SAINT LAWRENCE SEA-WAY

The Saint Lawrence Sea-way is one of the most developed water ways in North America and in the whole world.
It is an inland water way partially artificially constructed from the Gulf of Saint Lawrence to the western end of the Great lakes.
The Saint Lawrence Sea-way is a massive Canadian-United States navigational project constructed under the Saint Lawrence Project whose main aim was to create navigable water way in order to promote trade and development. The Saint Lawrence sea-way covers a distance of 3769kilometres.
A massive Canadian-United States navigational project was completed at a cost of US$ 470 million and employed 22,000 workers.
The problems of transportation had existed earlier on but it took long the project to begin. The delay of the project was mainly because the United States of America was unwilling to cooperate and yet Canada did not have sufficient funds to carry out the work on her own.
The construction of the Sea-way begun in August 1954 and it was completed in April 1959.When the project was completed in April 1959; Ocean going vessels/ships were able to sail for the first time all the way from the mouth of Saint Lawrence River to the western shores of Lake Superior.

A sketch of the Great lakes and Saint Lawrence Se-way showing the ports/towns, rapids, waterfalls, water bodies and states of USA and provinces of Canada.

Research work: Draw a well labelled diagram showing a section along the Great Lakes region from Lake Superior to the Saint Lawrence River

Reasons why the Saint Lawrence project delayed

1. Canada did not have adequate capital to start the work.
2. The United States of America feared that her railways would lose market to the sea way and become redundant.
3. The United States of America feared that the New York Port and other gulf or Atlantic ports would lose market since traffic was going to be diverted to the sea way.
4. The United States of America felt that small ships would still sail in the region of the Great lakes and Saint Lawrence river without the construction of the sea way.

However, some companies within the United States of America for example the United States of America Steel industry favoured the construction of the Saint Lawrence sea way because it would obtain iron ore cheaply from Labrador and in the areas of west of Lake Superior.

In 1950, the United States of America finally accepted to cooperate with Canada in the construction of the sea way and in 1954, the great engineering work began.

The USA agreed to cooperate because of the following reasons:

- By 1950, Canada had accumulated a lot of sums of money to start her own work and the United States of America realized that if Canada built the sea way alone Canada would monopolise the dues paid by the shipping companies.
- The United States of America realized that if Canada was in total control of the sea way, she would be liable to pay charges for the use of the sea way.
- The United States of America also realized that the construction of the sea way would lead to the development of iron and steel industries since they would be able to obtain raw materials very cheaply.
- The United States of America realized that there was need for socio-economic and political cooperation with her northern neighbour for strategic reasons.

Aims of the Saint Lawrence sea way project

1. To improve navigation between Saint Lawrence estuary and the Great lakes between Ontario and Montreal town to promote economic activities.
2. To generate hydro electrical power through the construction of the dams in the region.
3. To provide cheap sea-route into the interior for bulky export and import goods.
4. It was to open up the interior of North America with the rest of the world.
5. To promote regional/international cooperation between Canada and United States of America.
6. To provide alternative route to the northern route because it is under frozen conditions during the winter.
7. To control floods along the Saint Lawrence River.

Therefore, Saint Lawrence Sea way is a multi-purpose project because it was designed for several uses.

SHIPPING HAZARDS/BOTTLENECKS/OBSTACLES ON THE GREAT LAKES AND SAINT LAWRENCE RIVER BFORE THE CONSTRUCTION OF THE SEA-WAY PROJECT

1. Rapids and water falls:
   - There were a number of rapids between Montreal and Lake Ontario like the Long Sault rapids and Lachine rapids; Sault Ste Marie between lakes Superior and Huron.
   - Water falls like **Niagara Falls**:
     - Niagara is an Indian word meaning "Thunder of water".
       It lies between lakes Eric and Ontario along river Niagara and it is about fifty (50) kilometers.
       The Niagara Falls passes through a narrow gorge (a gorge is a narrow valley) with foaming rapids. The water fall is almost 100 metres.
       The gorge was formed as the water falls plunged over resistant dolomite limestone rocks. However, the water fall is gradually wearing way the dolomite limestone rocks at a rate of one metre per annum.
       Steps are being taken to reduce the rate of erosion on the gorge through which the water fall passes. Niagara Falls is an important tourist attraction.
       It attracts over two (2) million visitors from within North America and outside.
     - Other important water falls are **Horse shoe fall** in Canada and the **America falls** in USA. These two water falls are separated by ***Goat Island.*** The water falls and rapids hampered navigation.
2. The shallow rocky areas/underlying rocks/rock shoals/water barriers. Some parts of the Sea-way were covered by underlying rocks for example there was a thousand islands section just after Lake Ontario.
3. The different levels of water/water heights for example it was difficult to sail between lakes Ontario and Eric.
4. The freezing of the water during the winter season for five months of the year forcing the sea-way to be closed.
5. Occurrence of fog which limits visibility creating the risk of accidents.

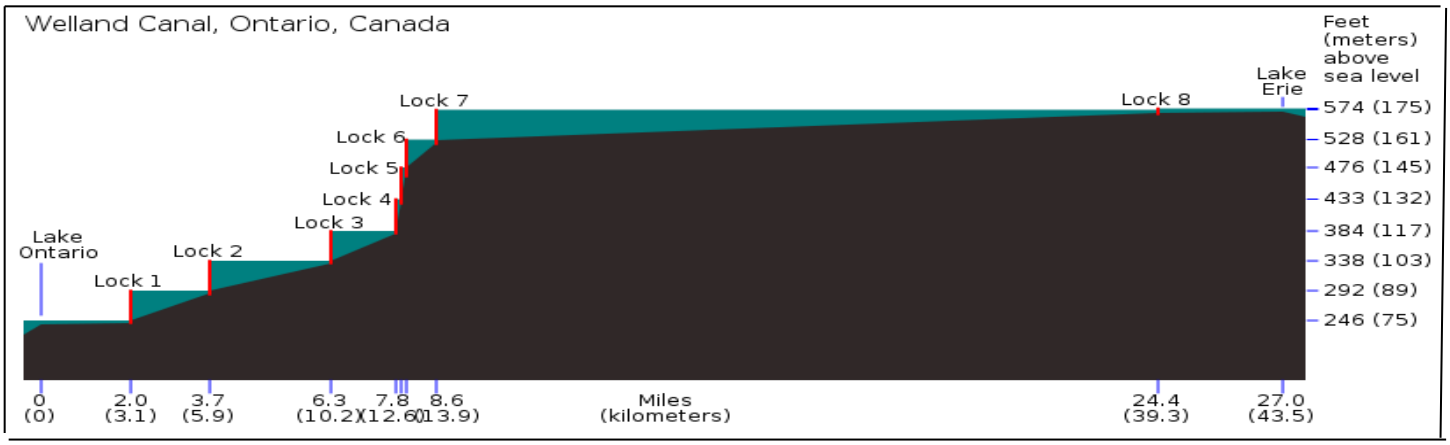
Draw a diagram showing the Great Lakes region before and after the establishment of the Saint Lawrence sea-way

- Before the construction of the Saint Lawrence sea-way. Refer the North America by Yiga Matovu
- After the construction of the Saint Lawrence sea-way. Refer to North America by Yiga Matovu

Steps being taken to solve the problems along the Lawrence sea- way

- **Construction of locks** along the Saint Lawrence River to regulate the water levels at the time of navigation. This minimizes water fluctuations.
  Locks were constructed between Ontario Lake and Montreal town on the Saint Lawrence River.
  There are eight locks between Lake Ontario and Montreal which include: - Eisenhower, Snell locks near Massena, Iroquois, Melocheville, Beauharnois (2), Cote Ste. Catherine and Saint Lambert as illustrated below:

A profile of Saint Lawrence sea-way showing the locks that helps to overcome varying water levels

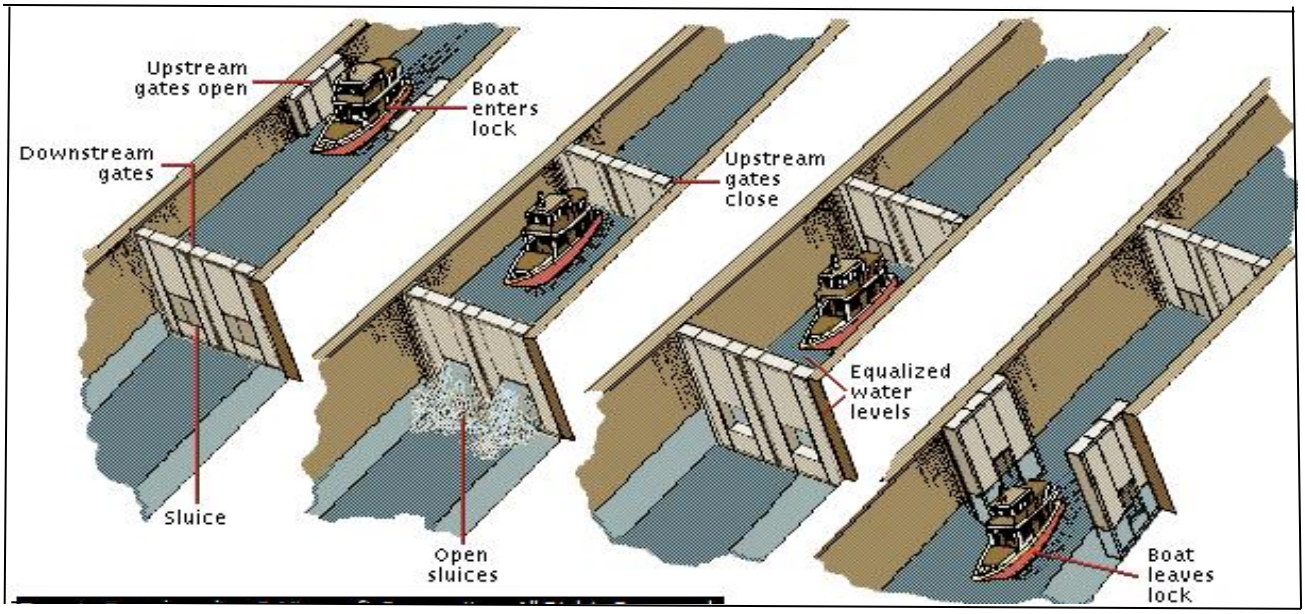


Draw another diagram showing the A profile of Saint Lawrence sea-way showing the locks that helps to overcome varying water levels refer to North America by Yiga Matovu

How the locks work

- Locks were constructed at the dams to enable navigation or the sailing of the ships from one height level to another.
- They have sluice gates which are opened to allow in water or closed to enable water to accumulate so as to raise the water levels to enable shipping activities.
- In most of the areas where locks have been constructed, efforts have been made to construct twinned gates to enable two- way traffic to avoid delays.

Series of diagrams showing the movement of a ship through a lock



- **Dredging of the Saint Lawrence River** from Kingston to Montreal to make the river deeper that is 27 feet (8 metres) deeper and wider 200 feet (61 metres) to allow the navigation of large ocean-going vessels. Dredging involve the deepening and widening of the river channel to accommodate and allow big vessels to sail through.
- **Blasting of the rock shoals using dynamites** to eradicate rock outcrops from the Saint Lawrence River at the head of Lake Ontario around the thousand islands section.

- **Installation of strong lights/radar systems** which increase visibility under foggy conditions.
- **Construction of dams** along the Saint Lawrence River to control the floods and for generation of hydroelectric power. Several dams were constructed to control the floods for example Long Sault dam, Sir Adam Beck power dam, Moses-Saunders dam.
    - It is important to note that the greatest concentration of developed hydro electrical power in the world is around the Niagara Falls. The generating plants altogether produce more than 4,000 megawatts of power. The production of HEP, running water is used to turn the turbo-turbines that drive the generators to produce electricity. It is being used for agricultural, domestic, communication and industrial purposes.
- **Construction of canals** to by-pass rapids like the Long Sault rapids and Lachine rapids between Montreal and Lake Ontario and Sault Ste. Marie between lakes Superior and Huron; water falls like Niagara between lakes Eric and Ontario and Horse shoe fall in Canada and connect the Great lakes.
  Examples of the canals are Corn well canal, Montreal canal, Beauharnois canal, Wiley-Dondero canal, Welland canal, Sault Ste. Marie canal.

Case studies of the canals

1) **The Welland** canal connects lakes Eric and Ontario to by-pass the Niagara Falls as a hindrance to navigation as illustrated below:

Location of the Welland Canal

The original canal was built in the 1860's and improvements were made several times until 1932 when a modern ship canal was constructed. There are eight (8) locks on the Welland canal. As part of the Saint Lawrence sea way project, further improvements were made on the Welland canal and these included the following:

a) It was deepened by dredging to minimum depth of 8.2 metres.
b) It was widened to enable larger vessels to sail through.
c) The existing locks were doubled (twinned) to enable two-way traffic to avoid delays.

2) **Sault Ste Marie canal (Soo canal)** by- passes a stretch of rapids on St. Mary's river between Lakes Superior and Huron. It was constructed to link Lake Superior to Lake Huron by- passing the Sault Ste Marie rapids. This canal, however, has a restricted season because of severe winter period. When the Sault Ste Marie canal (Soo canal) is in operation, it is able to handle more traffic than the Suez and Panama canals combined together.

Problems created by Saint Lawrence sea-way

- Lake Saint Lawrence –a man-made lake flooded large areas and destroyed villages, towns and over 50km of the Canadian high way and national railway lines.
- It drained the economies of the two countries because it was very expensive venture.
- It led to destruction of the natural environment or eco-system.

Problems which are still facing Saint Lawrence sea-way

Problems	Steps being taken to solve the problems
• Siltation of the water way	○ Constant dredging
• Freezing of the water way during the winter season	○ Use of ice breakers to allow a few vessels to go through.
• Poor visibility during the winter due to fog and smog	○ Installation of neon flood lights and use of the radar system to avoid accidents
• The sea way is still shallow and narrow to allow very long ocean vessels	○ The use of alternative routes through the Bunge canal on the Mohawk gap via the Hudson river to New York
• Traffic congestion at the sea ports especially in the winter season	○ Containerization
• Delays at the locks	○ Time tabling of the voyages

Products transported by the Saint Lawrence sea way

1. Exports carried along the Great lakes and Saint Lawrence sea-way includes:
   - Manufactured products like Vehicles, Machinery, Electronics and Armaments.
   - Agricultural products: like Beef, dairy products, fruits, Barley, Wheat and Corn.
   - Forestry products: timber, News print, plywood, furniture, blocks boards, round wood.
2. Imports carried along the Great lakes and Saint Lawrence sea-way includes:
   - Minerals like Iron ore, Limestone, Coal, Petroleum
   - Agricultural products, Machinery and Textiles.

Benefits of the Saint Lawrence sea way

- It has promoted the development of industries around the Great lakes and along Saint Lawrence River which depend on imported raw materials for example iron smelting plants in Cleveland.
- It has led to the growth and development of urban centres/towns/conurbations with associated facilities like Kingston, Prescott, Ogdensburg, Cornwell and inland ports such as Chicago on shores of Lake Michigan and Duluth on Shores of Superior Lake due to the increased volume of trade.
- It has led to provision of employment opportunities to people of Canada and USA. There are so many people who are employed in manufacturing sector, transport sector and construction units which have led to improved standards of living of the people.

- It has led to production of cheap hydroelectric power from dams like Long Sault dam, Sir Adam Beck power dam, Moses-Saunders for industrial, agricultural, communication and domestic purposes.
- It has promoted the international trade between United States of America, Canada and other countries.
- It has promoted the exploitation of agricultural land in the interior of Canada and United States of America therefore, the development of the agricultural sector.
- It has led to the development of the mining industry. It has led to the exploitation of minerals for example iron ore from Thunder Bay and coal from Cleveland and Pittsburgh.
- It has led to improved water transport along the Saint Lawrence River and on the Great lakes. Navigation along the water way is possible for bigger vessels.
- It has led to the development of improved transport and communication: - roads, railways, airports, inland ports and seaports have been constructed and it has eased mobility of people in the region.
- It has promoted the development of the tourism industry because it is a tourist attraction hence generating more income for the two countries. It has increased tourism along the water way to see the Niagara Falls and the lock system.
- It has led to the development of social amenities like schools, hospitals and recreational centres.
- It has increased the tax base of United States of America and Canada through the toll paid by the shipping companies.
- Occasional floods along the region have been controlled by construction of dams.
- It has led to industrialisation of the region because of the cheap transport means and presence of a reliable market in the region.

Development around the Great lakes Region

Several developments have been cropped up around the Great lakes region and around the Saint Lawrence River. This has been mainly attributed to the construction of the Saint Lawrence sea way. These developments include the following:

- Development of a well-developed transport & communication systems
- Development of the agricultural sector
- Development of cities/conurbations
- Development of the mining industry
- Development of the industrial sector
- Exploitation of forestry resources

Industrial development in the Great Lakes region and along the Saint Lawrence River

The area around the Great lakes and along Saint Lawrence River is one of the major regions of United States of America and Canada.

The major industrial centres found in the Great lakes region include:

- Pittsburgh
- Cleveland
- Chicago
- Buffalo
- Duluth
- Montreal
- Thunder Bay

The major industries found in the major industrial centres are

- Iron and steel industries
- Textiles
- Food processing industries
- Metallurgical industries
- Fuel and power industries
- Auto mobile industries

- Chemical works/industries
- Engineering industries
- Pottery ware

The development of industries in the Great lakes region and around the Saint Lawrence sea-way is **attributed** to the following factors:

- Presence of reliable source of raw materials for example agricultural produce like wheat from the Canadian prairies, corn from Dakota state; minerals like iron ore from Thunder Bay and Mesabi mountains and water from the great lakes.
- Presence of different/abundant sources of energy or power for example the hydro electrical power from Sir Long Sault dam, Sir Adam Beck power dam, Moses-Saunders, energy from the high grade coal from Cleveland and Pittsburgh; nuclear power and natural gas which is used in running of the machines and in all the production lines for the manufacturing of the goods.
- Presence of efficient and improved transport and communication networks for transportation of workers and industrial inputs and distribution of the manufactured goods within United States of America and Canada.
- Presence of ready market for the manufactured goods both internal and external markets because of the high-quality goods manufactured.
- Use of advanced/appropriate technology in the processing and manufacturing goods.
- Presence of large supply of skilled and semi-skilled labour used in the processing marketing and distribution of manufactured goods.
- Availability of adequate capital provided by multi-national companies for industrial development, mineral exploration and extraction.
- Presence of abundant water supply from the Great lakes and Saint Lawrence River for cooling and cleaning of the industrial machines.
- Positive government policy of both Canada and United States of America of encouraging industrialization.

Contribution of the industrial sector to the development of the great lakes

There are several benefits of industrialization and these include:

- It has improved the United States of America's balance of trade through the exportation of processed commodities which command higher prices in the outside markets. It also reduces the volume of imports into the United States of America's markets.
- The Manufacturing sector has led to self-sufficiency in manufactured goods.
- Manufacturing industries provides employment to the people of United States and Canada.
- It has encouraged efficient and maximum use of the available resources like minerals for example iron ore and water resources.
- Industrialization has raised the standards of living since the urban industrial workers have higher and more reliable incomes than farmers.
- It has also stimulated the development of infrastructure and social services.
- It has led to growth and development of urban areas like Thunder Bay and Cleveland.
- There is capital inflow from the foreign investors.
- It has promoted the tourist industry.
- Diversification of the economy of United States of America and Canada through inter-sectorial linkages between agriculture and industry.

Problems resulting from industrialization

Industrial development has come along with disadvantages as listed below;

- Environmental pollution of air, water and land through oil spills, dumping of waste, emission of poisonous fumes.
- It has led to unemployment in the region due to the use of automated machines.
- It has led to depletion of natural resources like fish and forest resources.
- It has led to de-vegetation of large areas that affects bio-diversity.
- It has led to process of urbanization with its related problems.
- It leads to displacement of indigenous population
- Increased competition for labour force between the agriculture and manufacturing sector lead to high labour costs.

Case study: The iron and steel industry in the great lakes region

This industry is based on iron ore. It involves the smelting of iron ore and processing of the mineral into iron or steel products.

The iron and steel industry form the basis of all the ferrous metallurgical industries.

It is the most important of all industries known.

The existence and prosperity of automobile, metallurgical industry, ship building and aircraft industry and mineral extracting industry is directly linked to that of the iron and steel industry.

Most the iron and steel industries are located in the north-eastern parts of the United States of America.

The iron is extracted through the open cast mining method.

Iron ore is transported to the iron and steel industries by water and railway.

Characteristics of the iron and steel industries

- They are heavy manufacturing industries because they used a lot of raw materials.
- They used a lot of water for example 65,000 gallons are required to produce one ton of steel.
- They require a large source of skilled labour supply.
- Products are mainly producer goods; however, there are also consumer goods.
- Iron ore is the most important raw material and others are coal and limestone.

Factors that have led to the development of iron and steel industries in the great lakes region

- Availability of reliable source of pig iron scraps from Thunder Bay and Mesabi mountains and water from the great lakes.
- Presence of different sources of energy or power for example the hydro electrical power from Sir Long Sault dam, Sir Adam Beck power dam, Moses-Saunders, energy from the high-grade coal from Cleveland and Pittsburgh; nuclear power and natural gas used in smelting and processing the mineral.
- Presence of efficient transport and communication networks for transportation of workers and industrial inputs and distribution of the manufactured goods within United States of America and Canada.
- Presence of reliable market for the finished steel and by- products which is provide by United States of America and Canadian manufacturing industries like locomotives and

electrical engineering and external market because of the high-quality goods manufactured.

- Use of advanced technology in the processing and manufacturing goods.
- Presence of large supply of skilled and semi-skilled labour used in the processing marketing and distribution of manufactured goods.
- Availability of adequate capital provided by multi-national companies like United States Steel Corporation in Pittsburgh is used in the construction of the industries, buying of the inputs and advertising of the manufactured goods.
- Presence of abundant water supply from the Great lakes and Saint Lawrence River for cooling and cleaning of the industrial machines for example 65,000 gallons of water are required to produce one ton of steel.
- Favourable government policy of both Canada and United States of America of encouraging industrialization.

***Project work**: Outline the uses of products obtained from the iron and steel industries.*

Development of efficient transport system

The Saint Lawrence Sea way has created an efficient transport link and it is by far the best known American inland water way.

It was designed for the shipment of cargo at high speed. All the ports or terminals along the sea way are equipped with advanced facilities like cranes to handle the goods.

There are seven locks used to regular water to allow big ships to sail through the sea way.

In addition, the use of ice breakers has helped in facilitating the shipment of goods during the winter period. Links to other forms of transport like roads, railway and air transport have been improved in the region.

Development of the mining industry in the great lakes region

Mining is a term generally used to mean all the processes involved in the extraction of valuable minerals either in Liquid or solid or gaseous form from the earth's crust for economic uses.

The Minerals are chemical compounds, which occur in the earth's crust and forms the bases of the rocks. Minerals are rocks or natural substances that are extracted from the earth's crust because they are resource full to man.

Development of the agricultural sector

Agriculture has been developed in the region mainly because the inputs and products are easily transported by the sea way, roads, railways and air ports.

Agriculture is more important in the Prairies where the crops like wheat, corn and fodder crops are grown. There is also livestock farming involving dairy farming, beef cattle ranching, factory farming and piggery. The main crops grown in the lowlands of the Saint Lawrence River especially in Gaspe Peninsula are vines, tobacco and fruits like pitches.

The physical conditions favouring the growing of these crops include:

- The presence of well drained fertile soils for plant growth.
- The presence of mild climatic conditions which are favouring the growing crops.
- The presence of large water bodies like Saint Lawrence River which provide water for irrigation farming.
- The gently sloping landscape has eased mechanization and construction of the transport networks.

Dairy farming is also practiced in the Saint Lawrence lowland and main products include milk, cheese and butter.

Development of the cities and inland and sea ports

This has been prompted by the availability of land, abundant power supply, efficient transport systems as well as the presence reliable source of raw materials for industrialisation. The development of the cities and inland ports has been a reflection in the different economic activities carried out in the region.

The major cities and ports include:

Montreal:

Montreal is the largest city and chief port in Canada.

Montreal is one of the leading industrial cities in North America and the major industries include: clothing and textile, air craft industry, grain milling, food processing industries, pulp and paper industry, automobile and electronic industry.

Quebec:

Quebec is located at the Saint Lawrence estuary.

It is well known for the wood pulp and paper industries.

Others industries include textiles, food processing industries and metallurgical industries.

Quebec is one of the main inland ports of Canada and handles minerals like iron ore and crops like wheat.

Ottawa:

Ottawa is the capital city of Canada.

Ottawa has a number of industries for example timber, wood pulp and paper industries.

Toronto:

Toronto is found on the north western shores of Lake Ontario and is Canada's second largest city. The main industries include metallurgical industries, automobile, wood pulp and paper industries and food processing industries.

Thunder Bay:

It is located on the western shores of Lake Superior.

It is the main Canadian inland port in the great lakes' region.

It handles a number of commodities mainly wheat from the Canadian Prairies and iron ore.

It has several elevators for storage purposes.

Rochester:

It is located south of Lake Ontario in the United States of America and handles products like iron ore and steel products, petroleum and beef products.

Duluth:

It is found on the western tip of Lake Superior.

It is an inland port that handles iron ore from the mining fields around Lake Superior; cobalt and wheat.

Buffalo:

It is found at the eastern part of Lake Eric and handles a variety of products. It has industries such as grain milling industries, metallurgical industries and chemical works.

Cleveland:

It is found in the southern part of Lake Eric.

It has industries like iron and steel industries, chemical industries and electrical manufacturing industries.

Detroit:

It is found in the western part of Lake Eric. It is a major city as well as a port.
It has industries like metallurgical industries, air craft manufacturing industries, automobile and chemical works.

Chicago:

It is found on the southern tip of Lake Michigan. It is the largest city in the great lakes region and the third largest city in the United States of America.
It is the world's largest grain and beef market. It has the following manufacturing industries metallurgical industries, pharmaceuticals, food processing industries, Auto mobile industries, Chemical works and Engineering industries.

Others cities and port around the great lakes region include: Milwaukee, Hamilton, London and Lansing.

Types of minerals found in the great lakes region

There are three types of minerals. These include:

- **Metallic minerals**. These are probably the most important being used for a very wide range of purposes. These include iron, aluminium, copper, nickel, cobalt and precious metals like gold and silver.
- **Non –metallic minerals**. These include asbestos, limestone, salt/Trona and phosphate.
- **Fuel minerals.** These are non-metallic minerals derived from vegetable remains and important because they burn. These include oil, coal, natural gas, and geo-thermal.

Others are **rocks,** rocks are aggregations of minerals. Those commercially exploited include granite, marble, sandstone and gravels.

The distribution of minerals in the great lakes region

MINERAL	LOCALITY	USES
IRON ORE	Mined in the south western and eastern shores of Lake Superior. The most important deposits are at Mesabi. Others are Cuyuna, Gogebic and Menominee.	
COAL	Mined in the north east of Lake Eric mainly in Pittsburg. The leading coal field is Pennsylvania coalfield (Luzerne, Scranton, Carbondale, Wikes Barre are the chief mining towns)	
COPPER	Mined in the western shores of Lake Superior and in the northern areas of Lake Huron	
URANIUM	Mined in the north east of Lake Huron	
OIL	Mined in the areas east of east of Lake Michigan and south of Lake Ontario	

Research work:
Draw the sketch map of the great lakes' region showing the distribution of the minerals

Methods of mining

Mining is an extractive industry; once the minerals are extracted from the ground, they cannot be replaced. The deposit in which minerals are contained is known as the ore.

A wide variety of different methods of mining are employed in different parts of the great lakes region. The main methods include:

Open cast mining:

Open cast is the exploitation of minerals that occur close to the surface. It involves the removal of the overburdening materials that is the vegetation and unwanted material and damped nearby. The rock ores are blasted using explosives, and then huge power shovels are used. The mineral ore is removed from the blasted rocks and taken for processing.

The bench method:

This is the open cast mining where terraces or benches are constructed to remove the Ore found at deeper levels. IT ensures that the sides do not become so steep and it helps in transporting of the Ore.

Underground mining:

Underground mining is used in areas where the mineral deposits are covered by a great thickness of earth rocks. In this method, most minerals occur in deep rocks that are extremely hard to remove using mechanical shovels.

Vertical shafts are sunk downwards for several meters to reach mineral seams.

From these shafts, horizontal tunnels are driven outwards to reach the seams of the mineral bearing rocks. Explosives are used to blast the minerals being extracted.

Railway tracks are used to transport ore and waste materials to the foot of the shaft for hoisting to the surface.

Adit mining:

This is employed where minerals occur in gently sloping seams with outcrop on the side of the high land or valley. They are horizontal or gently inclined tunnels that are driven into the hillside.

Oil drilling:

When oil –bearing rocks have been located a hole is dilled from surface to the rocks containing oil. This is done by means of a large metal structure called derrick, from which a steel pipe, the end of which is fitted with a drill head, called a bit, is slowly forced through the surface rocks. As the hole deepens, more steel pipes are added and this continues until the oil deposits are reached. During the drilling mud mixed with water is forced down the pies to lubricate the bit and to flush out the drilled –out rock particles.

Oil gush out of the oil deposit under natural pressure or pumped out.

Alluvial/placer mining:

This is employed when minerals occur in alluvial deposits.

It is done by mixing the alluvium with a great deal of water and tilting or rotating the gravels until the lighter practices (sand, mud, dust, stones) are washed off, leaving behind the heavier ores like gold, tin, chromium, platinum which have a higher specific gravity.

Depending on the extent of the alluvial deposits, the quality of the mineral particles and the nature of the underlying surface, one of the following methods are employed:

- A dredge
- Hydraulic mining

Factors favouring the development of the mining industry in great lakes region

- Presence of rich mineral deposits like iron ore in the Thunder Bay.
- Presence of adequate capital provided by the American governments, private sector.

- Presence of large market for the minerals in different parts of the world for example local market is provided by manufacturing sector and international market is provided by European and Asian countries.
- The presence of reliable and efficient transport and communication networks, Most the mining areas are well served with roads, railways, pipelines to transport oil and natural gas, airports and seaports.
- Availability of ready sources/wide variety of power or energy in the world for example there are several hydroelectric power stations constructed to provide power to mining areas for example Sir Long Sault dam, Sir Adam Beck power dam, Moses-Saunders, energy from the high-grade coal from Cleveland and Pittsburgh.
- Presence of abundant skilled and migrant labour employed in the mining sector.
- Advanced technology used in the mining activities like use of drilling method in Michigan State and placer method in the mining of gold in the Porcupine-Kirkland Lake district of Ontario of Canada.
- Nearness of the minerals to the earth's surface like iron ores in Thunder Bay and coal in Cleveland and Pittsburgh has eased their extraction using open cast method.
- Geological research carried out by the mineral departments of the American countries.
- Favourable government policies like liberalization and the promotion of the private sector to export have led to the development the mining sector.
- Presence of water bodies like rivers and lakes, which provide water, used in the processing of minerals and rivers generate hydro electrical power used in processing of the minerals.

Importance of the mining industry in the great lakes region

- Mining is an important source of foreign exchange in the North American countries for example iron from Labrador in Canada is export mainly to United States of America and this earns the Canadian government foreign exchange.
- It has led to the development of industries: minerals provide the basic raw materials for small scale and large manufacturing industries for iron ore mining in United States of America has led to the development of iron and steel industries.
- The mining sector generates revenue for example the American Governments get revenue from exporting minerals and charge taxes on companies that deal with minerals.
- It provides employment to the people of the United States of America and Canada. This has led to improved standard of living and increased the purchasing power of the miners to buy the manufactured goods.
- Mining improves upon the infrastructure of the United States of America and Canada. The areas where mining is carried out are served with improved and well-maintained roads and railway networks, electricity and telephone services.
- It has led to the development of towns like Cleveland and Pittsburgh.
- It has led to diversification of the economies of the United States of America and Canada thereby reducing their reliance on other sectors like tourism, forestry and fishing.
- Mining has promoted the international relations and co-operation.

- It has boosted tourism in the United States of America and Canada because mining sites are tourist attractions.
- It has facilitated the exploitation of other resources for example underground mining has facilitated the exploitation of forest resources because timber props are as pillars to protect the wall tunnels from collapsing.
- It has contributed towards research and education.
- It has boosted the agricultural sector by providing ready market to the agricultural produce. This is because the large mining population provides ready market for agricultural and industrial products.
- Minerals are sources of power/energy for domestic and industrial use for example oil, coal, uranium, natural gas and coal are used in the industrial sector.

Negative effects of mining to the environment

- It has led to destruction of useful agricultural land by the use of open cast mining.
- The open cast mines are affected by severe winter seasons leading to the filling of the pits with ice making mining very difficult.
- The mining sector has increased pollution of air, water and land by processing industries.
- It has to the destruction of vegetation cover/deforestation.
- Mining has affected underground acquirers (Stores of water) due to reduced infiltration and increasing evaporation caused by quarrying.
- It has led to destruction of habitat for wildlife.
- It has led to the development of urban centers with their associated evils.
- Mining brings about health problems for example dust from the limestone mines bring about bronchitis and asthma.
- Increasing costs of mining.
- It has led to the loss of the aesthetic value of the landscape as hills are excavated.
- Mining has led to exhaustion of some mineral in the great lakes region.

Case study: Coal mining in the great lakes region

Coal is a black or brownish rock consisting mainly carbon and a non-metallic mineral (fuel mineral).

Coal is used as a domestic fuel, a source of industrial power, and vital raw materials for the chemistry industry. Coal is mined mainly in the southern parts of the great lakes region.

The main coal producing states are Pennsylvania, Alabama, Tennessee, Illinois, Kentucky, Iowa, Missouri, and Michigan.

Coal yields gas, tar, benzole and sulphate of ammonia which have many industrial uses.

Types of coal: anthracite, bituminous, lignite and peat.

Coal mining:

It occurs in sedimentary rocks in layers or seams of varying thickness may be exposed or concealed.

It is easily and economically mined by open cast or strip-mining method.

The coal bearing rocks are simply stripped off by giant shovels and scooped up into the trucks to be carried away.

Coal is transported to the processing and manufacturing industries by railways and water ways. The presence of coal in the great lakes region has attracted a number of industries including iron and steel industries.

Reasons for easy mining of coal in the main producing areas

a) Coal layers or seams are exposed to the surface of the earth hence the use of strip-mining method.
b) The underground coal is found in horizontal strata making the extract easier.
c) There are abundant and rich deposits of high-quality coal in the region.
   The great lakes region has the best type of coal known as anthracite.
d) The use of advanced technology in the extraction of coal.
e) The presence of adequate and efficient infrastructure like roads, railways, communication facilities in the region.

Importance/uses of coal

- Coal as source of energy: most of the coal is produced to provide energy either by burning it directly to produce heat and then stem for generating thermal power electricity.
- Coal for making coke: the main use of coke is for smelting iron ore in the blast furnaces.
- Coal as a raw material for example:
  - Benzol is used for making benzene which is added to gasoline which car engines work better. Detergents and insecticides are also made from benzol.
  - Tar has many uses like for making road surfaces (bituminous roads) and creosole for preserving timber.
  - The ammonium compounds are used for making fertilizers and other valuable products.
- It is used for research and study purposes as well as a tourist attraction.

Problems facing the coal mining in the great lakes region

- Stiff competition for market from other sources of energy like hydro electrical power, natural gas and nuclear energy.
- High costs of coal mining especially in the areas where coal deposits are very deep.
- Some areas have the poor-quality coal like lignite and peat which are not worth mining.
- In some areas the coal deposits are scattered and small which are uneconomically to mine.
- Competition between oil and natural gas as source of energy.
- Exhaustion of high-grade coking coal.
- Decline in demand for coal in relation to other minerals due to improved technology which requires use of less input.
- Presence of alternative sources of materials for example synthetic fibres like dye and other materials.
- Fluctuating prices of coal on the world market.
- Destruction of natural beauty of the great lakes' region.
- There is environmental pollution.

General problems facing the mining industry of great lakes region

- High costs of exploitation of mineral which are found deep underground.

- Competition between oil and natural gas as source of energy.
- Uneconomical deposits of minerals which are scattered and small.
- Competition from cheaply imported minerals like oil from Middle East.
- Exhaustion of minerals for example the exhaustion of the high quality of coal.
- Decline in demand for coal in relation to other minerals due to improved technology which requires use of less input.
- Alternative sources of materials for example synthetic fibres like dye and other materials
- Fluctuating prices of coal and oil on the world market.
- Destruction of natural beauty.
- Mining accidents
- Environmental pollution.