toxic-inheritance>.

6. Organisation for the Prohibition of Chemical Weapons, 'Annex on Chemicals', <https://www.opcw.org/chemical-weapons-convention/annexes/annex-chemicals/annex-chemicals>, accessed 3 May 2023.

# Acknowledgements

The authors would like to thank the peer reviewers for their valuable feedback and suggestions.

This report was made possible by the support of Global Affairs Canada.

# Executive Summary

THIS REPORT ON the Ponghwa Chemical Factory is the first in a series exploring different chemical production facilities throughout North Korea. The project seeks to map out the North Korean chemical industry and its potential links to a chemical weapons programme. There is nothing in open sources that suggests this site is involved in producing chemical weapons. However, it is the main oil refinery in North Korea and, as such, would provide the building-block raw materials for the production of organic chemicals. Ponghwa Chemical Factory is therefore a central part of North Korea's chemical industry, and no networked assessment of the country's national industrial-chemical capacity, and its potential to produce chemical warfare agents (CWAs) would be complete without analysis of a site producing these basic raw materials.

The report covers a brief history of the site from its construction and commissioning in the 1970s through to satellite imagery demonstrating that it is still operational. Individual areas are identified and analysed in relation to their purpose. Finally, local links to the site are explored to give it a wider context within the area.

The features and areas of the site are consistent with those expected in a refinery, making it unlikely that it is directly involved in the manufacture of chemical weapons. The site manufactures various fractions from crude oil. These fractions include liquid petroleum gas/refinery gas, petrol/gasoline, kerosene/paraffin, diesel oil, heavy fuel oil and bitumen/tars/coke.

# Ponghwa Chemical Factory: North Korea's Chemical Facilities: Site Profile 1

## Site Selection

THE PONGHWA CHEMICAL Factory is an important site for North Korea. As a refinery, its hydrocarbon oil-based products not only provide a significant part of the country's fuel needs, but also the basic building-block chemicals that play a key part in its chemical industry. The site is fundamental to the North Korean chemical industry, particularly given the North Korean *Juche* (self-sufficient) ideology.[7] Given the relative availability of coal to oil in North Korea, hydrocarbons may also be derived from coal.

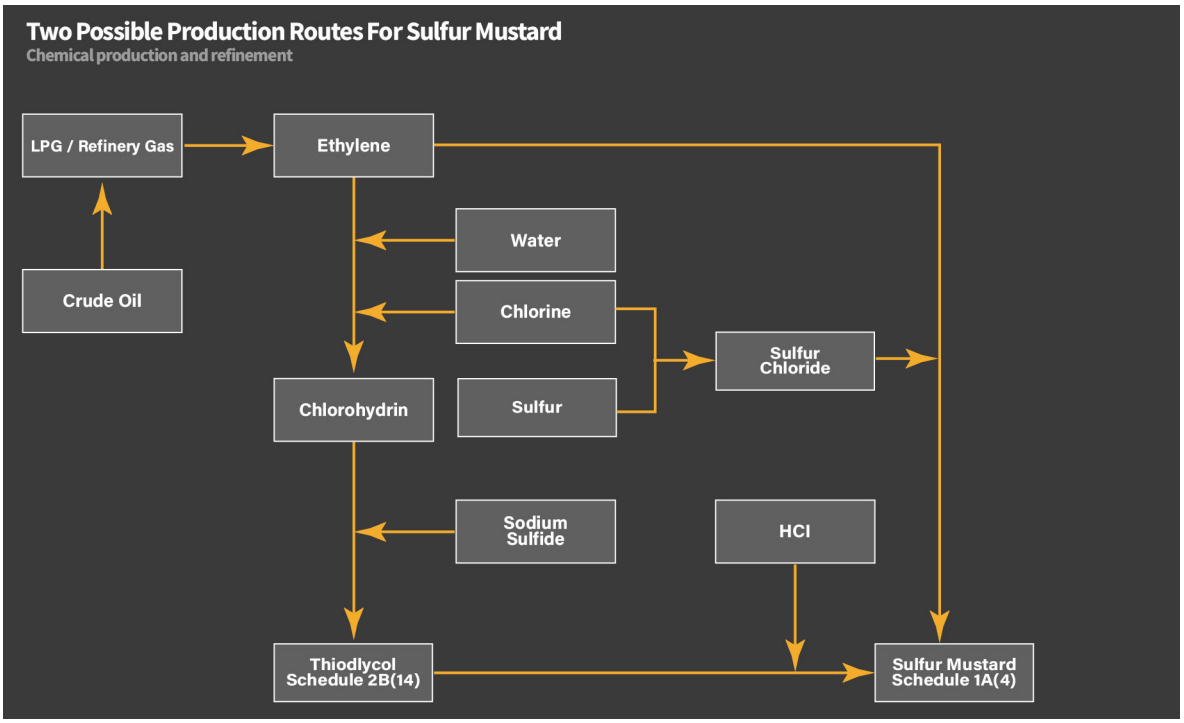
In addition, the basic raw materials of many chemical warfare agents (CWAs) – including sarin, VX, sulfur mustard and Novichok – are organic chemicals that have their roots in hydrocarbons, produced by refineries and the petrochemical industry. Thus, the ultimate raw material for a CWA is crude oil; and as the main operational refinery in North Korea, the Ponghwa Chemical Factory would be key to a self-reliant chemical weapons programme which would not be possible without the initial manufacture of hydrocarbons.

While there is no information to suggest that this facility plays a direct role in CWA production, a networked overview of the North Korean chemical industry would not be complete without inclusion of this site.

Figure 1 depicts just one example of how the output from a refinery such as the Ponghwa Chemical Factory might play a part in the production of a CWA. It should be noted that this is a depiction for one agent and that other CWAs are similarly rooted in crude oil.

7. Grace Lee, 'The Political Philosophy of Juche', *Stanford Journal of East Asian Affairs* (Vol. 3, No. 1, Spring 2003).

**Figure 1:** Production Routes for Sulfur Mustard




*Source: I L Finar,* Organic Chemistry *(London: Longmans Green, 1951), p. 274.*

Sulfur mustard is a common name for a blister agent. It has the CAS number 505-60-02 and is also known as bis(2-chloroethyl) sulfide, HD, H and even mustard gas. The latter is somewhat misleading considering it is highly unlikely to be encountered as a gas in normal atmospheric conditions.

## Methodology

This site is regularly referenced in open sources, which is understandable given its key role in imported oil and in the production of basic raw materials for the organic chemical industry.

In addition, two publications focus more on the site itself. Joseph S Bermudez Jr and Sun Young Ahn's analysis and description of the site in 2015 included a brief history and overview. They focused mainly on the distribution of oil and oil-based products.[8] In 2020, David von Hippel and Peter Hayes gave a general overview of the supply and demand of oil in North Korea between 2010 and 2020, including estimated storage capacity at the Ponghwa Chemical Factory and the impact of a cracking unit, installed around 2016.[9]

8. Joseph S Bermudez Jr and Sun Young Ahn, 'North Korea's Ponghwa Chemical Factory', *38 North*, 10 July 2015.
9. David von Hippel and Peter Hayes, 'Updated Estimates of Refined Product Supply and Demand in the DPRK, 2010 – 2020', Nautilus Institute, 2 September 2020, <https://nautilus.org/napsnet/

RUSI reviewed open source information for the Ponghwa Chemical Factory and categorised declassified government intelligence and satellite imagery as primary sources. Information such as think tank analysis and news coverage were classed as secondary sources.

This report features satellite imagery analysis. RUSI used the formalised, well-established imagery analytical approach as trained and adopted by the military imagery analysis community. This approach considers eight factors: location; size; shape; shadow; tone/colour; texture; pattern; and associated features.

The information was analysed by an expert consultant. The analysis was subsequently reviewed within the team (which includes satellite imagery experts). The report was also externally peer reviewed with inputs included, as appropriate.

The satellite imagery analysis was coupled to the analysis of all the other information to provide overall analysis of the site.

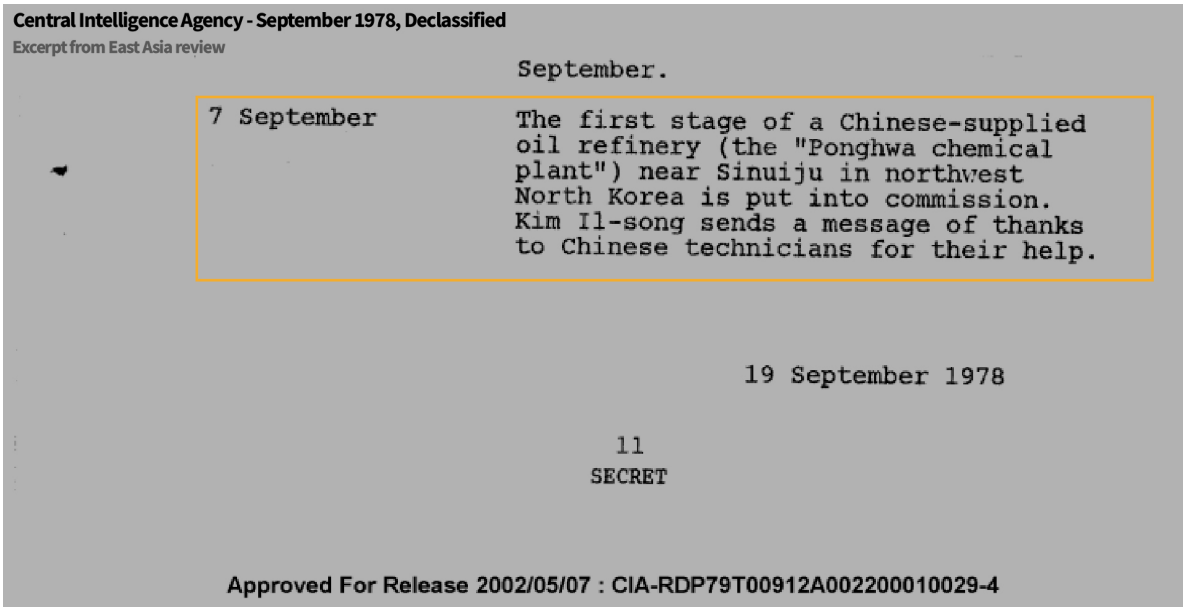
## What is the Ponghwa Chemical Factory?

The Ponghwa Chemical Factory is an oil refinery, based on Chinese design, that has featured in several declassified CIA documents since the late 1970s.[10] Construction started in 1976 and partial operation began in late 1978. It was not fully operational until September 1980.

napsnet-special-reports/updated-estimates-of-refined-product-supply-and-demand-in-the-dprk-2010-2020/?view=pdf>, accessed 15 February 2023.

10. CIA, National Foreign Assessment Center, 'East Asia Review', RP EAR 78-004, 19 September 1978, <https://www.cia.gov/readingroom/docs/CIA-RDP79T00912A002200010029-4.pdf>, accessed 14 February 2023.

**Figure 2:** Excerpt from the CIA's East Asia Review, September 1978


Central Intelligence Agency - September 1978, Declassified
Excerpt from East Asia review

September.

7 September — The first stage of a Chinese-supplied oil refinery (the "Ponghwa chemical plant") near Sinuiju in northwest North Korea is put into commission. Kim Il-song sends a message of thanks to Chinese technicians for their help.

19 September 1978

11
SECRET

Approved For Release 2002/05/07 : CIA-RDP79T00912A002200010029-4

*Source: CIA, National Foreign Assessment Center, 'East Asia Review', RP EAR 78-004, 19 September 1978, <https://www.cia.gov/readingroom/docs/CIA-RDP79T00912A002200010029-4.pdf>, accessed 14 February 2023.*

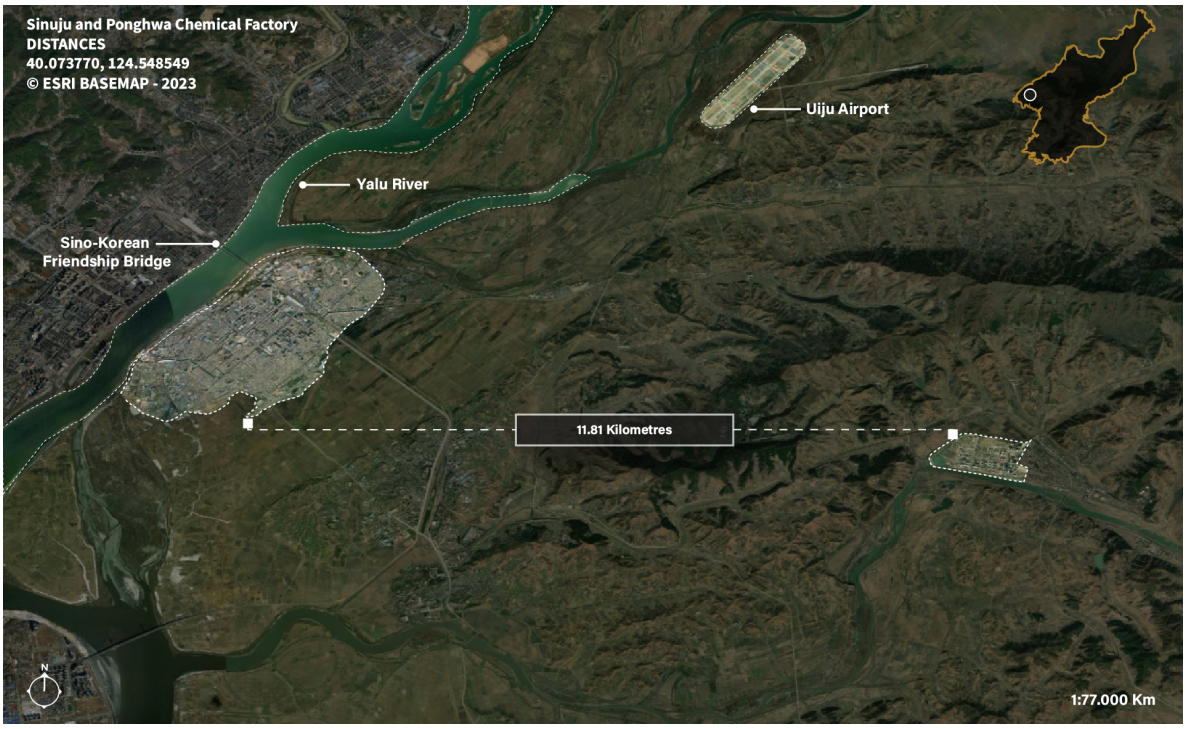
## Where is the Ponghwa Chemical Factory and How Does it Connect to Nearby Areas?

The Ponghwa Chemical Factory is situated in the far northwest of the country near Sinuiju, an important border city. Sinuiju is situated opposite Dandong (which plays a crucial role in the life of North Korea) in China, on the other bank of the Yalu River.

The Ponghwa Chemical Factory is located at 40°04'20"N 124°32'50"E, close to the village of Paengma-ri in the North Pyongan province. It sits approximately 12 km east-southeast of Sinuiju as the crow flies, at an altitude of approximately 15 metres above sea level and approximately 13 km from China at its nearest point.

Figure 3 shows the location of the Ponghwa Chemical Factory and its proximity to Sinuiju, the Yalu River, the border with China and Dandong.

**Figure 3:** Location of Ponghwa Chemical Factory




*Source: ESRI Basemap, 2023. Annotated by the author.*

The Samgyo-chon (Samgyo Stream) runs to the south of the site while a much smaller stream runs along the north side of the refinery before turning in a southwesterly direction to join the Samgyo-chon, a tributary of the Yalu River entering to the south of Sinuiju. There are no quays, docks or infrastructure related to the potential loading or offloading of boats in the plant site's vicinity.

**Figure 4:** View of Ponghwa and the Local Surrounding Area


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

The site has well-developed transport links by North Korean standards. The rail link is a spur of the main north–south rail line linking Pyongyang and Sinuiju. That line also links North Korea with China over the Sino-Korean Friendship Bridge, running to the Chinese border trading town of Dandong and beyond. The rail spur enters the facility through two branch lines at the southwest edge of the site, one of which terminates in a marshalling yard. Another marshalling yard and station (Paengma Station) are located to the northeast of the facility.

The road network is equally well developed, with a metalled dual carriageway circumnavigating the facility. This road also links the main route from Pyongyang to Sinuiju and an arterial road linking eastern parts of the country.

## How is the Plant Site Defined: What is Part of the Site?

A wall surrounds the production areas, tank farms, railway loading/offloading area, administrative buildings, and more. On the western side of the site, just west of the site wall, there is some farmland and several bodies of water, bounded by a dyke. These areas appear to be part of the plant site and will be discussed in more detail later.

The plant site is predominantly surrounded by farmland and small residential settlements; there are various other areas that are clearly more closely associated with the site. The associated areas are discussed later in the report.

**Figure 5:** Perimeter Walls (Yellow Broken Line) and Area of the Ponghwa Chemical Factory Site (Highlighted Area)


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

## The Ponghwa Chemical Factory: Manufacturing Areas

The main site is split into several distinct areas. The individual plant and unit boundaries have been estimated based on differentiation between what appear to be the major site roads and more minor plant roadways. They are all connected by pipelines either to the tank farm or to other plants.

The different manufacturing areas are used for separate refinery processes. While they broadly have the same requirements, refinery processes vary around the world.[11]

11. US Energy Information Administration, 'Oil and Petroleum Products Explained: Refining Crude Oil', updated 13 April 2023, <https://www.eia.gov/energyexplained/oil-and-petroleum-products/refining-crude-oil.php>, accessed 13 April 2023.

The composition of the crude oil used at Ponghwa, as with most refineries, defines the possible products and the relative quantities that are attainable by distillation alone. In simple terms, distillation will split the crude oil into different fractions containing a mix of hydrocarbons (chemicals containing carbon and hydrogen only), based on their relative boiling points. The degree of separation and purity of these fractions depends on the amount of distillation that takes place. Processes known as cracking can be used on certain, typically higher-boiling, fractions such as residual fuel oil to break down those larger higher-boiling (heavier) molecules into smaller, lower-boiling (lighter) and generally more useful molecules. The amount of distillation and cracking would be strongly influenced by the crude oil's initial composition, the available technology and its cost, and which fractions (oil products) are more in demand.

The petrochemical industry would take one or more of these fractions and, through a variety of processes, produce more specific products or individual molecules.[12] In many situations, there is overlap between refinery and petrochemical operations.

Terminology for the different processes and products manufactured differs throughout the world and in reference to particular refinery and petrochemical operations. However, the principles of operation are the same: crude oil is separated into more useful fractions and products by means of distillation and an element of restructuring molecules.

It is very difficult to ascertain what is actually produced at a refinery without knowledge of the feedstock as well as the process equipment and operating parameters – such as temperature, pressure and flowrate. Von Hippel and Hayes refer to outputs from the Ponghwa Chemical Factory as being liquefied petroleum gas (LPG)/other gases/refinery gas, gasoline, diesel oil and kerosene/jet fuel 'bottoms', which are heavy products – thick liquids and solids (including residual or heavy fuel oil) – and petroleum coke.

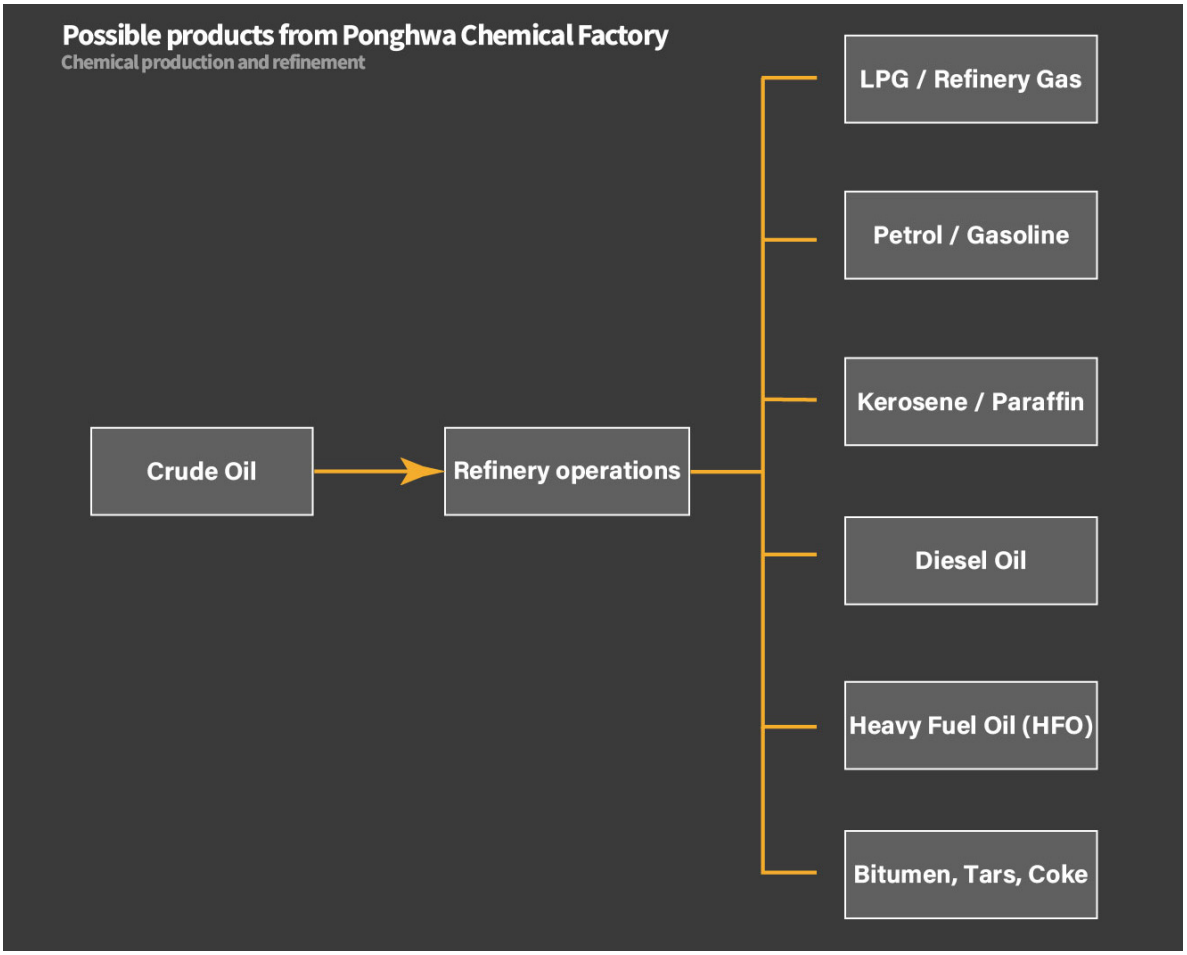
LPG generally refers to propane, butane or a mixture of the two.[13] Refinery gas covers a broader range of chemicals in addition to propane and butane, such as methane, hydrogen and ethane.[14] These types of chemicals, which are normally gases at atmospheric pressure and room temperature, are usually stored under pressure as a liquid in stock tanks specifically designed to handle such material, such as spherical tanks. Spherical tanks are discussed later in this report.

12. Britannica, 'Petrochemical', updated 28 February 2020, <https://www.britannica.com/science/petrochemical>, accessed 3 April 2023.
13. Health and Safety Executive, 'About Liquefied Petroleum Gas (LPG)', <https://www.hse.gov.uk/gas/lpg/about.htm>, accessed 3 April 2023.
14. Britannica, 'Petroleum Products and Their Uses', <https://www.britannica.com/technology/petroleum-refining/Petroleum-products-and-their-uses>, accessed 3 April 2023.

Bottoms are the higher boiling point fraction that is left over at the end of the distillation process at the bottom of a distillation train.[15] Bottoms may be turned into coke to make it a more valuable commodity.

Figure 6 depicts these separate streams, as described with other commonly used terminology.

**Figure 6:** Likely Products from the Ponghwa Chemical Factory




*Source: David von Hippel and Peter Hayes, 'Updated Estimates of Refined Product Supply and Demand in the DPRK, 2010-2020', Nautilus Institute, 2 September 2020, p. 23, <https://nautilus.org/napsnet/ napsnet-special-reports/updated-estimates-of-refined-product-supply-and-demand-in-the-dprk-2010-2020/?view=pdf>, accessed 15 February 2023.*

Von Hippel and Hayes's analysis gives the following breakdown of fractions, following the installation of a catalytic cracker around 2016, in which heavy fuel oil is 'cracked' (larger

15. Academic Dictionaries and Encyclopedias, 'Vacuum Tower Bottoms', Petroleum Refining Glossary, <https://petroleum_refining.en-academic.com/469/vacuum_tower_bottoms>, accessed 3 April 2023.

molecules converted to smaller ones) to increase the amount of the other 'lighter' fractions, most notably gasoline and LPG.

**Figure 7:** Output of Ponghwa Chemical Factory, as Weight Per Cent, Following Installation of a Cracker

| Fuel/Fuel Category | Output as Weight Fraction of Input |
|---|---|
| Heavy Fuel Oil | 19.0% |
| Gasoline | 32.1% |
| Diesel Oil (Light Cycle Oil) | 23.1% |
| Kerosene/Jet Fuel (Light Cycle Oil) | 4.6% |
| LGP/Other Gses/Refinery Gas | 12.0% |
| *Bottoms and Coke (Non-Energy)* | 4.7% |
| **Implied overall Refinery Efficiency with Fluid Catalytic Cracker Unit** | **95.4%** |

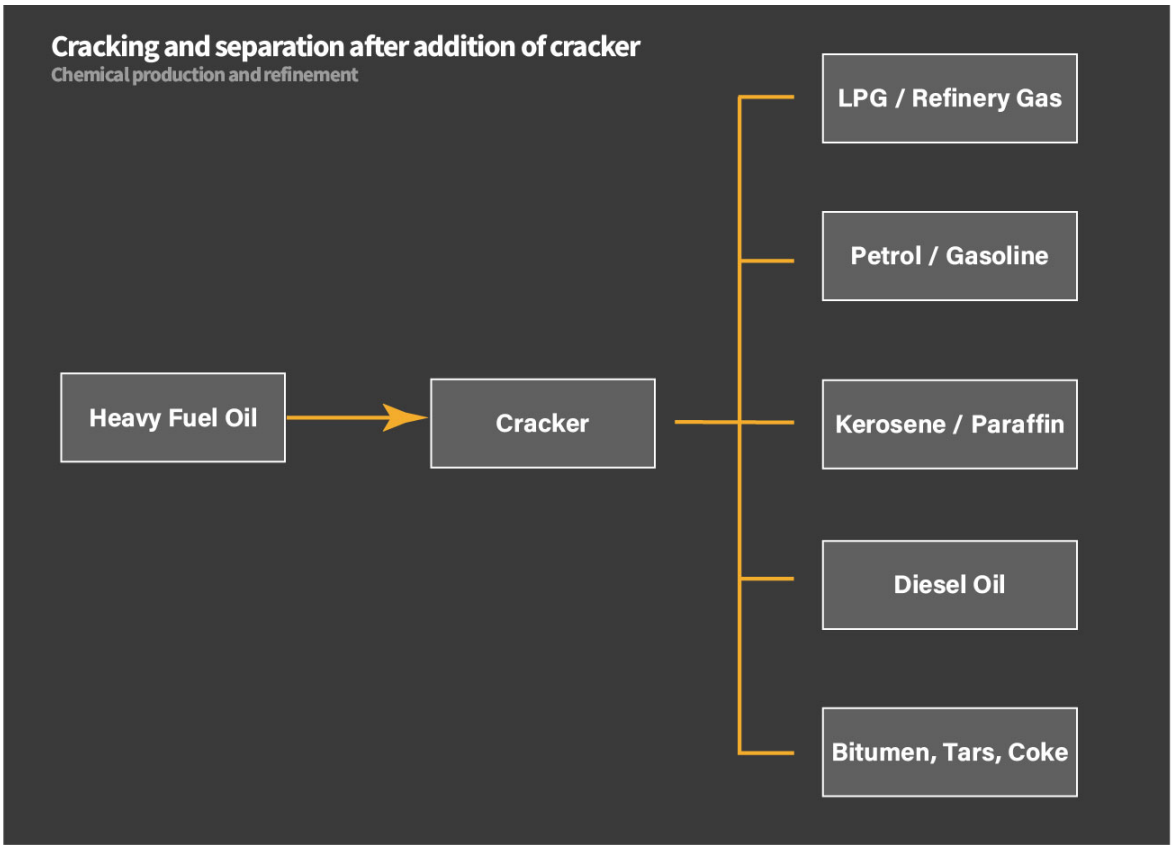
*Source: David von Hippel and Peter Hayes, 'Updated Estimates of Refined Product Supply and Demand in the DPRK, 2010-2020', Nautilus Institute, 2 September 2020, Table 10, p. 23, <https://nautilus.org/napsnet/napsnet-special-reports/updated-estimates-of-refined-product-supply-and-demand-in-the-dprk-2010-2020/?view=pdf>, accessed 15 February 2023.*

In addition to Von Hippel and Hayes, *NK News* reported the likely addition of a catalytic cracker between 2015 and 2017 to one of the manufacturing areas within the Ponghwa complex.[16] A separate March 2017 report by the same outlet references a deal for a Chinese company to import LPG produced at the Ponghwa Chemical Factory.[17] While not definitive, this implies increased availability of LPG which, in turn, appears to confirm increased production of LPG from a cracking unit.

16. Leo Byrne, 'Satellite Imagery Shows Upgrade at North Korea's Functioning Refinery', *NK News*, 4 August 2019.
17. *Ibid.*

The process of cracking the heavy fuel oil, followed by distillation into different streams, is shown in Figure 8.

**Figure 8:** Cracking and Separation after Addition of Cracker



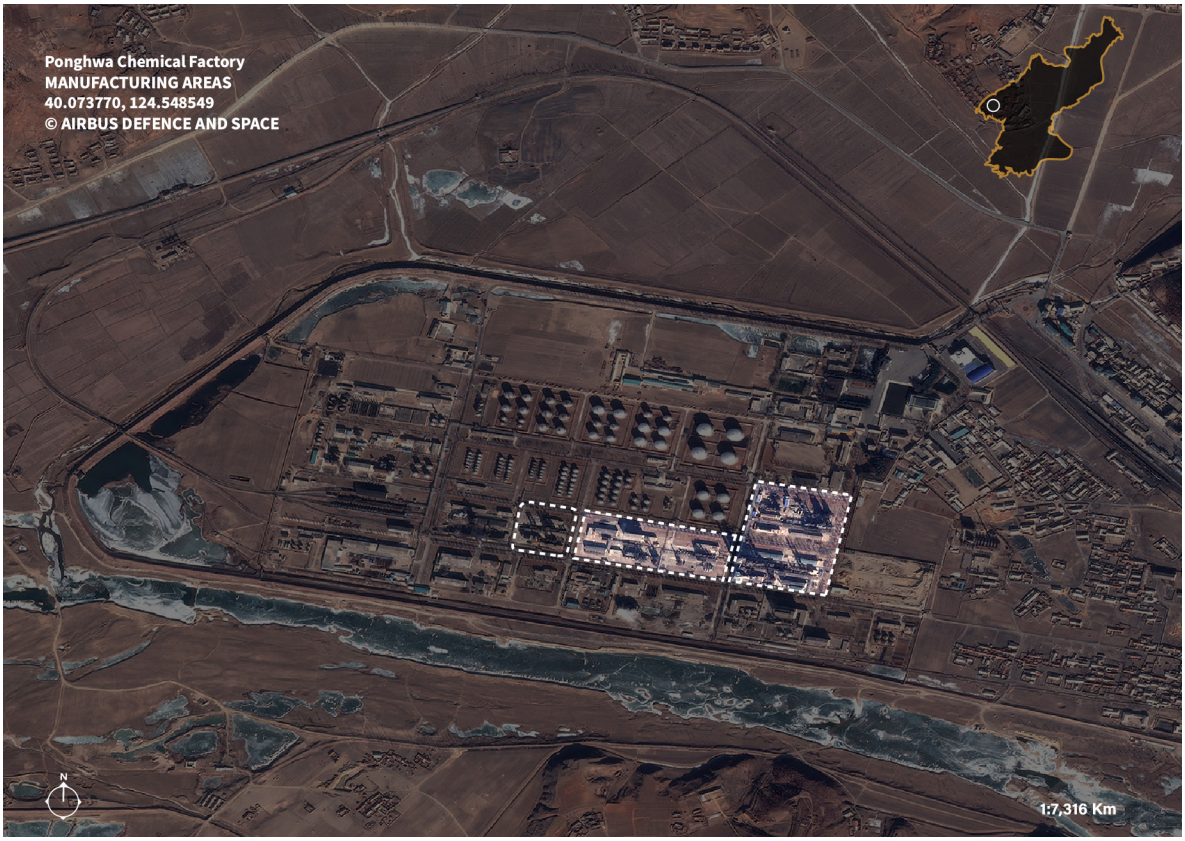

*Source: David von Hippel and Peter Hayes, 'Updated Estimates of Refined Product Supply and Demand in the DPRK, 2010-2020', Nautilus Institute, 2 September 2020, p. 23, <https://nautilus.org/napsnet/ napsnet-special-reports/updated-estimates-of-refined-product-supply-and-demand-in-the-dprk-2010-2020/?view=pdf>, accessed 15 February 2023 .*

Most of the equipment at the Ponghwa Chemical Factory is relatively large in scale and consistent with that expected for refining crude oil, although the Ponghwa refinery is small by international oil-refining industry standards. The manufacturing areas are broadly similar, comprising equipment in open structures, plant-dedicated stock tanks and buildings. Buildings likely house control rooms, quality-control laboratories, offices and localised amenities as well as additional parts of the process.

It is possible to make out numerous distillation columns in satellite imagery which would be a major part of any refinery.

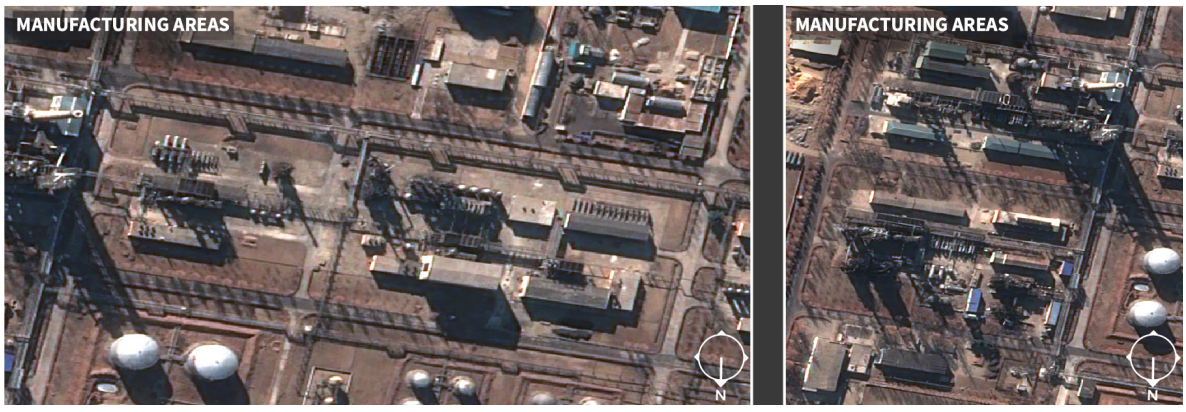
The satellite images in Figures 9 and 10 show the locations and close ups of the manufacturing areas within the Ponghwa Chemical Factory.

**Figure 9:** Manufacturing Areas




*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

**Figure 10:** Close Ups of the Manufacturing Areas




*Source: Airbus Defence and Space, 17 January 2022. Annoted by the author.*

A portion of the lighter fractions from refineries tends to be used at least in part as feedstocks for the petrochemical industry, which produces the more specific molecules used widely in the organic chemical industry and would serve as the building blocks for any chemical weapons programme.

## The Ponghwa Chemical Factory, Materials Handling: Tank Farm, Pipe Tracks, Loading/Offloading

A tank farm occupies a significant area of the site. This is unsurprising given that refineries tend to operate on large volumes and a variety of different product streams. The tank farm, comprising over 100 stock tanks of varying sizes, is contained within several different bunded areas. These include five spherical vessels, which would typically be used for more hazardous material such as liquefied gases.

The tank farm likely holds the raw materials, intermediates, final products and perhaps recycle material for all the manufacturing areas on site. In August 2020, Von Hippel and Hayes estimated the storage capacity at Ponghwa.[18] This capacity did not include the five spherical tanks. The separate bunding implies groupings of the same or similar chemicals and indicates good chemical engineering design.

18. Von Hippel and Hayes, 'Updated Estimates of Refined Product Supply and Demand in the DPRK, 2010-2020'.

**Figure 11:** Location of the Ponghwa Chemical Factory Tank Farm Within the Site


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

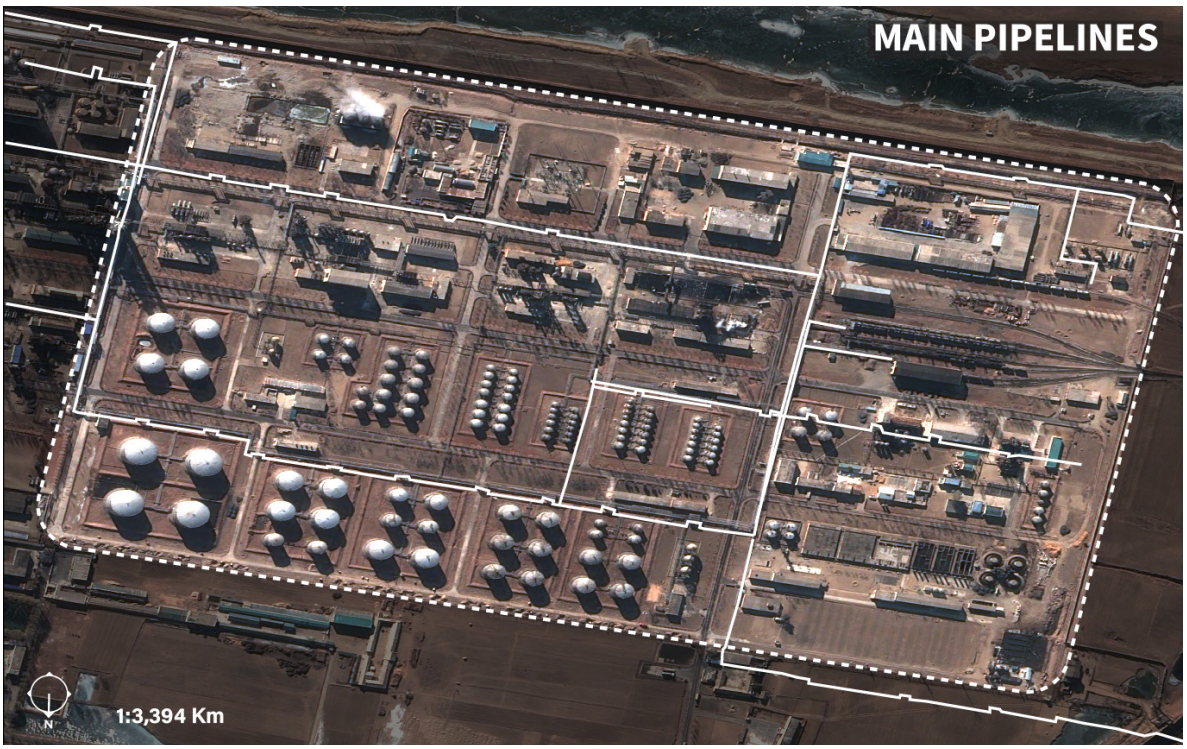
**Figure 12:** Tank Farm


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

The tanks are connected to the various manufacturing areas by means of pipe tracks which also connect to the rail loading/offloading area.

When physically present on sites, it can be difficult to differentiate between various pipe runs, and this is nearly impossible to do using satellite imagery. However, piping clearly runs throughout the plant site, enabling the transfer of process fluids between loading/offloading facilities, the individual processes and the tanks in the tank farm. Pipelines also connect the site with external areas, which will be covered later.

**Figure 13:** Main Pipe Tracks Throughout the Site




*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

There appears to be a second, smaller tank farm with associated buildings in the southwestern corner of the plant site. The size of the buildings relative to the stock tanks means it is unlikely that any production or processing takes place in this area. Its proximity to the railway along with what appears to be a gantry indicates that rail tankers are filled or offloaded here.

A significant amount of activity takes place in the rail transhipment yard with tanker cars frequently observed in the integrated rail sidings. These are most likely outgoing products as incoming crude oil is more likely to be offloaded into the Songun-ni storage facility, as discussed later. However, it is possible that it is also used for incoming raw materials for use on the site.

**Figure 14:** Location of Rail Loading/Offloading Yard Within Ponghwa Chemical Factory


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

**Figure 15:** Rail Loading/Offloading Yard


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

The main road access to Ponghwa is in the northeastern corner of the site. Satellite imagery has shown road tankers waiting to enter and there is also what appears to be a weighbridge near the main road entrance to the site. It therefore follows that there will be facilities on site used for the loading/offloading of these tankers. There is a structure in the northwest corner of the tank farm, adjacent to the spherical tanks, which likely houses a road-tanker loading station, but aside from that, no other road-tanker loading facilities were identified from available satellite imagery.

## The Ponghwa Chemical Factory: Utilities

The adjacent coal yard storage has a possible limited washing/preparation/processing capability. The small scale of this area and lack of conveyors suggest that coal is not a primary source of fuel for the facility. Adjacent to the coal yard, there is a small plant which is likely a coking plant using the residual tars from the other plant as a feedstock. Petroleum coke produced at the Ponghwa Chemical Factory is likely transferred to the coal yard for storage before being filled into rail wagons for transport elsewhere.

The electrical substation is relatively small and is secured with additional fencing, as would be expected throughout the world.

Power appears to be generated internally through a gas- or oil-fired power station at 40°04'14.0"N 124°33'09.0"E, in the southeast corner of the site. This is a relatively small power station for the size of the facility and may suggest that only a limited amount of processing occurs there, although some of the refinery gas is likely used directly to raise steam which would be used in

boilers. The minimal Google Earth imagery available during the winter periods support this view due to the relatively low amount of visible snow melt.

The suggested limited amount of processing is also borne out by the reduction in cooling capacity. Recent satellite imagery has shown that many cooling towers have been demolished, leaving only three to cover the cooling requirements of the whole site.

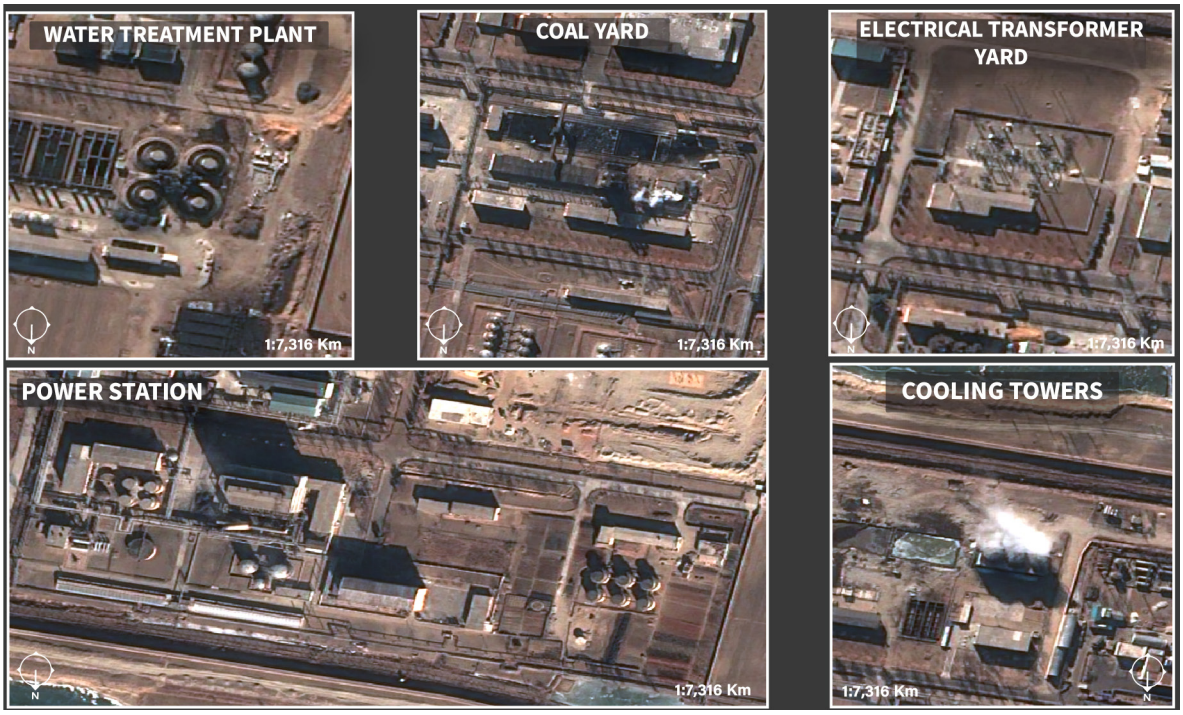
## The Ponghwa Chemical Factory: Waste Treatment

There is a waste treatment facility to the northwest of the site. There are structures that would enable the separation of solids and the organic and aqueous phases of refinery waste streams. There are four circular structures which would likely be used for microbial digestion of organic content in wastewater. A channel on the other side of the site wall, close to the facility, leads to a pool on the west of the site. This may be the outfall directly from the waste treatment facility or simply a drainage channel for the rainwater drains from the site.

**Figure 16:** Location of Utilities and Wastewater Treatment in the Plant Site


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

**Figure 17:** Utilities and Waste Treatment




*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

## The Ponghwa Chemical Factory: Administrative Areas and Amenities

The main road entrance to the site is a controlled access point at the north of the facility, although there is another road entrance to the south which is more suited for employees living in the nearby residential area. This also has controlled access.

Administrative and recreational areas are located near the main road entrance to the site. The probable main administrative block is marked by its proximity to the entrance and the manicured vegetation in front of it. There are clearly sports pitches in this area. Bermudez and Ahn also refer to the presence of a clinic, a cultural facility, a school, several dorm-style housing buildings, research labs, workshops, a maintenance/motor-pool area, a leadership memorial and a number of miscellaneous support buildings.[19]

19. Bermudez and Ahn, 'North Korea's Ponghwa Chemical Factory'.

**Figure 18:** Location of Administrative Areas and Amenities


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

**Figure 19:** The Main Administrative Area and Amenities


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

## The Ponghwa Chemical Factory: Watercourses and Outside the Main Site Wall

Immediately to the west of the site, there are agricultural fields and irregularly shaped bodies of water that are fed from two watercourses running in a westerly direction within the plant site wall. The layout and site connections to this area, outside the wall but bounded by the banks of the pond, indicate that this area is, to all intents and purposes, part of the plant site.

**Figure 20:** Site Water Courses


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

These westerly flowing water courses originate in rectangular ponds located inside the boundary wall. The southernmost watercourse is likely partly employed as the drainage system for rainwater from the site. The northernmost one is more likely linked to irrigation and drainage of the agricultural fields than it is to any refinery operations. It is unclear where the water in the rectangular ponds originates.

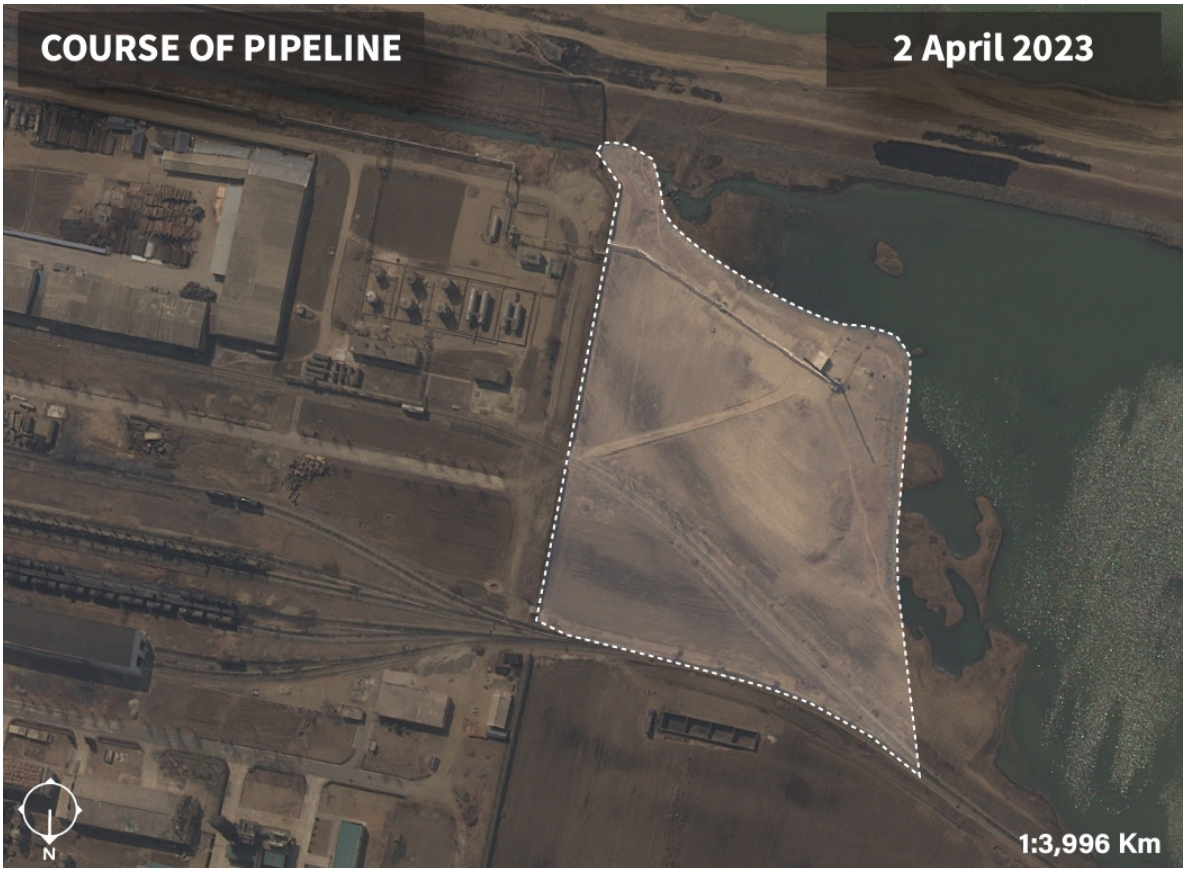
**Figure 21:** Connections Between Site Water Courses


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

The purpose of the water is not clear but given the flammable nature of the chemicals handled on site, it is reasonable to assume that it is a water reservoir for use in firefighting. It may have other or multiple purposes, such as evaporation lagoons for gross contamination with volatile organic compounds, a process water reservoir or a conduit to the river for rainwater from the site.

A pipeline can be seen connecting the main part of the site and the area in its southwestern corner. The purpose of this pipeline is not clear, but its proximity to water suggests it may be used to supply process, cooling or fire water to the site.

**Figure 22:** Southwestern Corner of Site Showing a Pipeline to/from the Main Area



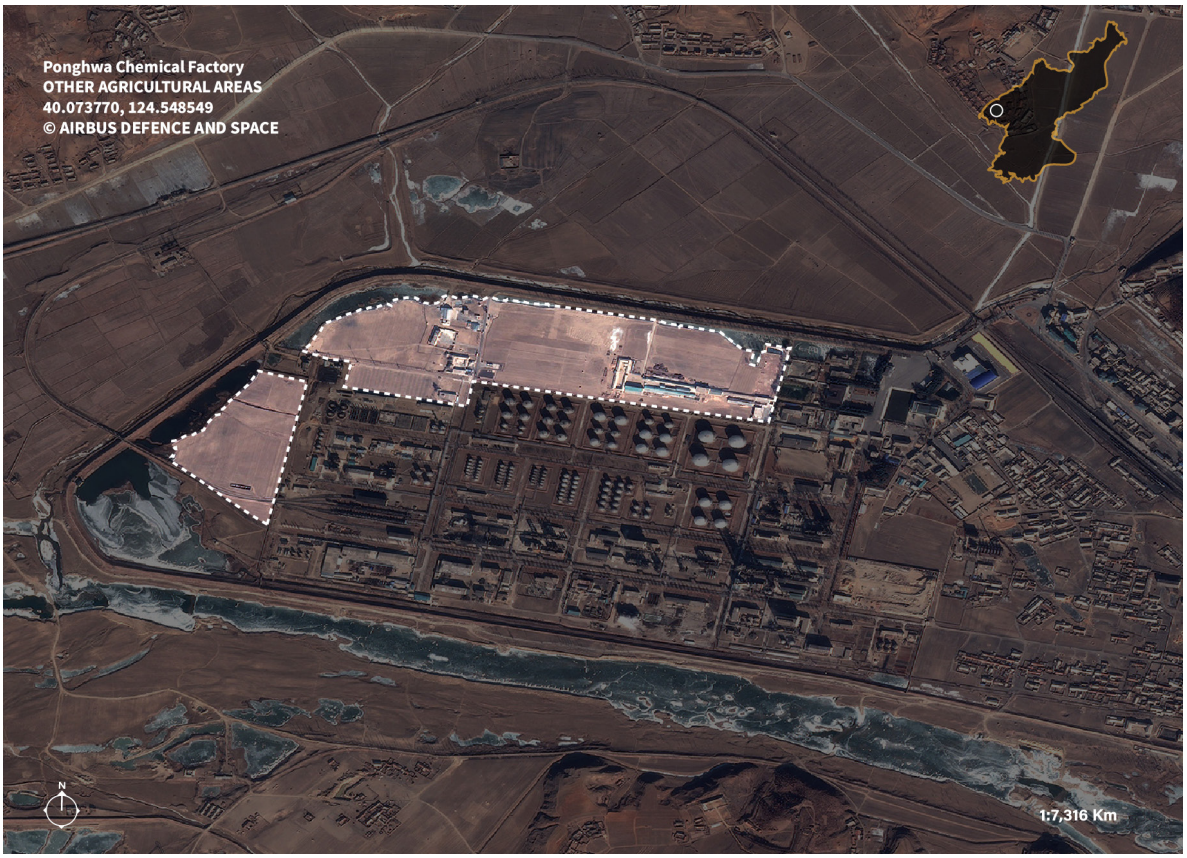

*Source: Airbus Defence and Space, 2 April 2023. Annotated by the author.*

## The Ponghwa Chemical Factory: Agricultural Land

There are areas of agricultural land within the site boundary wall and along the northern length of the site which can only be accessed from the inside. The land is likely used to supplement site workers' diets either directly or by producing animal feed.

North Korea commonly permits suitable land to be used for farming. The close proximity of farmland to operational areas of the site indicates that the site is unlikely to be handling particularly toxic chemicals, which might harm farm animals or crops.

**Figure 23:** Agricultural Areas: Area to the West, Outside the Site Wall, and the Northern Section, Within the Site Wall




*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

## The Ponghwa Chemical Factory: Site Security

Small buildings are at each entrance to the facility (road and rail). These are presumably staffed and control access to the site. The facility itself, as indicated previously, is secured by a wall. Several of the different areas within the site are also walled, but there is nothing on imagery to indicate particularly sensitive areas within the overall facility (for example, no additional guard towers, fencing or restricted access). Moreover, security is consistent with that expected for an industrial site within North Korea and indeed in many other parts of the world.

## The Ponghwa Chemical Factory: Is It Still Operational?

Recent construction work at the Ponghwa Chemical Factory demonstrates continued investment and is a strong indicator that the site remains operational.

In addition to the new catalytic cracker, mentioned earlier, construction of a new building near the main site entrance commenced in mid-2018. It is roughly 80 x 40 m and comprises two sections. There also appears to be an additional covered structure on part of the larger building. At the opposite end, there is a structure of approximately 18 x 15 m, supporting a circular/cylindrical arrangement. Piping appears to connect the roof of the building and this supporting structure.

The purpose of the building or the structure on top is not clear, but its location, poor access for large vehicles and lack of significant security measures suggest it forms an administrative or support function for the site.

**Figure 24:** Location of New Building Near the Site Entrance


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

Figure 25 shows the progress over time from partway through its construction in August 2018 through to more recent imagery showing the growth of vegetation on the roof in April 2023.

**Figure 25:** Recently Constructed Building at the Site Entrance

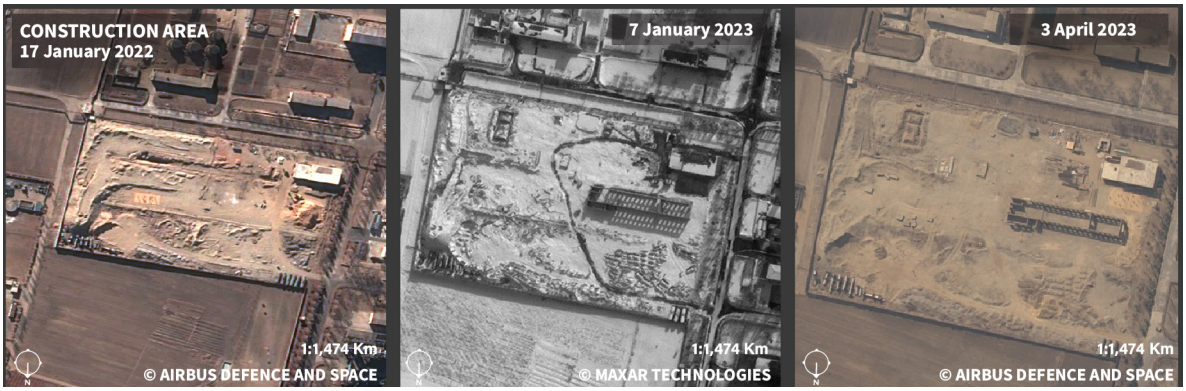

*Source: Airbus Defence and Space, 31 August 2018, 17 January 2022 and 4 April 2023. Annotated by the author.*

In another development, since 2019, the site boundary wall was demolished in one area and reconstructed to incorporate a parcel of land formerly outside the site wall. Construction work appears to have started on this land but is progressing slowly.

**Figure 26:** Location of Ongoing Construction and Recent Incorporation of Land Within the Site Boundary


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

**Figure 27:** Ongoing Construction




*Source: Airbus Defence and Space, 17 January 2022 and 3 April 2023; Maxar Technologies, 7 January 2023. Annotated by the author.*

In addition to these construction projects, recent satellite images have shown emissions from vents as well as water vapour coming from the cooling towers. Furthermore, wagons and tankers are seen in the wagon yard as well as what appears to be workers on the construction site. These indicators demonstrate not only that the site is operational, but that there is continued investment, emphasising the importance of the Ponghwa Chemical Factory to North Korea.

**Figure 28:** Other Ongoing Activities


*Source: Airbus Defence and Space, 17 January 2022 (base image), 2 April 2023 and 3 April 2023; Maxar Technologies, 7 January 2023 and 2 April 2023. Annotated by the author.*

## How is the Plant Site Defined? What is not Part of the Site, but Appears Related to It?

Several places are connected to the site by pipeline. There are also areas linked to the site by geography or local infrastructure. These related areas are described below.

### Sojung-ni Oil Storage Facility (40°03'55"N 124°34'45"E)

Crude oil is delivered to the facility via an underground pipeline from China.[20] Pipelines connect this storage facility with the main site.

20. Seulkee Jang, 'Construction Work on Sino-North Korean Oil Pipeline Underway', *Daily NK*, 17 August 2021, <https://www.dailynk.com/english/construction-work-sino-north-korean-oil-pipeline-underway/>, accessed 3 March 2023.

From here, the crude oil can be transferred via pipelines to the main site. Rail sidings at this facility would allow for the loading and offloading of rail cars, either for transfer of crude oil elsewhere in the country or for the delivery of crude oil from sources other than the pipeline from China.

**Figure 29:** Sojung-ni Oil Storage Facility


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

### Locomotive Shed (40°04'44"N 124°32'18"E)

This comprises two main structures; one covers the rail tracks and the other is a stone/concrete building. This area is connected to the main plant site by means of pipeline. The rail line is connected to the branch line referenced above. Rail tankers are routinely seen within the facility at this terminal point.

Bermudez and Ahn indicate that diesel locomotives are maintained at this facility and that the pipeline supplies diesel, as fuel, from the facility.[21] The pipeline's length indicates it is dedicated to one fluid and the limited space for any potential loading/offloading of rail tankers would support this statement.

21. Bermudez and Ahn, 'North Korea's Ponghwa Chemical Factory'.

**Figure 30:** Locomotive Shed


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

### Industrial Unit (40°03'18"N 124°34'55"E)

This facility is connected to the Ponghwa Chemical Factory by pipeline. Spherical rail tanks present at the facility indicate the handling of liquefied gas(es). What appear to be pressurised cylinders are also present. There is a solids-handling unit at the eastern end of the unit which links to three buildings. Three storage yards with their own overhead cranes are used to load or offload items from rail cars.

**Figure 31:** Industrial Unit


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

### Production Unit (40°04’20”N 124°33’25”E)

This is a small standalone facility, connected to the main facility via a pipeline. The solid material is probably limestone with the facility producing lime-based products, such as milk of lime, using oil to generate heat to break down the limestone. Ponds immediately to the east of the plant site appear to be artificial and likely supply water needs to the facility.

**Figure 32:** Production Unit


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

## Mixed-Use Area (40°04'15"N 124°33'35"E)

The area immediately to the east of the site and bounded by the main road and railway line to the east is a mix of residential housing, industrial areas (including the one connected by pipeline, mentioned above) and open land, which appears to be agricultural. The site can also be accessed from this area which suggests that the housing is for those who work on the site.

**Figure 33:** Residential/Agricultural/Industrial Area


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

## Cement Kiln (40°04'01"N 124°33'45"E)

To the south of this mixed-use area, there is what is likely to be a small cement kiln. This is consistent with construction activities in the area.

**Figure 34:** Cement Kiln


*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

### Samha-dong Storage Facility (40°06'09"N 124°35'33"E)

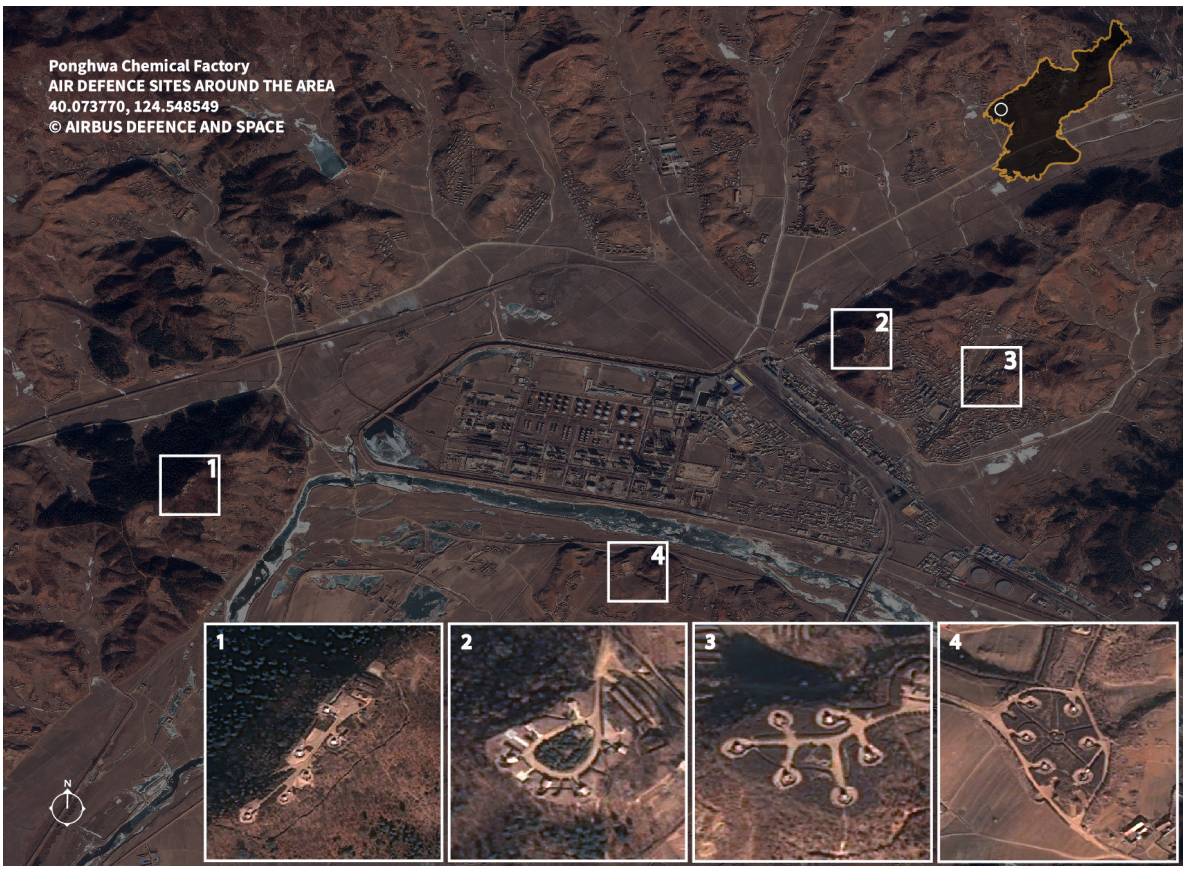
In addition to areas connected by pipeline, a branch line from the railway terminates at a facility to the north of Ponghwa Chemical Factory. Bermudez and Ahn referred to this as the Samha-dong Storage Facility and hypothesised that it is an underground storage facility for either crude oil or petroleum products.[22] Given its close location to the site, approximately 3 km to the northeast, and its connectivity by road and rail, it seems highly likely that activities relate to products manufactured on the site. Its hypothesised use as storage for these products is logical, given the need to protect fuel in a time of conflict.

### The Ponghwa Chemical Factory: External Security

There are four confirmed and one possible air-defence sites surrounding the facility, although the latter may be storage for missiles or ammunition. The close proximity of these sites to the facility indicates that these act as point defence and are likely to be short range. The quality of available Google Earth imagery, the fact that North Korea often uses non-standard air-defence site layouts and the presence of environmental shelters preclude positive confirmation of the air-defence systems present. While the presence of these sites indicates the strategically significant nature of the site, it is not unusual for North Korea's critical national infrastructure to be protected in this way and this in itself does not indicate anything particularly sensitive.

22. *Ibid.*

**Figure 35:** Location of Air-Defence Sites




*Source: Airbus Defence and Space, 17 January 2022. Annotated by the author.*

## Conclusions and Next Steps

The Ponghwa Chemical Factory is nearly 50 years old. At such an age, it would be expected that the site would not be operational without regular maintenance and replacement of equipment. Recent satellite imagery has demonstrated continued investment in the site as well as indicators to its ongoing operation.

This site profile has identified the features in and around the Ponghwa Chemical Factory. Features are consistent with those that would be expected of a refinery that is viewed as critical national infrastructure. Furthermore, this provides a good baseline of the features and infrastructure expected on an industrial chemical factory in North Korea.

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