THE FARGO LANDFILL:

What is a Landfill?

Dump - an open hole in the ground where trash is buried and that has various animals (rats, mice, birds) swarming around.

Landfill - carefully designed structure built into or on top of the ground in which trash is 'isolated' from the surrounding environment (groundwater, air, rain). This isolation is accomplished with a bottom liner and daily covering of soil.

The purpose of a landfill is to bury the trash in such a way that it will be isolated from groundwater, will be kept dry and will not be in contact with air. Under these conditions, trash will not decompose much. A landfill is not like a compost pile, where the purpose is to bury trash in such a way that it will decompose quickly.

Proposing the Landfill

For a landfill to be built, the operators have to make sure that they follow certain steps. The Environmental Protection Agency regulates where a landfill can be placed and how it can operate. The whole process begins with someone proposing the landfill. Taking care of trash and building landfills are local government responsibilities. Before a city or other authority can build a landfill, an environmental impact study must be done on the proposed site to determine:

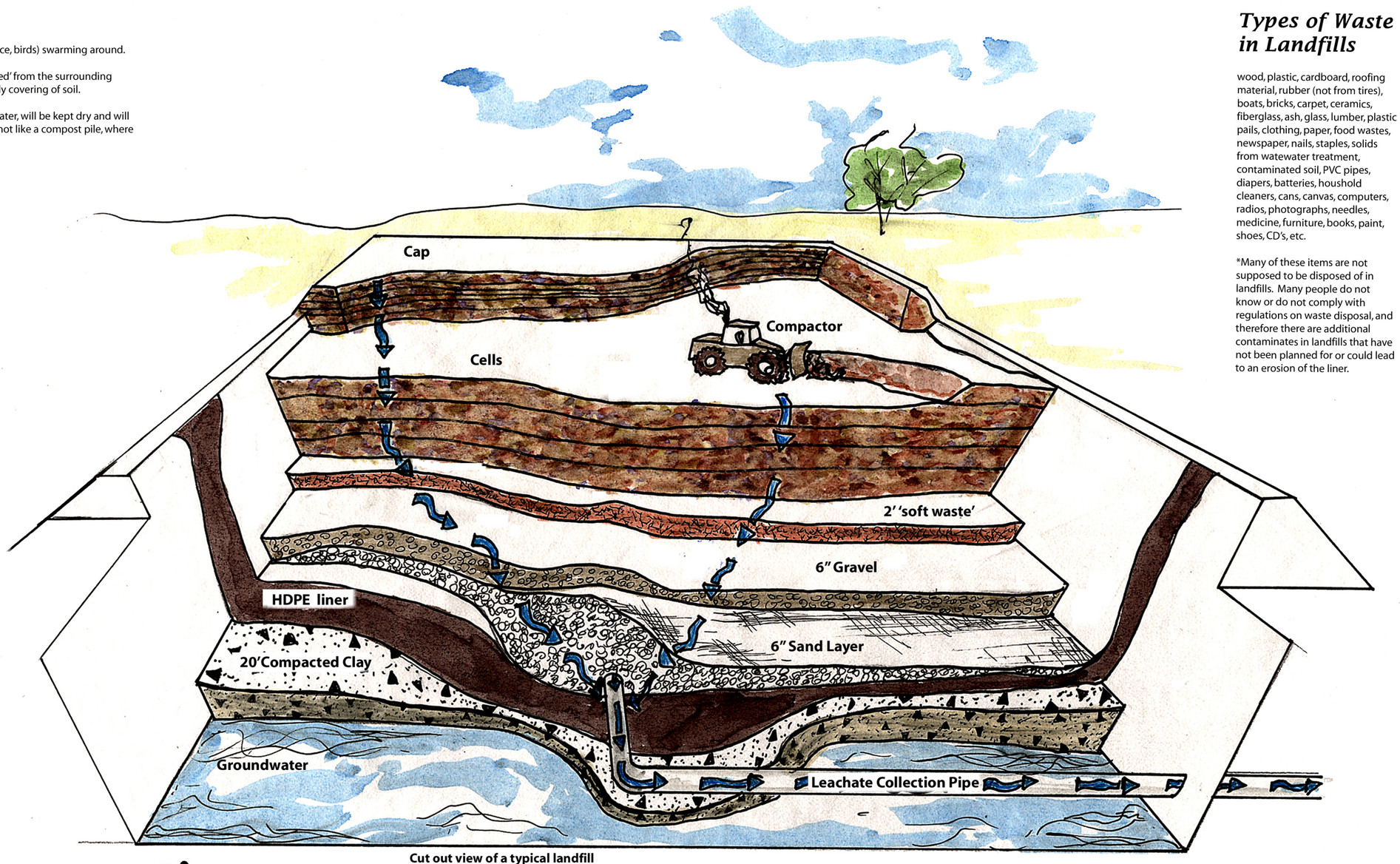
- the area of land necessary for the landfill
- the composition of the underlying soil and bedrock
- the flow of surface water over the site
- the impact of the proposed landfill on the local environment and wildlife
- the historical or archaeological value of the proposed site

Once the environmental impact study has been completed, permits must be obtained from the local, state and federal governments. In addition, money will have to be raised from taxes or municipal bonds to build and operate the landfill. Because funding usually comes from some public source, public approval must be obtained through local governments or a referendum.
Once the environmental impact study is complete, the permits are granted and the money has been raised, construction begins.

First, access roads to the landfill site must be built if they do not already exist. These roads will be used by construction equipment, sanitation services and the general public. After roads have been built, then the landfill can be excavated.

Bottom Liner System

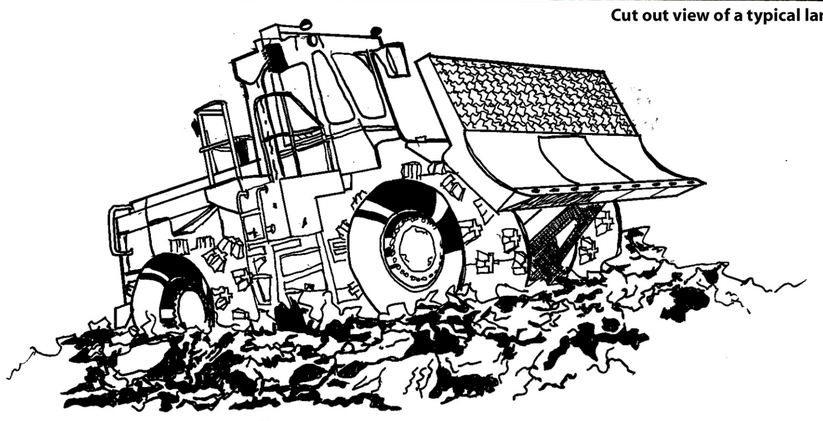
A landfill's major purpose and one of its biggest challenges is to contain the trash so that the trash doesn't cause problems in the environment. The bottom liner prevents the trash from coming in contact with the outside soil, particularly the groundwater. In MSW landfills, the liner is usually some type of durable, puncture-resistant synthetic plastic (polyethylene, high-density polyethylene, polyvinylchloride). It is usually 30-100 mils thick. The plastic liner may be also be combined with compacted clay soils as an additional liner. The plastic liner may also be surrounded on either side by a fabric mat (geotextile mat) that will help to keep the plastic liner from tearing or puncturing from the nearby rock and gravel layers. Trash put in a landfill will stay there for a very long time. Inside a landfill, there is little oxygen and little moisture. Under these conditions, trash does not break down very rapidly. In fact, when old landfills have been excavated or sampled, 40-year-old newspapers have been found with easily readable print. Landfills are not designed to break down trash, merely to bury it. When a landfill closes, the site, especially the groundwater, must be monitored and maintained for up to 30 years.



Cut out view of a typical landfill

Cells

One of the most precious commodities and overriding problems of a landfill is air space. The amount of space is directly related to the capacity and usable life of the landfill. If you can increase the air space, then you can extend the usable life of the landfill. To do this, trash is compacted into areas, called cells, that contain only one day's trash. A cell is approximately 50 feet long by 50 feet wide by 14 feet high (15.25m x 15.25m x 4.26m). The amount of trash within the cell is 2,500 tons and is compressed at 1, 500 pounds per cubic yard. This compression is done by heavy equipment (tractors, bulldozers, rollers and graders) that go over the mound of trash several times). Once the cell is made, it is covered with soil and compacted further. Cells are arranged in rows and layers of adjoining cells.


Compactor

Methane Collection System

Bacteria in the landfill break down the trash in the absence of oxygen. A byproduct of this anaerobic breakdown is landfill gas, which contains approximately 50 percent methane and 50 percent carbon dioxide with small amounts of nitrogen and oxygen. This presents a hazard because the methane can explode and/or burn. So, the landfill gas must be removed. To do this, a series of pipes are embedded within the landfill to collect the gas. In some landfills, this gas is vented or burned.

More recently, it has been recognized that this landfill gas represents a usable energy source. The methane can be extracted from the gas and used as fuel. The landfill will increase its gas production over time (from 300 cubic feet per minute to 1,250 cubic feet per minute). The excess gas will have to be burned. It is not cost-effective to compress the excess gas to liquid and sell it.

Groundwater Monitoring

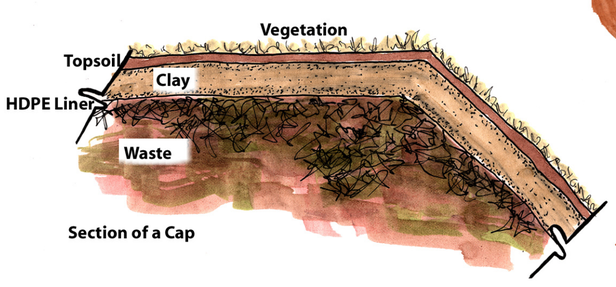
Surrounding the landfill are groundwater monitoring stations. These are pipes that are sunk into the groundwater so water can be sampled and tested for the presence of leachate chemicals. The temperature of the groundwater is measured. Because the temperature rises when solid waste decomposes, an increase in groundwater temperature could indicate that leachate is seeping into the groundwater. Also, if the pH of the groundwater becomes acidic, that could indicate seeping leachate.

The groundwater monitoring stations are placed around the landfill to detect the seepage of leachate. However, leachate water does not spread outward from a leak in a circular fashion. The leachate will find the path of least resistance andsnake along it until it reaches an outlet. The probabilities of groundwater monitors catching a leak before a major problem is remote.

Cap

When a section of the landfill is finished, it is covered permanently with a polyethylene cap (40 mil). The cap is then covered with a 2-foot layer of compacted soil. The soil is then planted with vegetation to prevent erosion of the soil by rainfall and wind. No trees, shrubs or plants with deep penetrating roots are used so that the plant roots do not contact the underlying trash and allow leachate out of the landfill.

Occasionally, leachate may seep through weak point in the covering and come out on to the surface. It appears black and bubbly. Later, it will stain the ground red. Leachate seepages are promptly repaired by excavating the area around the seepage and filling it with well-compacted soil to divert the flow of leachate back into the landfill.



Section of a Cap


How a landfill is designed to leak


Typical Groundwater Monitor

How a landfill actually leaks

Leachate Collection System

No system to exclude water from the landfill is perfect and water does get into the landfill. The water percolates through the cells and soil in the landfill much as water percolates through ground coffee in a drip coffee maker. As the water percolates through the trash, it picks up contaminants (organic and inorganic chemicals, metals, biological waste products of decomposition) just as water picks up coffee in the coffee maker. This water with the dissolved contaminants is called leachate and is typically acidic. To collect leachate, perforated pipes run throughout the landfill. These pipes then drain into a leachate pipe, which carries leachate off site to a water treatment facility.

Dry Tomb Landfilling vs Wet Landfilling

The most common type of landfilling is the dry tomb method. In this method the idea is to keep air, light, and water from entering the cells of waste. The reasoning for this is to minimize methane production, which could cause an explosion. Also, if no water enters the landfill, then no leachate will need to be treated.

There are several problems with this method. First of all, in this kind of environment, nothing will breakdown. We would be stuck with a mountain of waste forever. Secondly, it is impossible to keep all outside elements out of a landfill. Eventually caps and liners fail, which leads to infiltration of the waste.

A new type of landfilling is the wet cell approach. Water is cycled through the waste prior to capping in an attempt to leach all the toxins out of the landfill before capping and to make the waste produce all the methane possible right away, rather than continuous production.

This technique is undoubtedly better than the dry tomb approach, but still has flaws. For instance, more leachate water is produced; which will need to be treated. Also, nothing is done to remediate the waste, so in the end there is still a mountain of waste.

Dry tomb landfilling is one of the older types f landfilling and is seen by many as unsustainable and outdated.

How a Landfill Closes

It can cost anywhere from $80,000 to $200,000 per acre to close a landfill. Most of this comes is due to the capping procedure. It is very expensive to haul in 3 feet of clay and 1-2 feet of topsoil to prevent leakage and grow vegetation.

Most landfills are designated for 'wildlife habitat' after closure. Th eonly wildlife a capped landfill attracts are ground nesting birds and vectors. A closed landfill is not suitable habitat for anything, due to high levels of contaminates and lack of shelter.

Some closed landfills are being designed for reuse as parkland and open space for cities. This seems like a good solution to a problem, until you consider that the waste is not addressed at all. The problem is simply covered up even more; literally by topsoil and larger vegetation, and figuratively by putting a fancy facade on top of a pile of waste.

When a landfill leaks it adds millions of additional dollars to the closing cost due to expensive remediation efforts. A scary thought is that a landfill only needs to be monitored for 30 years post operation. It will have the potential to contaminate forever, but we will have no way of knowing if it is.

Types of Waste in Landfills

wood, plastic, cardboard, roofing material, rubber (not from tires), boats, bricks, carpet, ceramics, fiberglass, ash, glass, lumber, plastic pails, clothing, paper, food wastes, newspaper, nails, staples, solids from watewater treatment, contaminated soil, PVC pipes, diapers, batteries, houshold cleaners, cans, canvas, computers, radios, photographs, needles, medicine, furniture, books, paint, shoes, CD's, etc.

*Many of these items are not supposed to be disposed of in landfills. Many people do not know or do not comply with regulations on waste disposal, and therefore there are additional contaminates in landfills that have not been planned for or could lead to an erosion of the liner.

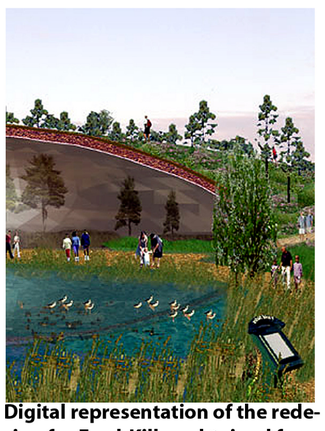
Common Chemicals in Landfill Gas and Soil

Methane	Trichloroethylene
Dichloromethane	Benzene
Trichloroethane	Carbon Dioxide
Tetrachloroethylene	Mercury
Vinyl Chloride	Lead
Dichloroethane	Arsenic
Dibromoethane	*Various other heavy metals and Volatile Organic Compounds-VOC's
Trichloromethane	
Tetrachloromethane	**When these materials are burned they are known to give off dioxins which are endocrine disruptors and carcinogens

***There are 60,000 chemicals used in everyday commerce in the U.S., fewer than 200 of them are analyzed for potential groundwater**

Common Chemicals in Leachate

Iron	Chloride
Manganese	Sulphate
Hydrogen Sulfide	Chromium
Heavy Metals	Cadmium
Vinyl Chloride	Phenoxypropionic acid
Calcium	Trichloroethylene
Magnesium	Mercury
Sodium	*Any chemical in landfill soil and gas can be presumed to also be in the leachate


Digital representation of the redesign for FreshKills. - obtained from the City of New York website

Case Study 1- FreshKills Landfill

FreshKills landfill is located on Staten Island, New York. Before it was a landfilling site, it was a low-lying marsh filled with creeks and an excellent habitat for various birds and fishes. Part of the site remains this way, and has been designated an important habitat by the New York Department of Environmental Conservation. Fresh Kills has been in operation since 1958 and encompasses 2,200 acres. By 1997, three of the landfill's six sectors were full and had been capped. The rest will be capped by 2011. The landfill was closed in 2001 but was reopened to accomodate 9/11 debris.

The park plan for the redevelopment of FreshKills will be implemented in 2007. It is considered to be one of the most ambitious public works projects in the world. Some of the main elements are: recreational fields, biking, hiking, arenas, marsh/tidal wetland preserve, golf course, memorials, and links to other parks.

The re-design of FreshKills landfill sheds a new light on the reclamation of landfills. This project was an international competition, thus opening the door for new ideas about what do do with closed landfills. This project is an innovative soluiton, but is superimposed on conventional ideas. The landfill is essentially a dry tomb, and does nothing to remediate the waste. This design still only masks the underlying waste and risks of pollution and contamination. The citizens of New York will always have a park sitting atop a mountain of trash.

Site Plan of FreshKills landfill. - obtained from the City of New York website

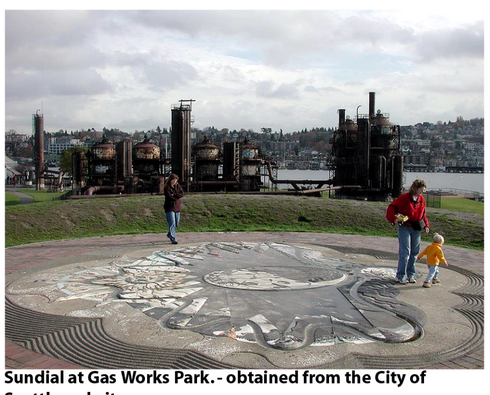

Old machinery at gasworks park. - obtained from the City of Seattle website

Case Study 2- Gas Works Park

Gas Works Park is located on the north side of Lake Union, in Seattle, Washington. It was a beautiful lakeshore perfect for birds, wildlife, and fish. In 1906 an industrial plant was constructed there to manufacture gas from coal. The plant operated until to 1950's when the import of oil made the coal production obsolete. In 1962 the abandoned, contaminated area was aquired by the City of Seattle for a park. By 1975 the park was open to the public.

Gas Works Park occupies 19.1 acres and has an excellent view of Seattle. It was initially said nothing would grow on this site due to contaminates like hydrocarbons, soot, and petrochemicals polluting the soil and water. Looking at some pictures, that is a correct statement. Topsoil has been added to some parts of the park to allow for moderate plant growth. Despite the remaining toxic pollution, the park is a favorite of Seattle residents and visitors. As many as 50,000 people gather here for the Fourth of July celebration. People use the site for: frisbee, sunbathing, kayaking, and picknicing. The main elements on site are: old machinery painted vibrant colors and used as a play structure, a manmade hill for kite flying, a sundial at the top of the hill, and various paths.

The creation of Gas Works Park on a polluted site opened the door for engineers and landscape architects to work together and create a place for the public to enjoy. During the 13 years the land was aquired but not opened to the public, the site went throuhg some very basic remediation procedures. The site had to be tested to make sure it was safe for people to go there. There are still warning signs about polluted water and soil, but people give them no heed anymore. Even though the site went through some remediaiton procedures, it was mainly just covered with topsoil. The toxins still remain in the original soil and water. Eventually the toxins will be gone, but this willl be due to them leaching off site and migrating elsewhere. It is a good park design, but does almost nothing to remediate, or protect people from pollution.


Sundial at Gas Works Park. - obtained from the City of Seattle website

Case Study 3- Becker County Landfill

The Becker County landfill in located on the outskirts of Detroit Lakes, Mn. The area of the landfill used to be semi hilly and used for agricultural purposes. The landfill began operation in 1972, and operated until 1990 when it was capped and closed. It is 33 acres square, and holds 1,372,000 cubic yards of waste. In 1992, the Minnesota Pollution Control Agency indicated the landfill required immediate action to protect the public health and environment from further pollution. In 1996 it was discovered that half the landfill was covered with 6" or less of topsoil, rather than 3'-4' as previously thought. The bottom liner also had leaks, which required the installation of pumps to extract the groundwater for treatment. It should be noted that the leaks cannot be fixed which means the groundwater pumps will have to run indefinately.

The landfill is now covered with an 'impermeable' synthetic membrane with 2.5' of topsoil as cover. Landfill gas is extracted and burned through a piping system, not sold to create energy. Landfill gas has already begun to seep out of the membrane and is killing vegetation at the seepage points. Waste was excavated from 15 acres of the site in order to create a stormwater and leachate management system. Water wells around the landfill are contaminated with numerous volatile organic compounds, levels of which are just beginning to stabilize due to groundwater extraction. The price tag for all these remediations has been steep. The total for just one year of bare-bones remediations was over $180,000. At least this amount will need to be spent for many years to come to prevent further pollution and to treat what they already have.


Groundwater and Stormwater treatment pond at the Becker County Landfill. - obtained on site

How Landfills Operate and Close

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Waste is a Terrible Thing to Waste

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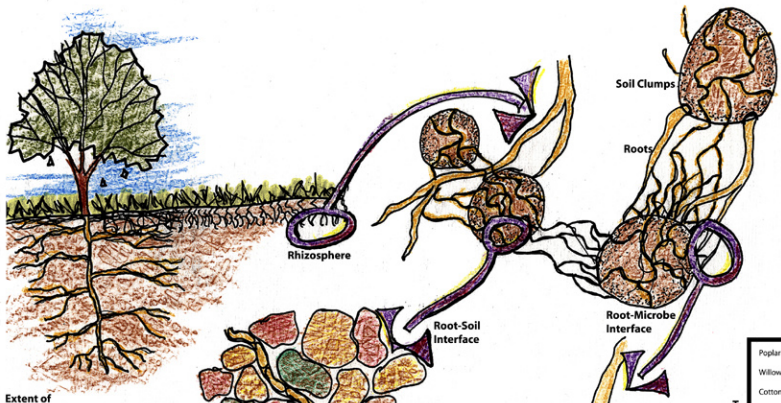


Bio-Remediation

Bio-Remediation is a newly recognized approach using a centuries old technology to treat contamination. Bacteria is the key. Hundreds of years ago people realized the extensive bacterial growth in biological waste i.e. sewage. Along the years this developed into part of the modern day treatment process used at water treatment plants. Recently the applications have been recognized to work for other types of contamination like petroleum, radioactive waste is soil, and other forms of pollution.

Bio-Remediation works by either waiting for bacteria to naturally colonize an area, introducing new types of bacteria to a site, or improving the conditions for the bacteria. This is done by increasing the amounts of oxygen, moisture, and temperature for the bacteria.

Bacteria will either breakdown the waste, stabilize it, or sequester it. The bacteria most often thrive in the rhizosphere (area around the roots of plants) and work with vegetation to break down and treat contaminates.

Phytoremediation

Phytoremediation is the use of plant material to treat, stabilize, and sequester contaminated soil, air, and water. It works is several ways:

Phytovolatilization - Plants take up water & contaminates through the roots, transport them to the leaves, and release the contaminates as detoxified vapor into the atmosphere.

Microorganism Stimulation - Plants secrete enzymes through their roots that stimulate the growth of fungi and bacteria which metabolize the contaminates.

Phytostabilization - Plants prevent contaminates from migrating by reducing runoff, erosion, and groundwater flow rates.

Phytoaccumulation/Extraction - Plant roots remove metals and transport them to leaves and stems where they can be harvested and recovered.

Phytodegradation - Contaminates are absorbed inside the plant and broken down to non-toxic molecules by natural chemical processes within the plant.

There are many advantages to phytoremediation. It is easy to implement and maintain, low cost, environmentally friendly, aesthetically pleasing, and can be used to treat a variety of contamination at once.

As with anything there are negative aspects as well. Phytoremediation may take several years to complete depending on contamination levels, is dependanto on climatic conditions, is only effective on areas within the root zone of the plants, and possible negative effects on the food chain if contaminated plant materials are consumed.

As many technologies will be used simultaneously at the landfill, phytoremediation will play an integral part of a larger whole. Contaminated plant material will be harvested the first two years and incinerated. After this is when animals will be introduced and in no danger of being poisoned.

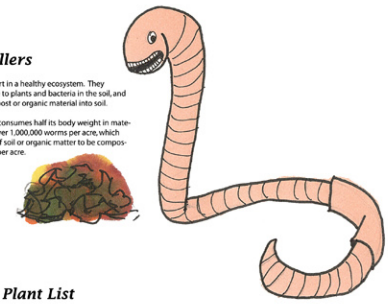
Grinder Operation

The grinder is where all the non-recycleable biodegradable refuse will go. It will take in waste such as newspaper, cardboard, branches, etc. The grinder functions as a paper shredder or meat grinder only on a much larger scale. The grinder will speed up the process of biodegration by increasing the surface area exposed to the elements. It will also allow the material to be more readily digestible by worms and bacteria. The grinder will be able to process in excess of 1,500 tons per day during excavation of the landfill and will more than adequately handle the lower amounts of refuse post landfill excavation.

Nature's Tillers

Earthworms are a vital part in a healthy ecosystem. They increase oxygen available to plants and bacteria in the soil, and help to break down compost or organic material into soil.

Every day an earthworm consumes half its body weight in material. Good soil contains over 1,000,000 worms per acre, which translated to 31,000 lbs. of soil or organic matter to be composted and aerated per day, per acre.



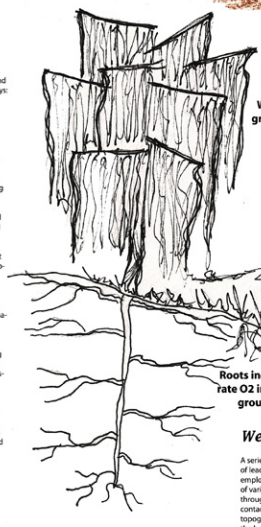
Phytoremediation Plant List

		Plant Type	Chemicals Treated
Trees	Perennials & Annuals	Poplar Ssp.	Atrazine (Herbicide)
		Willow Ssp.	Alachlor (Herbicide)
		Cottonwood	Chlorinated aliphatics TCE
		Aspen	Aromatics BTEX
		Mulberry	Excess Nutrients
		Apple	Ammunition Wastes (TNT, RDX)
		Osage Orange	Pesticides
		Chinese Evergreens	Polynuclear aromatic hydrocarbons
		Bamboo Palm	Pb
		Palm Trees	Cd
Grasses		Rye	Zn
		Bermuda	As
		Sorhgum	Cu
		Fescue	Se
		Bluestem	U
		Reeds	Hydrophobic Organics (PAH, PCB, DDT, dieldrin)
		Wild Rice	Benzene
		Cattails	Mercury
		Barely	Formaldehyde
		Hops	Trichloroethylene
		Hemp	Radionucleides
		Nettles	Trichlorophenols
	Aquatic	Sunflower	
		Clover	
		Alfalfa	
		Cowpeas	
		Draecena	
		English Ivy	
		Chrysanthemum	
		Spider Plants	
		Snake Plants	
		Aloe Vera	
		Ficus	
		Gerbera Daisy	
		Ribbon plant	
		Peace Lily	
		Iris Ssp.	
		Water Lily	
		Lemna	
		Algae	
		Seaweed	
		Fern Ssp	
		Moss	
		Lichen	

This list of plant and chemicals was obtained through various sources, including phytoremediation guidebooks, the Environmental Protection Agency, and the work of Bill Wolverton, a scientist for NASA who has spent the better part of his career studying the filtration abilities of plants.

It should e noted that neither the plant list nor the chemical list are complete. They are both just a small portion of a vast spectrum of possibilities. Phytoremediation is a relatively new technology and the treatment capabilities of all plants are not yet known.

A particularly good aspect of plants thought of as super-remediators, is that they are native species. If a plant has a large, fibrous root system it is a good choice. As well as plants with a large appetite for water. Air Scrubbing plants generally are water loving and have broad leave or are fast growing.



Wetland Systems

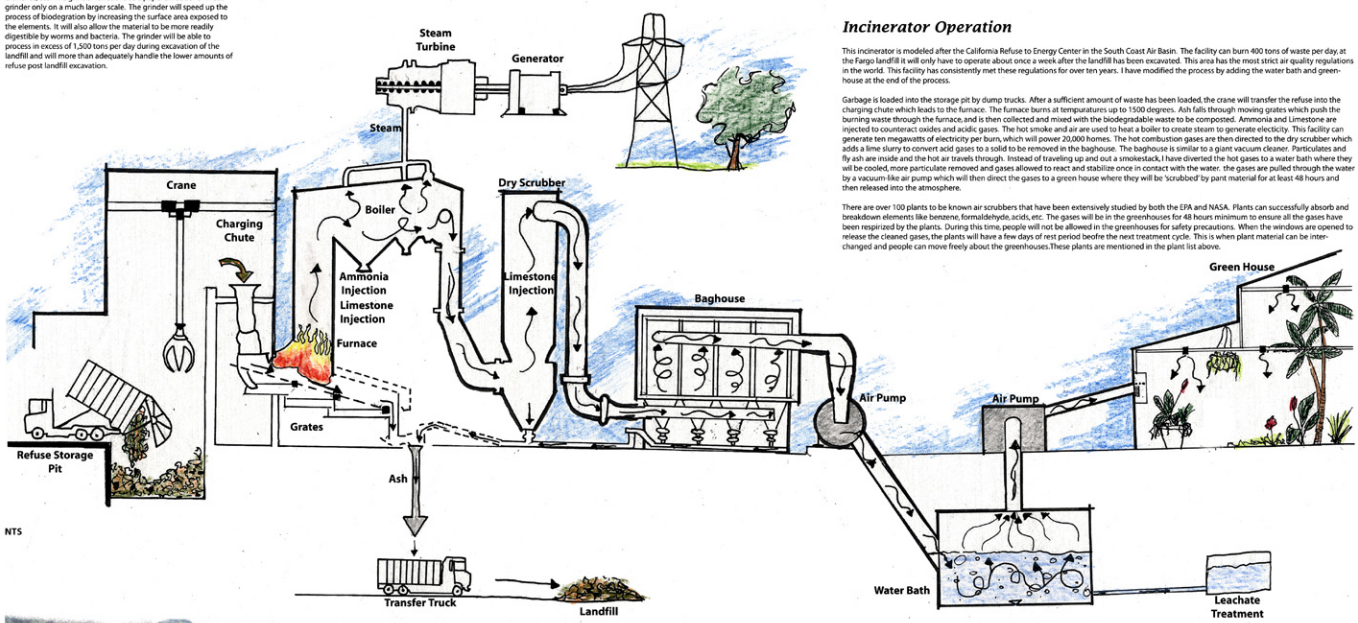
A series of wetland systems will be used to treat leachate water. An abundance of leachate water will be created due to the wet cell landfilling technique employed. Wetland systems have proven themselves successful in the treatment of various types of wastewater, including leachate. It works by filtering the water through soil, over rocks, and into plant material and resulting bacteria. The more contact time the water has with the wetland, the cleaner it gets. Curves and topography changes allow for more contact time. A flood-pulse approach is also the best approach. Wetlands wil be flooded, allowed to sit for 2 weeks, and then drained to remain dry to moist for 1-2 weeks. This allows the plant material and soil to have time to use up nutrients and become hungry for more.

Incinerator Operation

This incinerator is modeled after the California Refuse to Energy Center in the South Coast Air Basin. The facility can burn 400 tons of waste per day, at the Fargo landfill it will only have to operate about once a week after the landfill has been excavated. This area has the most strict air quality regulations in the world. This facility has consistently met these regulations for over ten years. I have modified the process by adding the water bath and greenhouse at the end of the process.

Garbage is loaded into the storage pit by dump trucks. After a sufficient amount of waste has been loaded, the crane will transfer the refuse into the charging chute which leads to the furnace. The furnace burns at temparatures up to 1500 degrees. Ash falls through moving grates which push the burning waste through the furnace, and is then collected and mixed with the biodegradable waste to be composted. Ammonia and Limestone are injected to counteract oxides and acidic gases. The hot smoke and air are used to heat a boiler to create steam to generate electicity. This facility can generate ten megawatts of electricity per burn, which will power 20,000 homes. The hot combustion gases are then directed to the dry scrubber which adds a lime slurry to convert acid gases to a solid to be removed in the baghouse. The baghouse is similar to a giant vacuum cleaner. Particulates and fly ash are inside and the hot air travels through. Instead of traveling up and out a smokestack, I have diverted the hot gases to a water bath where they will be cooled, more particulate removed and gases allowed to react and stabilize once in contact with the water. the gases are pulled through the water by a vacuum-like air pump which will then direct the gases to a green house where they will be 'scrubbed' by pant material for at least 48 hours and then released into the atmosphere.

There are over 100 plants to be known air scrubbers that have been extensively studied by both the EPA and NASA. Plants can successfully absorb and breakdown elements like benzene, formaldehyde, acids, etc. The gases will be in the greenhouses for 48 hours minimum to ensure all the gases have been respirized by the plants. During this time, people will not be allowed in the greenhouses for safety precautions. When the windows are opened to release the cleaned gases, the plants will have a few days of rest period beofre the next treatment cycle. This is when plant material can be interchanged and people can move freely about the greenhouses. These plants are mentioned in the plant list above.



Remediation Technologies

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Waste is a Terrible Thing to Waste

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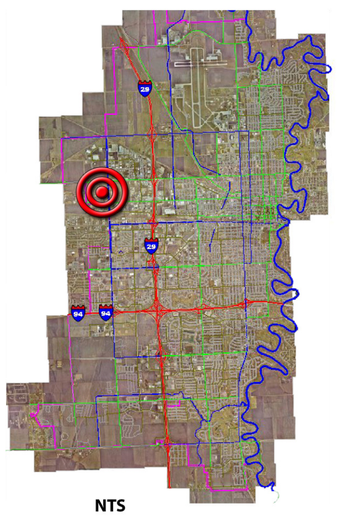

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Location

The Fargo landfill is located immediatley West of 45th St, between 7 Ave. N. and 12th Ave N. The landfill is no more than 10 miles away from any point in the city, and is located in a relatively central point when West Fargo and Moorhead are considered.

Demographics

The population of Fargo is close to 100,655 people. This number of people is added to significantly when West Fargo Harwood and Horace North Dakota, along with Moorhead and Dilworth Minnesota are taken into account; not to mention the students of North Dakota State, Minnesota State Moorhead, and Concordia College who are not considered residents here. The population of Fargo is steadily increasing at 22.2% every 10 years. The population is 50/50 male to female with the largest age group being 25-34 years old at 16.7%. The 20-24 years old age group is a close second at 14.9%. Caucasians are the predominate race of the area at 95%, followed by 1.7% Asian, 1.3% Hispanic, 1.3% American Indian, and 1% Black. There are about 39,268 households in the area, 52.8 of which are family households. Of the households, 10,751 of these have children under the age of 18. The average size of families in the area is 2.91. The Fargo area has a very good job market, with only a 2.2% unemployment rate. The average annual salary of a resident of Fargo is $31,320

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Area

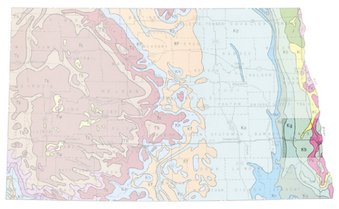
The overall area encompassed by the Fargo landfill is 160 acres. 155 of those acres will eventually be filled with garbage. The area of the old landfill is the west 35 acres of the site. The landfill will reach 30' down into the earth and 70' upward to create a 100' mountain of trash. The landfill will contain over 8million tons of waste when it reaches capacity.

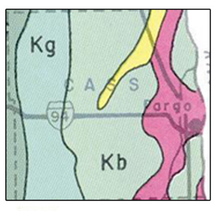
Prairie Potholes

Prairie potholes (sloughs) are water-holding depressions of glacial origin in the prairies of the Northern United States and southern Canada. Water is supplied to the potholes by precipitation on the water surface, basin runoff, and seepage inflow of ground water. Depletion of pothole water results from evapotranspiration, overflow, and seepage outflow. Since potholes generally do not overflow, seepage outflow is the principal way in which dissolved salts can be removed. Salinity of pothole water is therefore a good indication of the seepage balance. Net seepage outflow results in fresh to brackish waters that constitute ephemeral to semipermanent ponds, whereas net seepage inflow results in brackish to saline waters that constitute semipermanent to permanent ponds.

NTS

Prairie potholes, or sloughs, are water-holding depressions of glacial origin that occur in 300,000 square miles of prairies in north central United States and south-central Canada. These potholes provide the most productive wetland habitat for waterfowl in North America. Although comprising only 10 percent of the continental waterfowl-breeding, the pothole region produces about 50 percent of the duck crop in an average year and much more in bumper years. Potholes also furnish water for other wildlife and livestock.





Geology

Fargo is located in the Red River Valley in the remnants of glacial Lake Agassiz. The area is comprised of glacial deposits or a loose mixture of pebbles, sand and silty clay. Glacial lake remnants are the outwash areas, beach, and shore deposits of loose sand and gravel. Map created by John P. Bluemle.

Wildlife

There is limited wildlife at the Fargo landfill. The most noticeable would be gulls and black birds that have made the landfill their main food source. These birds constantly circle the landfill or perch on the adjacent power lines. The birds do not harm the land filling process in any way, but ingest harmful wastes and possibly transport these wastes off site. The other wildlife of the landfill would be a variety of vermin such as mice, rats, and rabbits. These animals also do not affect the land filling process, but could transport harmful material off site. The animal population will need to be controlled in some way as to keep landfill material on site.

Vegetation

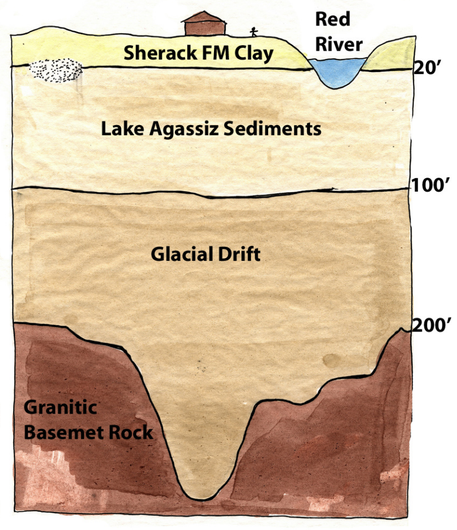
The vegetation of the landfill is comprised of buffer trees and shrubs along the south and east borders of the landfill and cover plants on the north side of the landfill. The buffer to the east is comprised of Ponderosa Pine, Redosier Dogwood, and Korean Lilac along with miscellaneous ditch vegetation. Next to the scale house is a planting of several Sugar Maples. The southern border of the landfill is comprised of Poplars and Ash trees. These trees are well established and serve as a good screen of the landfill. The north side of the landfill has been capped and covered. The cover vegetation is comprised of Kentucky Bluegrass, Fine Fescue, and Perennial Rye. Additional vegetation has begun to grow due to the spread of seed by wildlife, and wind mechanisms. The existing vegetation of the landfill is extremely limited. This is due in part to the cost of plant variety, the limited growing medium (2' of soil), and the climate extremes of North Dakota. The types of vegetation should be expanded to create visual interest in the site as well as for remediation purposes.

Existing Structures

There are minimal built structures at the landfill to accommodate the highest volume of waste. The landfill will not be able to accommodate built structures on top of the waste pile for at least 30 years after closure to allow for settling time. The current structures include: a scale house to weigh trucks and charge fees for dumping, an office to house documents of the landfill and provide a break-room for employees, an equipment quonset that houses the landfill's bulldozers and trucks, a methane collection building that collects and ships the methane to Cargill, there is also a flare built into the methane collection building to prevent excessive buildup of methane or explosions, and leachate collection pumps located at the base of the landfill on top of the liner, these pumps transfer the wastewater to be treated off site.

Soils

The landfill is located on Fargo and Ryan clays. These soils are typically deep level, poorly drained, fine textured soils formed in the glacial lacustrine areas. Sediments are found in the flats and slight depressions of glacial Lake Agassiz. The Fargo and Ryan clays provide a deep and level surface, but a concern is its shrink swell factor which occurs during the winter freeze and summer thaws. The shrinking and swelling of the earth create an area where the soil is constantly moving, therefore building structures becomes difficult. At the landfill the shrink swell is not a factor underneath the main part of the landfill, since it is 30' below road level. Where it would be a factor would be the edges of the landfill, and any part of the landfill not used to store waste.



Views

Views from the landfill are extensive. Since there is limited topography, one can see for miles without interruption. The views off and on site are impressive, but not necessarily good. This is due to its location in an industrial park, and trash that flies about on windy days. Views of the landfill are also extensive since it is the major topographic feature of the area. These views are also impressive but not good. The landfill is literally a giant pile of trash, until it is covered. Then it is a pile of trash masked by grasses and perennials.

Site Hydrology

Any water that enters the landfill is either directed off the landfill by the cap or filters through the landfill to create leachate. All the water on the site is collected and pumped to the Wastewater Treatment Facility located on 32nd avenue north in Fargo. The wastewater is treated and discharged into the Red River. I would like to create a closed water system at the landfill to reduce the amount of water discharged into the river. A closed system would also be a great learning opportunity for visitors to the site.

Transportation Linkages

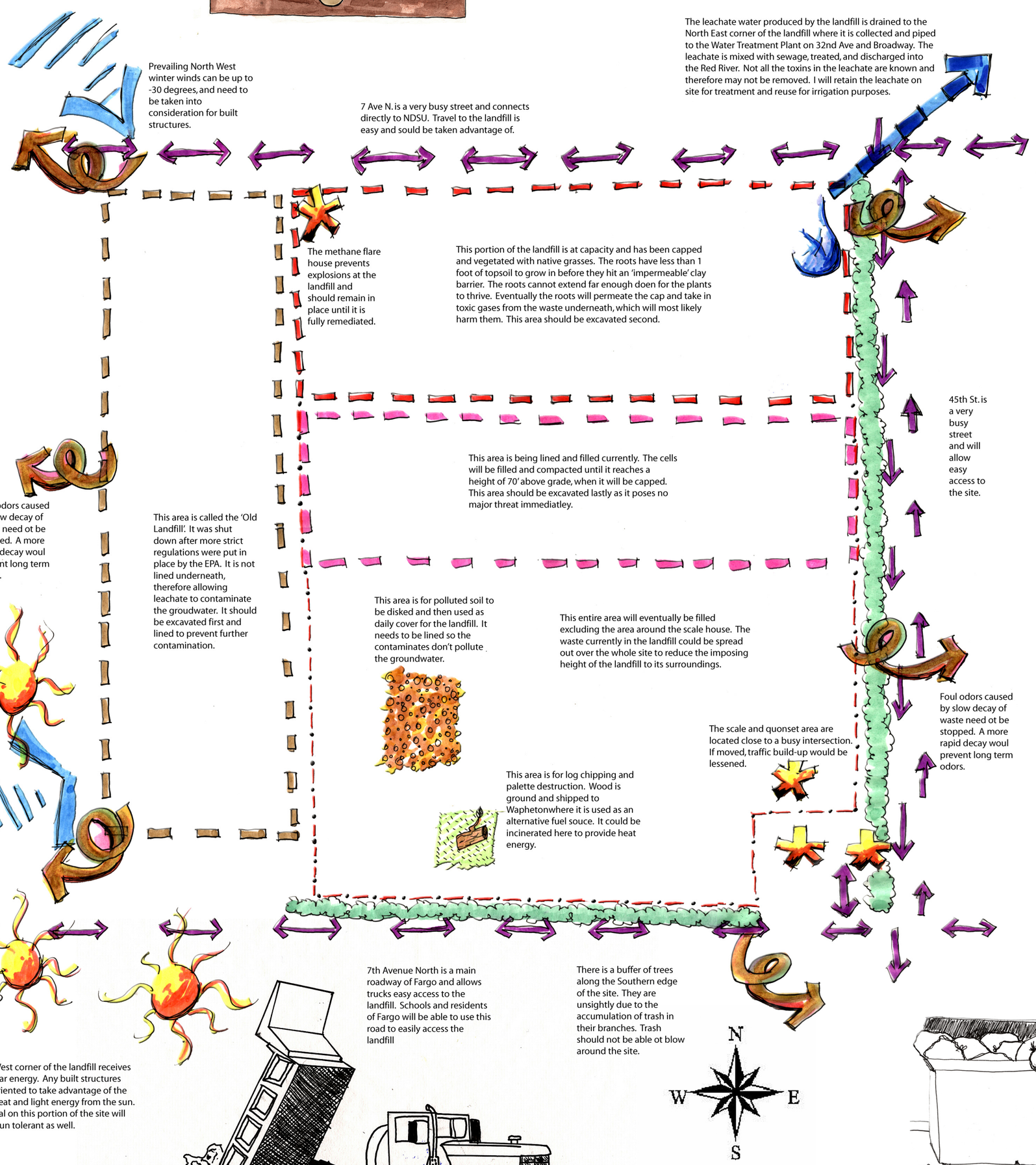
The Fargo Landfill is extremely easy to access. To the north the site is bordered by 12th avenue which is considered a minor artery by the city of Fargo. To the east is 45th street, which is considered a major artery. To the south is 7th avenue which is considered a minor artery as well.
Proximity to Schools
Since the landfill is located on the west-central side of Fargo, this places it in a relatively central location for access by schools. There are over 30 schools located within seven miles of the landfill in Fargo and West Fargo. The landfill would be a great place for field trips for students to learn about their environment.

Acoustic Environment

The landfill is an extremely noisy place. This is because of the constant stream of trucks coming to unload waste, and the bulldozers that move back and forth to compact the waste. The methane collection system and flare add noise as well, which is not noticed on top of or to the south end of the site due to the high volume of noise created by the trucks and bulldozers. If a learning center is to be operational during active land filling, it will need to be soundproofed to allow for classes to be held.

Solar Orientation

Day length and solar zenith angle are also important factors affecting North Dakota climate. Day length ranges from less than nine hours in December to more than 16 hours in June. Noon sun angles are much higher in summer than in winter. The combination of these factors at North Dakota's location produces much more radiational energy at the earth's surface in summer than in winter, which contributes to the large seasonal temperature changes and the general north-south temperature gradient across the state.



Annual Precipitation

The Fargo area is a fairly arid region. The area receives between 12 and 23 inches of precipitation per year. It seems the number would be greater considering the area receives over 20 inches of snowfall per year, but snowfall has less water content by volume than rain. Precipitation rates are greatest during the spring and autumn months of the year. Summer and winter are comparatively dry periods.
Annual Temperatures
The temperatures in Fargo fluctuate drastically from season to season. Throughout the year temperatures can range from -25° Fahrenheit to over 100° Fahrenheit. This creates a harsh environment for plant growth. Plants in the area need to be extremely hardy in order to survive.
Prevailing Winds
The average wind speed is at its greatest in ND in late winter and early spring. The wind is at its lowest speed during summer months. The winds in the Red River Valley happen to be 10-20% higher than the rest of the state. On an annual basis, the prevailing wind flow at Fargo shows strong incoming north and north-northwest flow and a strong south and south-southeast return flow.

Environmental Issues

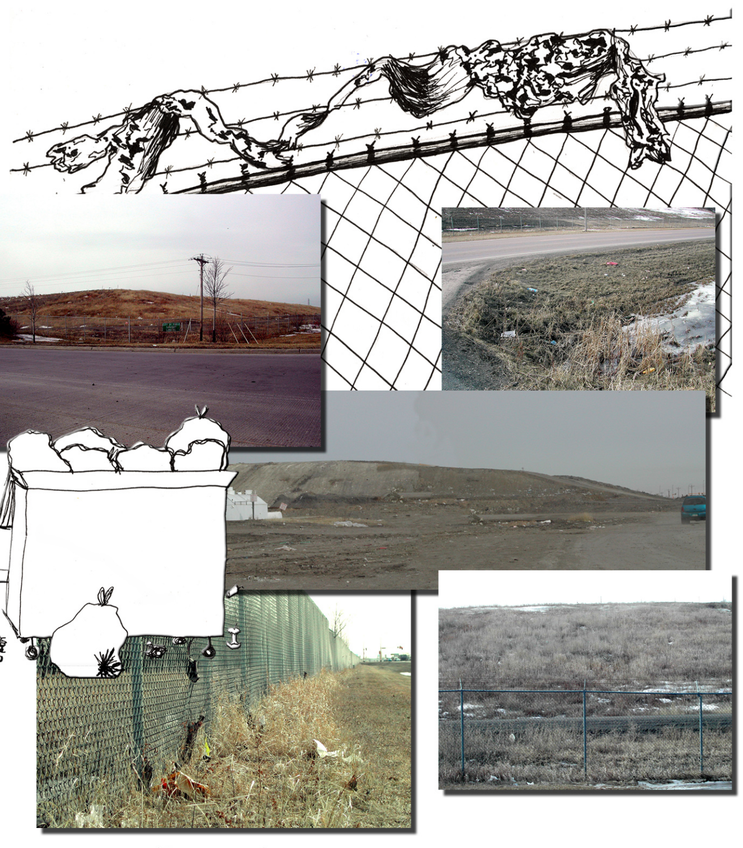
Ah, environmental issues at a landfill, where to begin. The most important environmental issue of a landfill is a failed liner. When the liners fail, surrounding groundwater and soils are severely polluted. A way to prevent this would be to remediate the waste rather than leave it to slowly decompose naturally. Another concern would be erosion. Landfills have very steep sloped sides. It is imperative to prevent erosion so the cap is not carried away by the wind or rainfall. Yet another issue is the leachate water produced after precipitation. This water is the primary contaminate associated with landfills. The leachate needs to be treated before it can be released into the surrounding water table. One more concern would be the waste itself. Some items are banned from a sanitary landfill, for safe disposal elsewhere. Items like batteries, paint, or other household hazardous waste can cause an increased likelihood of liner failure or more sever pollution. Some people throw these items in their regular garbage anyway, without thinking of the consequences. It must be planned for some hazardous waste to be included in the landfill in order to prevent dire consequences later on. Landfills today also try to prevent roots of cover vegetation from protruding through the cap into the waste. Such intrusions allow for water to permeate the landfill which creates more leachate and methane production. Methane production is the final environmental issue to be discussed. Methane production lasts for at least 30 years after a landfill is closed. It can prevent vegetation from growing, increase offending odors, or worse, cause an explosion if it is not properly monitored and released. At minimum, landfills need to collect the methane and either burn it themselves, or sell it to be used to create electricity.

Initial Impressions

The people of Fargo do not seem overly concerned with their environment or recycling. The garbage crisis is still perceived as nothing to worry about. This landfill is set to close in the next 15 years; the debate about where to expand has already begun. Are people concerned? Nope. "They" will figure out a good solution by that time. What residents of this area have not realized is that landfills in general simply aren't a good solution, and something better needs to be created.

The first thing I noticed about the Fargo landfill was the odor. You can smell the landfill long before you can actually see it. The breezy weather of the Fargo area does not help to abate this problem at all. Another thing the wind contributes to is scattered refuse all around the perimeter of the landfill. There are papers and plastic bags caught in everything. This does nothing to improve people's opinions of the landfill. Occasionally some of the refuse escapes the fencing and blows about on surrounding roads and clogs ditches.

Observing the landfill is one thing, but being on top of it is quite another. The drive up the access roads to the dumping area is exciting. It can reach near 40 degrees slope, which becomes even more interesting after a rain. The dumping area is by far more busy, noisy, smelly, and squishy than any other part of the landfill. The compacters whiz by at fast paces, not too far from where trucks are dumping. It is a good idea to stay out of their way. The way down the side of the landfill is just as adrenaline-filled as the ride up. Hopefully the brakes in your vehicle are in top shape.



Site Inventory and Analysis

Board 4 of 10

Waste is a Terrible Thing to Waste

THE FARGO LANDFILL:

Project Overview

The world is facing a garbage crisis. People keep creating waste, but we are rapidly running out of space to put it. In the U. S. in 1980 there were over 6,000 landfills. Today there are barely 2,000. As Americans, we generate 4 lbs of garbage per person, per day. In Fargo alone we generate over 73,000 tons annually. As our country has become more populous and developed, we have begun to ship the waste to areas less populated and more rural. The raw technology exists to solve the problem, we simply need to put it together.

Project Statement

Landfill remediations need to provide a cost effective, aesthetically pleasing, environmentally friendly solution to the garbage crisis. Rather than bury the waste to remain in the land to poison us for decades, remediation will face the problem head on and break it down. However, eliminating toxic contamination in the landfill should not create pollution in the air and water. On par with the idea of remediaiton is the concept of reuse. In fact, the purpose of remediaiton is to create an area safe for use by humans, plants, and animals. The combination of several remediation techniques is key to the success of this effort.

Design Process

I began the design process with a clear idea of the end prodect I would like to achieve. The gaol of this project is to inform and get professionals and citizens talking and working together. This idea is meant to be adaptable, and with cooperation even better solutions can be designed in the future. This project will simply start the process. My design for the Fargo landfill will solve the garbage crisis as far as I am able to take it with the allotted time and knowledge. I will create a space that is functional, safe re-usable, and beautiful. It will also respond to the area in which it is located, and provide actual habitats and ecosystems for people and wildlife. To get started, I made a list of elements to include in the project and then explored the relationships between them.

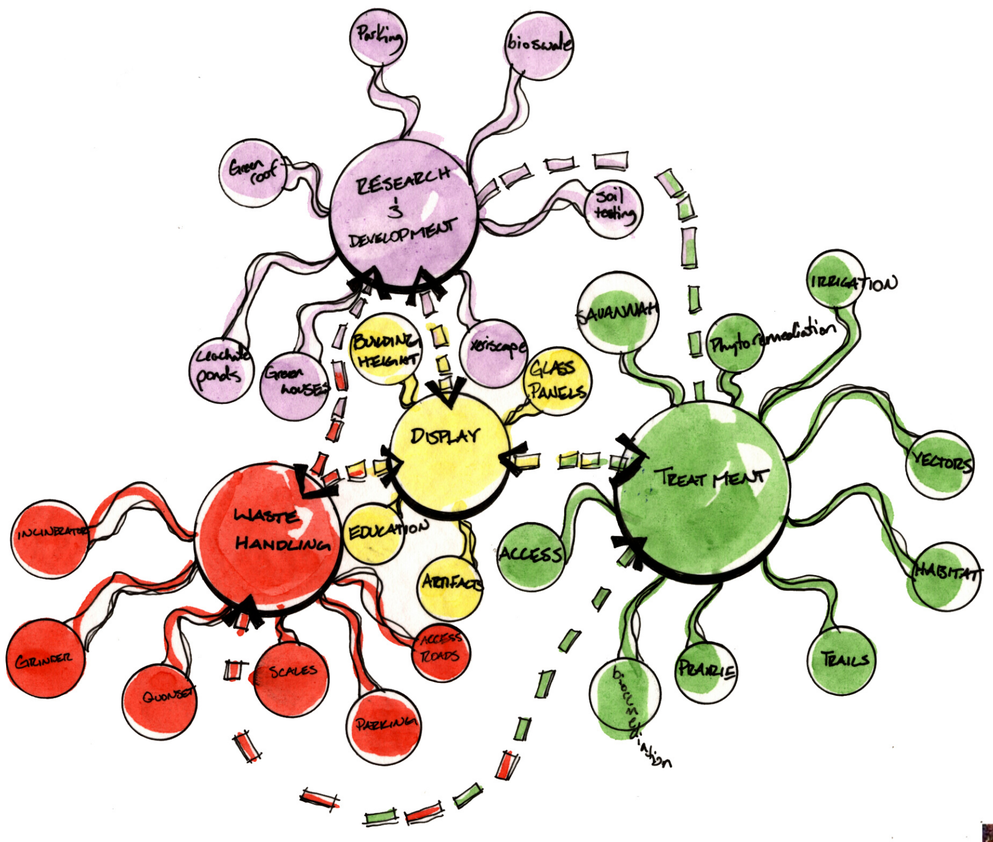
List of Elements

Waste Handling
Grinder
Wet Cell Landfilling
Incinerator
Scales
Support Buildings
Parking

Display Areas
Education
Artifacts
Confrontation
Habitats

Treatment
Native Vegetation
Bioremediation
Phytoremediation
Prairie
Wetlands
Savannah
Wildlife
Trails
Vectors

Research and Development
Green Roof Technology
Bioswales
Leachate treatment
Soil testing
Plant harvesting
Biopolymers
Biodiesel
Hydrogen Power
Wind Energy

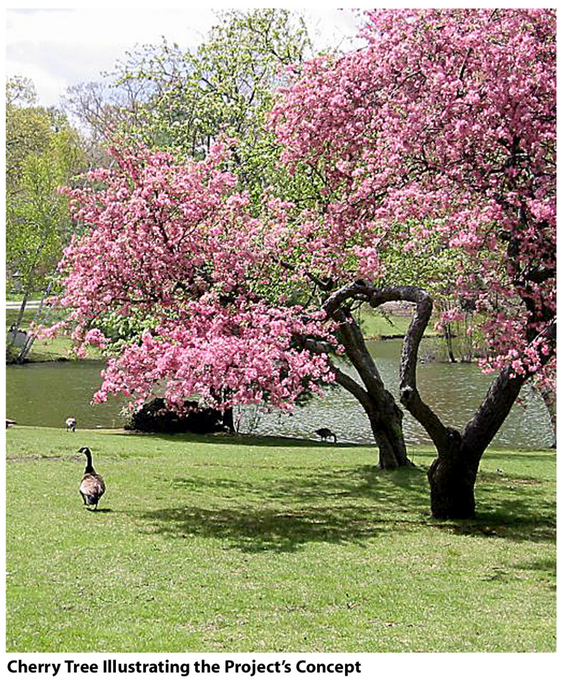


Waste Equals Food

In the book *Cradle to Cradle* the authors have a passage where they describe the excess in nature and how nutrients are reused. I am including it in its entirity as it influenced my project greatly.

'Nature operates according to a system of nutrients and metabolisms in which there is no such thing as waste. A cherry tree makes many blossoms and fruit to (perhaps) germinate and grow. That is why the tree blooms. But the extra blossoms are far from useless. They fall to the ground, decompose, feed various organisms and microorganisms, and enrich the soil. Around the world, animals and humans exhale carbon dioxide, which plants take in and use for their own growth. Nitrogen from the wastes is transformed into protein by microorganisms, animals, and plants. Horses eat grass and produce dung, which provides both nest and nourishment for the larvae of flies. The Earth's major nutrients-carbon, hydrogen, oxygen, nitrogen-are cycled and recycled. Waste equals food.'

It is completely possible for people to handle their excess in the same manner as a cherry tree. A large portion of waste is biodegradable, therefore useful. As for non-biodegradable refuse...help is on the way. With the advent of biosolids, ethanol, and other environmentally friendly products, there will be a day when there will be no such thing as waste. Fargo could be at the forefront of solving the garbage crisis if more research and development was done with these technologies.



Cherry Tree Illustrating the Project's Concept

New Recycling Program

Currently, the City of Fargo has both curbside pick up, and drop off recycling at various locations. Recycling in Fargo is not as successfull as it could be. It costs $4-$5 per month to supply a bin for pick up and for the collection of recyclables from homes. It costs extra for extra bins. Also, while there are many collection bins throughout the city for free drop off, it is still a hassle for people to save their garbage and then haul it ot ne collected.
A new recycling program for the city of Fargo is essential for the success of this project. It is estimated that close to 50% of waste is recycleable, the city of Fargo currently recycles at a rate of 9%. I am proposing mandatory recyling city wide. Bins will be provided for free, and picked up at no extra charge. The catch is that if people do not recycle, they will be charged a fine. This system works well worldwide, and is easily applyable for cities. The need for additional trucks will not be a financial problem, because not as many trucks will be needed to pick up other garbage. Items that will be recycled include but are not limited to: aluminum, plastic, glass, cardboard, and newspaper. Food waste will be picked up seperately and hauled to the compost pile, which will no doubt need to be expanded. -

Typical recycling truck and bin

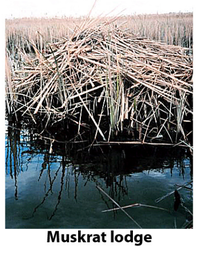
Garbage Composting

Any and all garbage that is biodegradeable will be composted, including waste already in the landfill. This will reduce the volume of the waste and also allow the waste to be remediated. The garbage will first be pu through a grinder, which operates much like a paper shredder on a way larger scale. The ground garbage will be mixed with the ash from the incinerator, and then piled in the open, excavated areas. The garbage will then be wet landfilled in a new way. The garbage will be irrigated twice a week to both speed break down, and to leach out chemicals. The garbage will be overturned two to three times by a disk in between irrigations. This will also speed breakdown. After one month composting time, the garbage will be planted and seeded. Both medium and small size trees will be planted along with native grasses and flower plugs as well as hydroseeding a native grass mix. This should ensure coverage and success of the plants. After planting and seeding, the landfill will need to be irrigated at least one more month to ensure plant growth. The leachate treatment system will be in place right away as to allow for treated leachate water to be used for irrigation purposes. The wetland system will be the first area to take in garbage for composting and planting as to further treat the leachate water. The entire landfill should be excavated, composted and treated withing five years. The end result will be the site plan that follows.

During Composting

Immediately After Planting

During Remediation



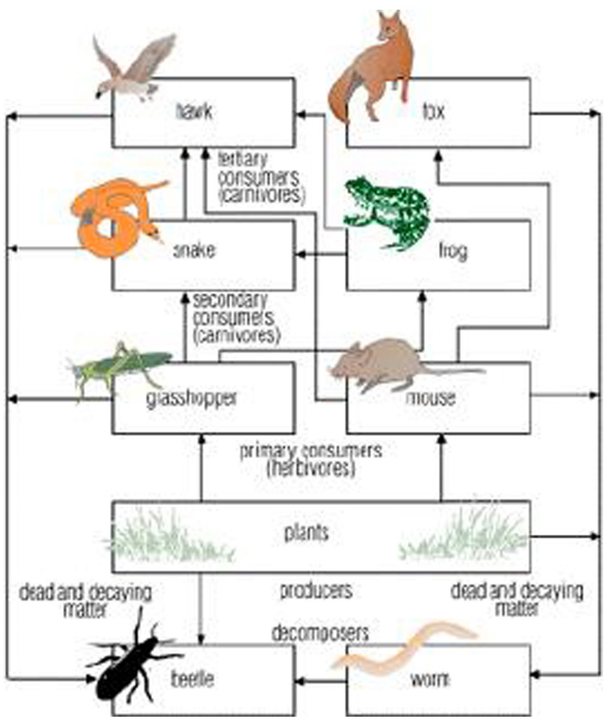
Muskrat lodge

Partial Food Web Illustration

One of the inspirations for this entire project was my knowledge that the Fargo landfill is to become designated for wildlife habitat after closure. A landfill closed under current practises and standards is no place for wildlife to be. As the landfill is not planned to be remediated or designed for habitat in any way, diverse wildlife will not populate it anyway.

If animal habitat is considered in the design phase, it is extremly easy to incorporate into the project. Not only that, but it will improve the site's sustainability and self preservation. For instance, worms, and bacteria will decompose the waste at the landfill turning it into useable soil by the plant material. the plant material will be eaten or used for housing by other animals, which will be eaten by other animals and so on. The grasses and animals that are eaten will become excrement and return to the worms and bacteria to become soil again. in this way, everything has a purpose and nothing will become overabundant. It will also provide a learning tool for designers, residents, and students.

The example food web provided is just a small portion of the web that will be created at the landfill post remediation. The bigger and more diverse the web, the better it will work. The Fargo landfill will be able to be designated for wildlife habitat, and actually mean it.



Sample Food Web From: Wild Way Productions website

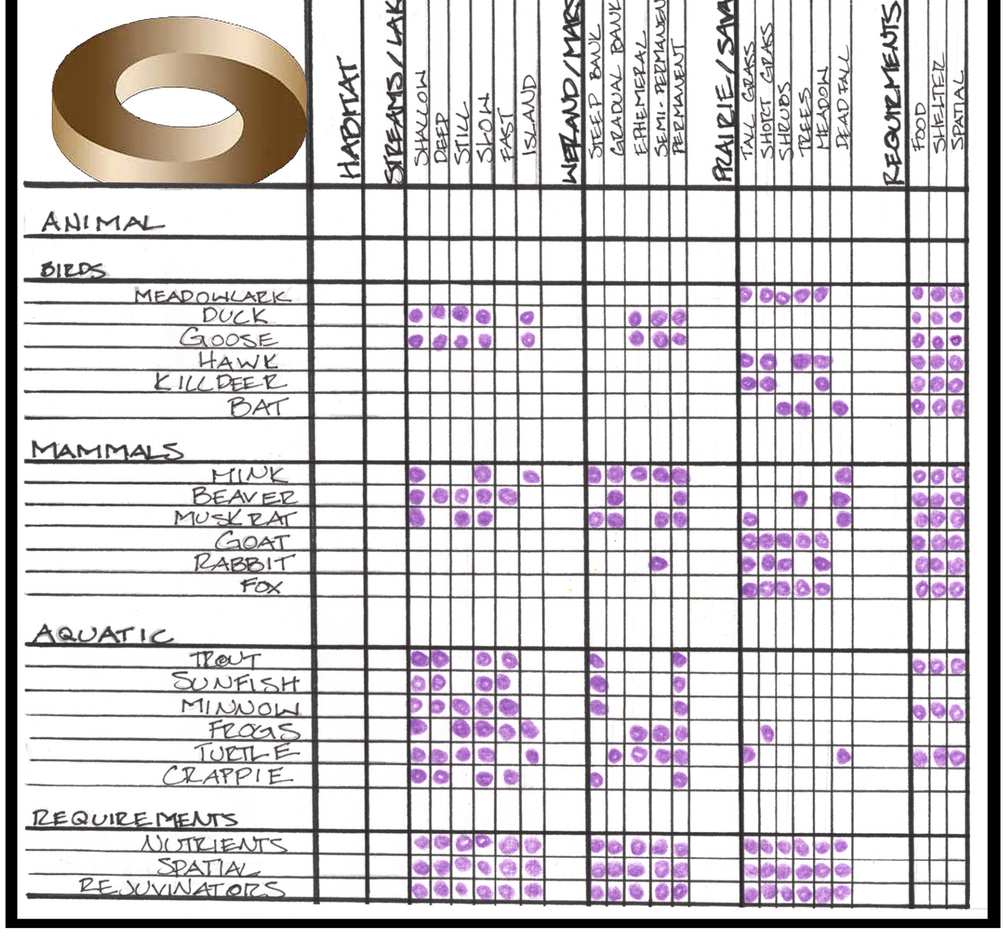
Animal Habitat Matrix

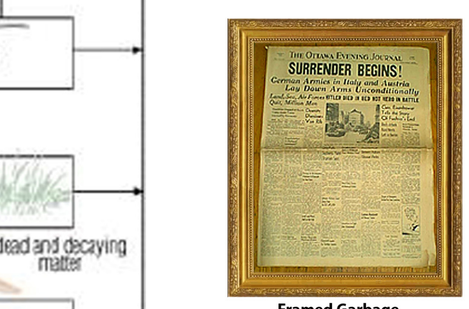
This is the matrix I used to help in the design of the habitat system for the landfill. It only represents a part of the wildlife that will inhabit the landfill. It would be nearly impossible to represent all of the possible animals that could survive there. The animals I chose to represent are native to eastern North Dakota, and coexist naturally in the wild. Others reasons for selection of certain animals would be their specific diet. For example, bats and sparrows eat almost twice their weight per day in mosquitoes; which I would like to keep in check naturally. Another example is the trout. This fish is very sensitive to pollution, so its inclusion towards the end of the water treatment system will be a natural monitor of any problem within the system.

Some of the animals in this list require deadfall, or larger trees for shelter. This material will need to be placed in areas as needed. This will not be a problem to attain because currently at the landfill, branches and stumps are brought in to be ground and burned. Some of this material can easily be diverted to become housing for animals. Some larger trees will also need to be brought in via spade, to speed up the time for trees to become large enough to be used as shelter. Most of the trees used selectively for their remediation qualities are fast growers anyway, so this should not be too much of a problem.

Other than the birds and insects, the rest of the animals to be included at the landfill will need to be brought in. There is simply no way a turtle can get in otherwise. I realize this will not allow the process to be totally natural, but given that the habitat is to be a remediated landfill in the heart of an industrial park, it is impossible for it to be a natural process anyway.

The beauty of this matrix and the food web, is that everything is dependent upon everything else for survival. The wetlands need inihabitants, the birds need the fishes and mammals. Everything is connected. Including humans. We need a place for our excess to go and be used by something to produce something else. We also need a place to remind ourselves that we are a part of a bigger whole. The Fargo landfill will give us that.



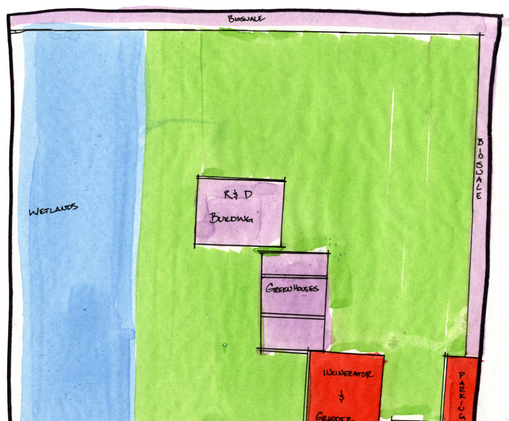


Framed Garbage

Waste Showcase/Confrontation

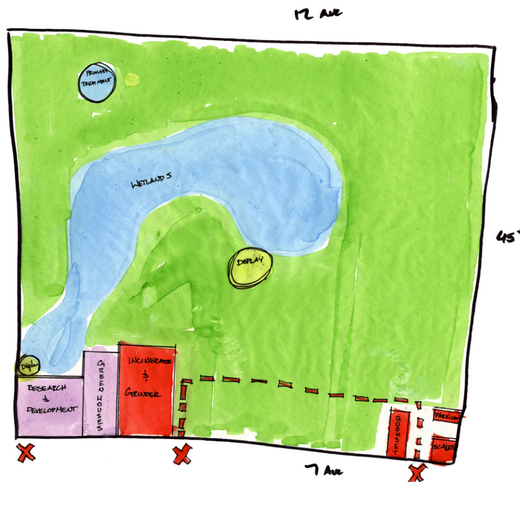
During the research portion of this project, I studied many remediation projects, many of them being closed landfills. The projects all provided a re use for the areas, and the public recieved them well. Not only did almost none of these do anything to remediate the waste, they did not attack the problem at the core. In these projects, waste was actually glorified. For example, in New Jersey old pvc pipe was used to create viewers. Another example was the classic tires painted with vibrant colors to become planters. These do nothing to remediate the waste; they just delay the inevitable discarding of the product. A true remediation of a landfill needs to address the garbage handling in that area, and let people know how much waste they create. Most people do not know they create 1 ton of refuse per year all by themselves, and when they find out are much mre willing to try and reduce their waste.

This task will be accomplished at the landfill with etched glass panels strategically places along the pathways at important vistas. The panels will be etched with images of garbage, putrid leachate ponds, rats, and other images of typical landfills. The glass will allow people to see through this waste into a meadow, wetland, or prairie. They will serve as an important reminder of what the Fargo landfill will look like if no remediaiton effort is done. Another effort will be inside the research and development building. Waste excavated from teh landfill will be framed and hung on the walls to remind employees and visitors what was at the landfill. The waste will be from at least 15 years ago but will not be decomposed.



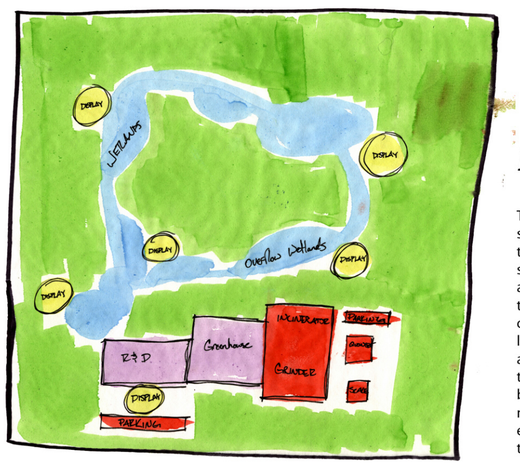
Layout Scheme 1

This layout includes most of the elements listed above. The blue area represents the area to be taken up by leachate filtration, in the form of a wetland. It is located where the old landfill was. As that will be the first part to be remediated, and as the landfill will need a leachate system right away, it makes sense to locate it here. The part that doesn't quite work is that it seems seperated from the rest of the site. The same goes for all the elements, they seem isolated. The incinerator and grinder have been located in near proximity to the scales, which is convenient for truck access. The location of the scales doesn't work because the impending increase in traffic to the landfill. The research and development building is not only by itself, it is too far away from the incinerator and grinder to successfully monitor them both.



Layout Scheme 2

This layout incorporates all the elements from the list, while creating a more dynamic flow through the site. The water filtration still begins at the old landfill, but extends further into the site. It still seems like a separate entity, rather than part of a whole. The research and development building as well as the incinerator, grinder, and greenhouses have been located on the southern side of the site to take advantage of sun angles and wind direction. Theses buildings are too far from the scales to minimize truck traffic on site. They are also too close to the edge of the landfill to allow for much elevation change between the road and the buildings. A few display areas have been noted, but more display would be better, to confront people about wastefulness and its repercussions.



Layout Scheme 3

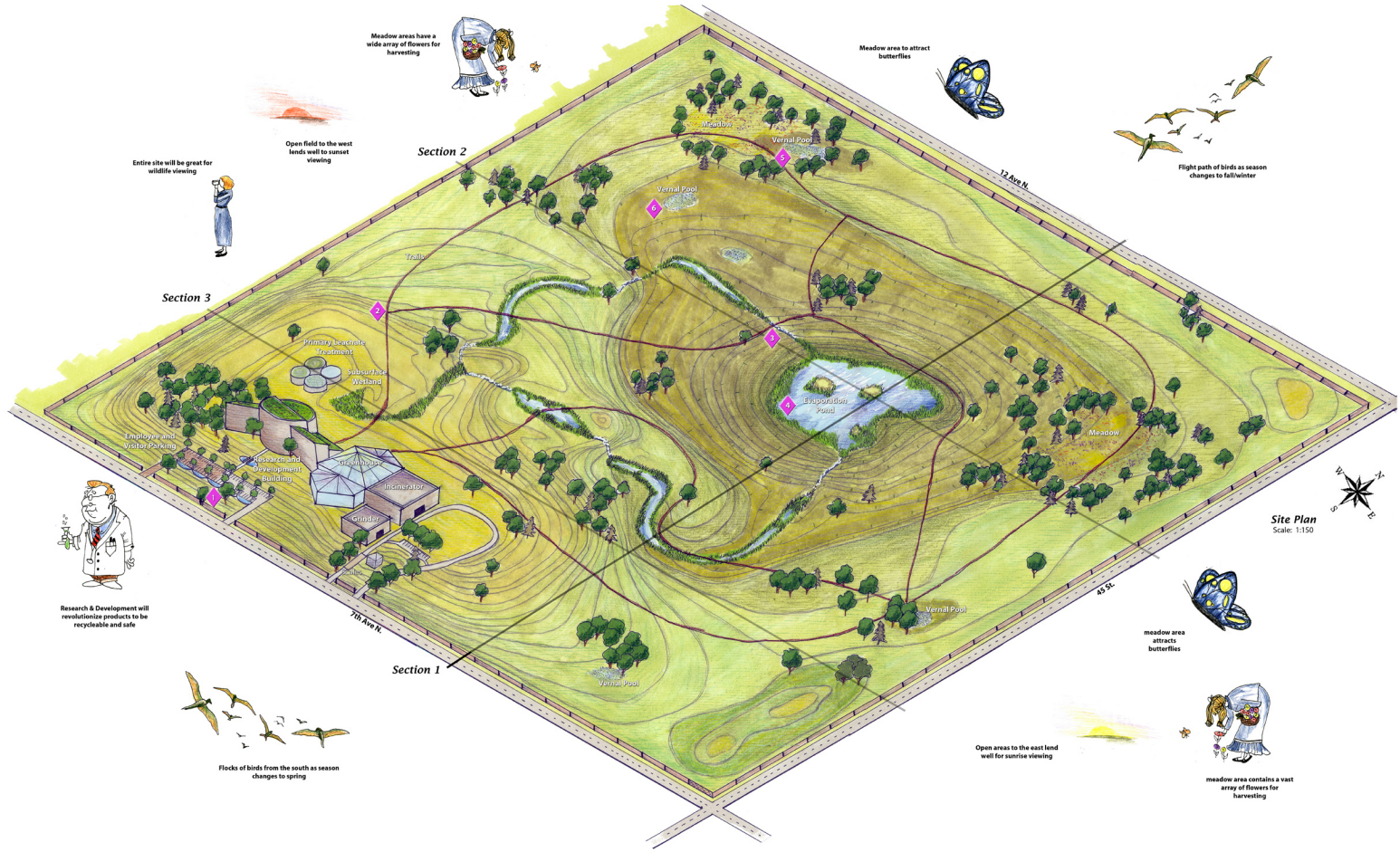
This design is by far the best. The wetland system has been further spread out throughout the site, and is divided in two systems, to allow for flood-pulse flow. There are more areas suitable for display, since throughout the site environments change so often. The built structures have all been located near one another to allow for ease of access and monitoring. The drawback to this is that it will be expensive to relocate the scales, but as cost is not an issue with this project it is not too big a problem. The many environments and ecosystems will lend better to wildlife habitat creation as well.

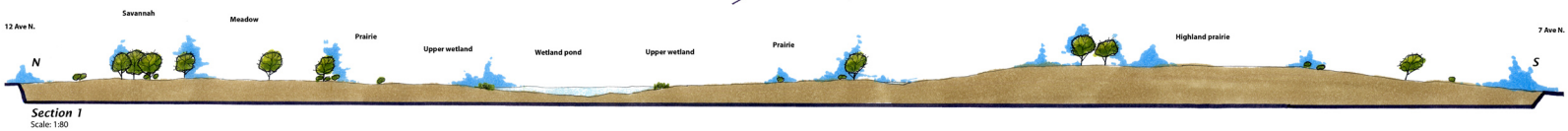
Design Development

Board 5 of 10

Waste is a Terrible Thing to Waste

THE FARGO LANDFILL:





Section 1
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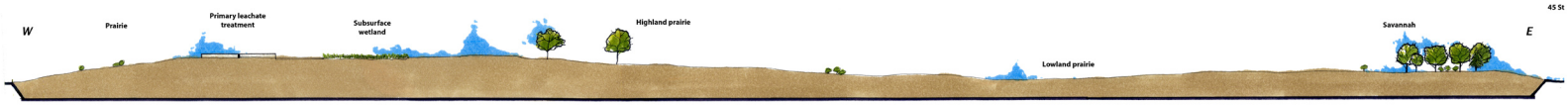


Section 3
Scale: 1:80

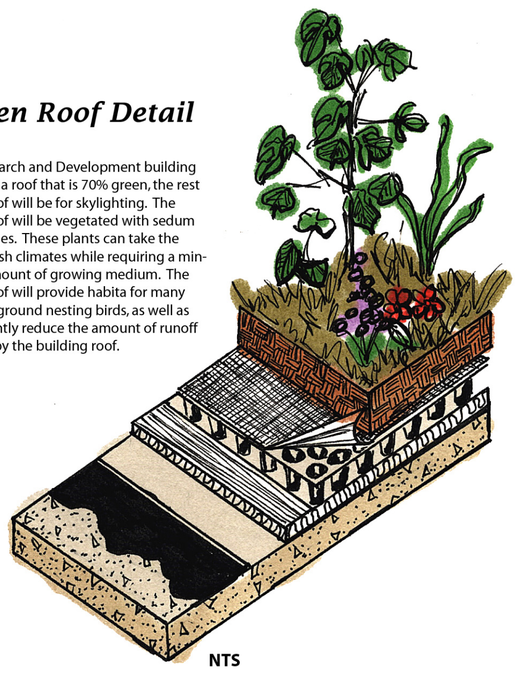
THE FARGO LANDFILL:

Perspective 1

The parking lot at the Fargo landfill will serve dual purposes; to provide a place to park, and to illustrate runoff differences between paving types. Half the parking lot will be paved with completely impervious concrete, while the other half will have a semi pervious brick/gravel pattern. Runoff will be directed into catch basins for people to observe and measure the difference in amounts. The semi pervious side will have significantly less runoff. After measurement or in the event of large rainfall, the basins will be drained into a bioswale for filtration and evaporation. Excess runoff will drain to the surrounding ditches and drained.

Green Roof Detail

The Research and Development building will have a roof that is 70% green, the rest of the roof will be for skylighting. The green roof will be vegetated with sedum and sedges. These plants can take the most harsh climates while requiring a miniscule amount of growing medium. The green roof will provide habita for many types of ground nesting birds, as well as significantly reduce the amount of runoff created by the building roof.



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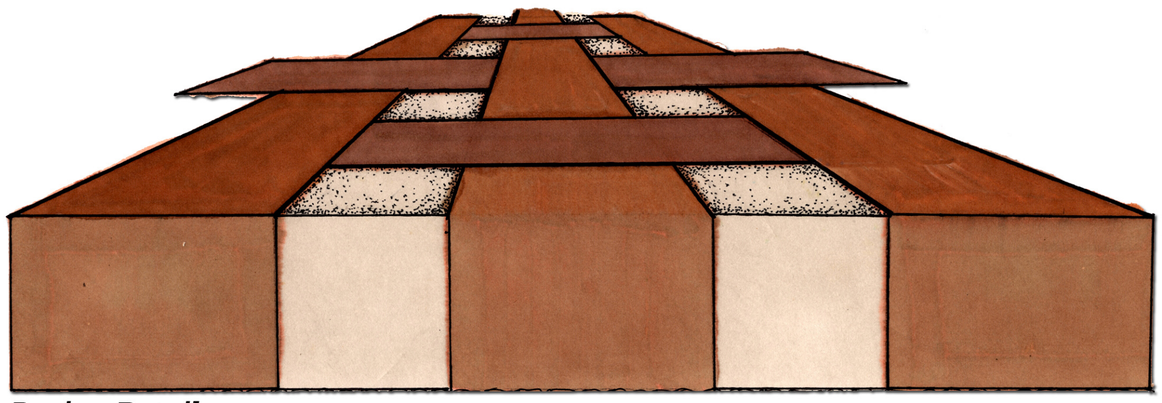


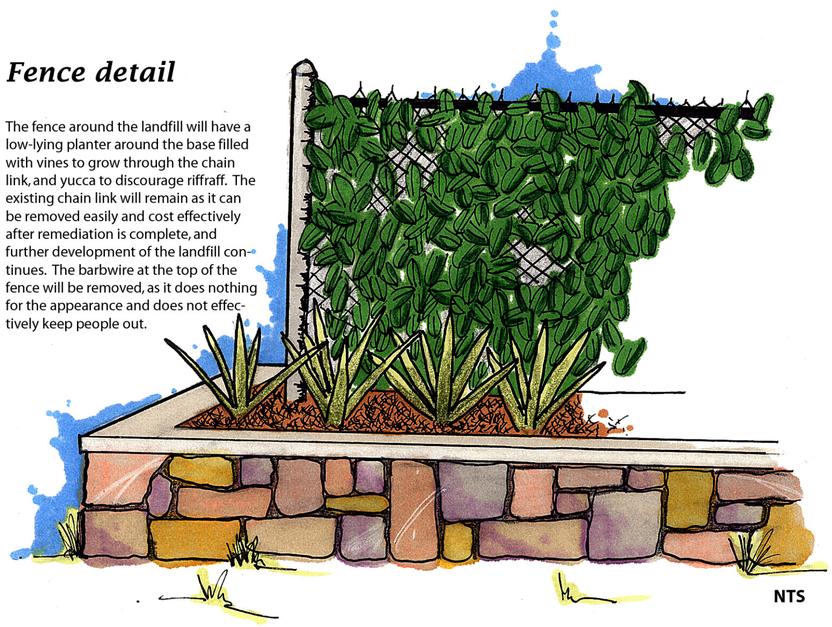
Paving Detail

NTS

The paving for the semi-perviou sside of the parking lot will be a combination brick/gravel. The brick will be laid in a loose basket weave pattern with gravel in between bricks. The gravel allows for the infiltration of water down to the soil. Larger grade gravel will be used underneath the paving as a base to allow further runoff.

Fence detail

The fence around the landfill will have a low-lying planter around the base filled with vines to grow through the chain link, and yucca to discourage riffraff. The existing chain link will remain as it can be removed easily and cost effectively after remediation is complete, and further development of the landfill continues. The barbwire at the top of the fence will be removed, as it does nothing for the appearance and does not effectively keep people out.



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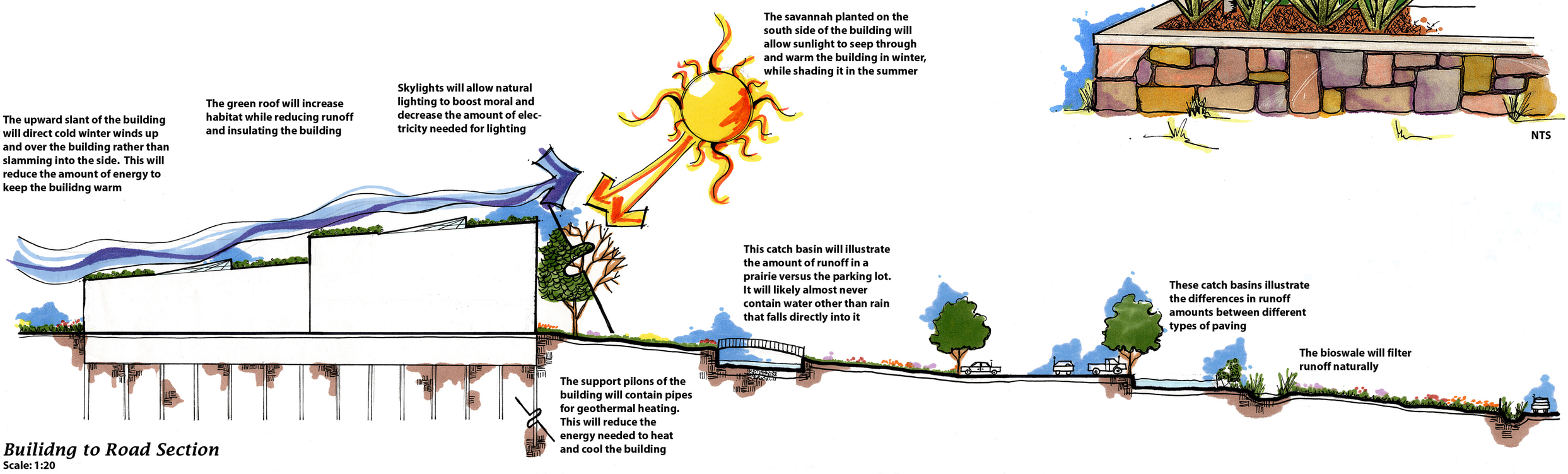


Builidng to Road Section

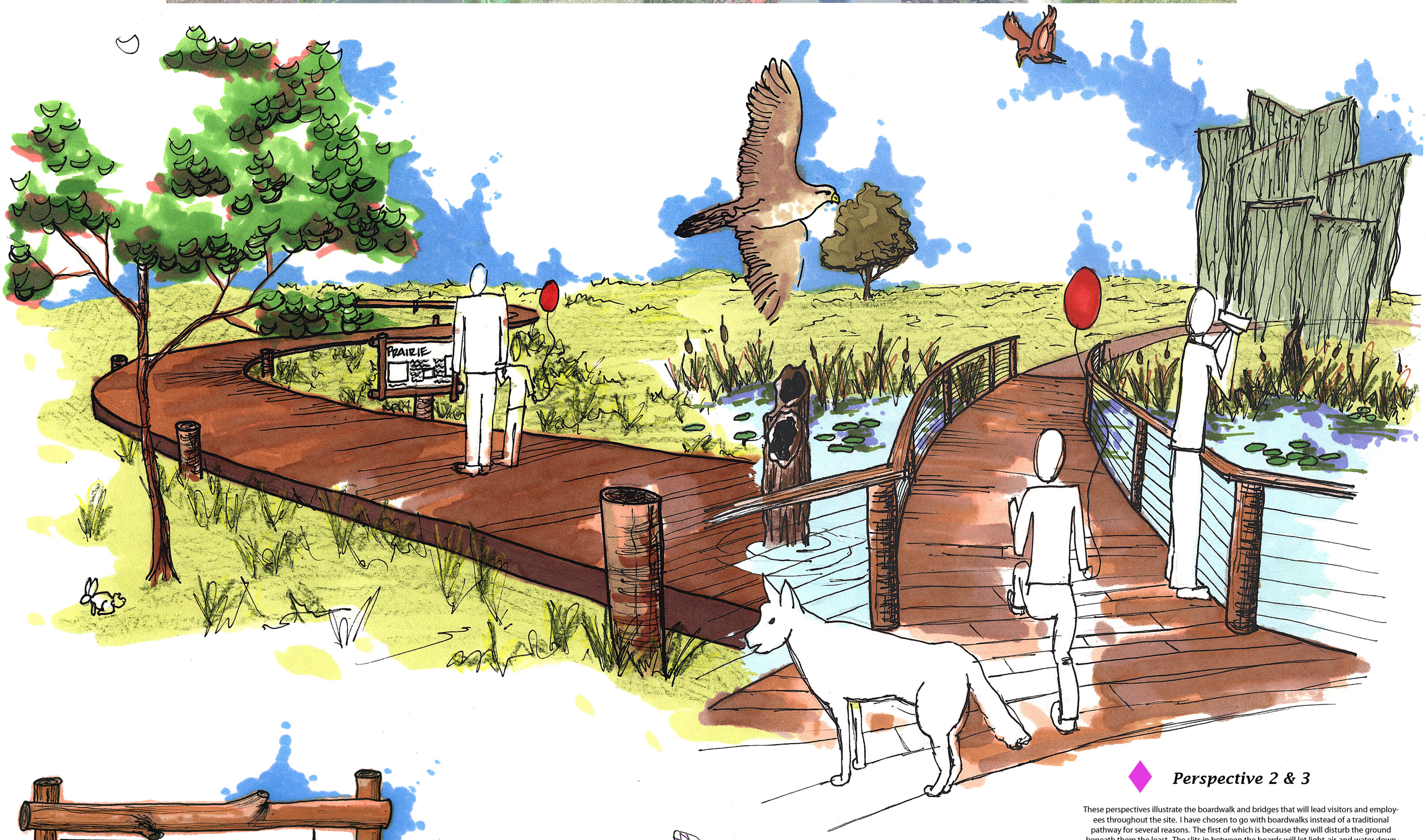
Scale: 1:20

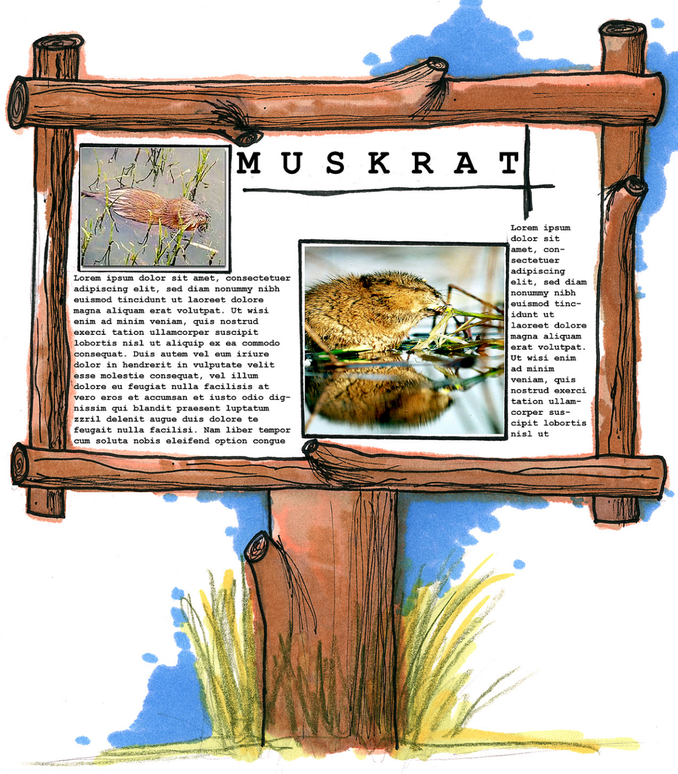
Perspectives and Sections

Board 7 of 10

Waste is a Terrible Thing to Waste

THE FARGO LANDFILL:

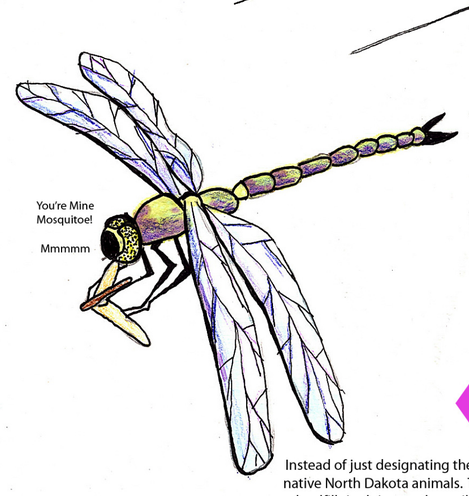




NTS

Sign Detail

Information signage will be constructed from logs and branches previously brought to the landfill for grinding and shipping. The information will be printed on recycled plastic and protected with glass on either side. Material represented will be anything from an animal and its habitat to what kind of garbage or contaminate a plant helps to remediate.



Perspective 2 & 3

These perspectives illustrate the boardwalk and bridges that will lead visitors and employees throughout the site. I have chosen to go with boardwalks instead of a traditional pathway for several reasons. The first of which is because they will disturb the ground beneath them the least. The slits in between the boards will let light, air, and water down through the boards while allowing plant material to grow up between them. The underside of the boardwalk can also become home to small mammals or bats. The boards for the boardwalks will be pressure treated to help against rot without using chemicals. When a board eventually rots, it can be easily replaced, without ripping out the whole structure. Rotted boards can be ground up and used as mulch elsewhere on the site. All along the path will be informational signs so visitors can learn about the flora and fauna they are amongst, and how they work together to survive.

Perspective 4

Instead of just designating the landfill to become 'wildlife habitat' I have chosen to create habitats for native North Dakota animals. The animals will live off the vegetation or other animals or insects at the landfill. In doing so, they will help to keep the system a self-sustaining one. For instance, muskrats need aquatic vegetation to build their nests and for part of their food supply. Mink need muskrats for food and to use their lodging as their own. Hawks eat mink and also use vegetation to build homes. So on and so on. After the Fargo landfill is remediated, and possibly developed further, part of the wildlife habitat can remain. The wetland system can become a fully functioning stormwater system and with some planning, most of the animals will be able to remain on site.

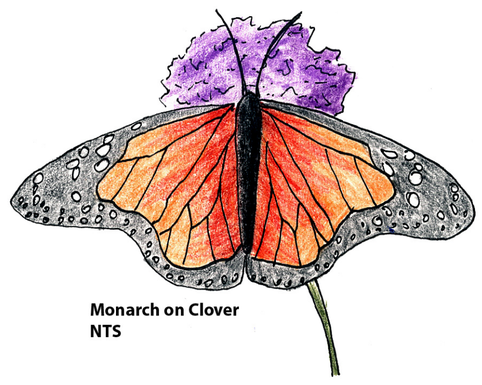
Perspectives and Details
Board 8 of 10

Waste is a Terrible Thing to Waste

THE FARGO LANDFILL:

Meadow Perspective

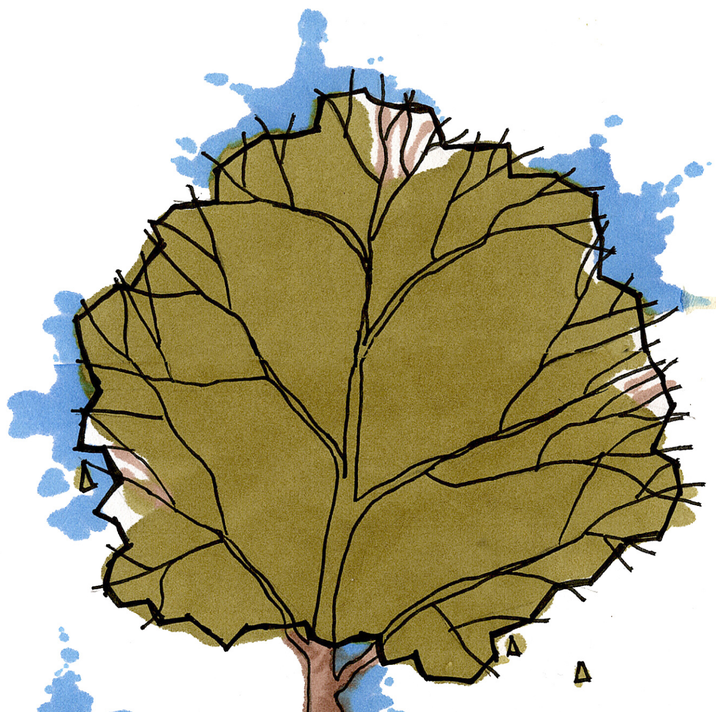
There are two meadow areas in the site plan. They are filled with a wildflower mix native to North Dakota and have bloom times varied throughout the year. The idea is to have visitors walk through the prairie and wetland areas which will be varying shades of green with few splashes of color, and then through a break in the savannah to an area bursting with vibrant color and fragrance. The flowers will also attract many butterflies, bees, and certain birds. The feeling inside the meadow is more protected, and seperate contrasting with the vast openess of the prairie and wetland areas.



Monarch on Clover
NTS

Vernal Pool Perspective

A vernal pool is basically a shallow depression in the ground that fills occasionally with water for a week or two after a large rain or snowmelt. Vernal pools are very important in a healthy wetland ecosystem. A vernall pool can act as a device to control and filter stormwater, not to mention provide mating grounds for several types of mammals, and many insects. Mosquitoes will not be able to reproduce in them as the larvae takes longer to develop than the pool will have water in it. There are several vernal pools throughout the site providing habitat for a variety of organisms.



Typical Wetland Section

This section depicts the connection of a wetland area to the pond by a rocky ephemeral stream. Each wetland will hold water for a two week time period so the water can settle and be filtered. After this time, gates holding the water back will be opened and the water will flow through th estream to the enxt wetland. The streams serve to aerate the stagnate wetland water, and effectively drain the wetland. This flood-pulse system gives the vegetation in the wetlands some time to recuperate and get 'thirsty' again.

The island in the pond is habitat for birds, a resting spot for turtles, and cover for fishes. Many birds require an island to mate and nest, while turtles need a spot to occasionally take a break from swimming. Fishes need cover to hide from other fishes as well as from certain types of birds. It will also allow for more vegetation to be grown in the deeper pond waters to aerate and filter the water. The main purpose of the pond is to allow for gradual evaporation of water.

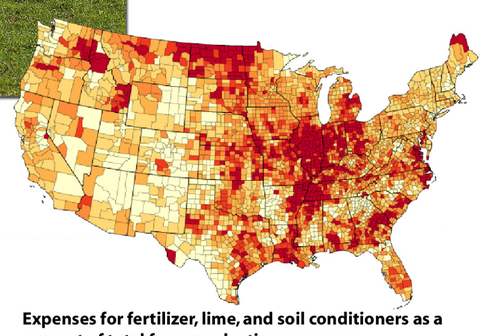
Progression of Vegetation Detail

One educational element of the site will be the ability of visitors to learn about the progression of different types of vegetation. The most striking examples will be along the waters edge in the wetland areas. The educational signs will help visitors to learn which plant is which

THE FARGO LANDFILL:

How This Project is Financially Feasible

Compost Spreader for Natural Agricultural Fertilization
image obtained from Internet



Expenses for fertilizer, lime, and soil conditioners as a percent of total farm production expenses
image obtained from USDA website

Cost Associated with Traditional Landfill Closure

It costs between $80,000 and $200,000 per acre to close and cap a landfill in the traditional manner. At $140,000 (the median price) the Fargo landfill which is 160 acres will cost upwards of $22,400,000 to merely cap and close the landfill.

The 'Old Landfill' is currently designated an EPA superfund site requiring cleanup. This will tack on at least an additional $10,000,000.

The Fargo landfill will inevitably leak. It is a fact that all liners eventually fail. Using the Becker County landfill as precedent, it will cost at least $500,000 to remediate any and all groundwater pollution, as well as any gas leaks and soil problems.

Revenue Associated with Traditional Landfill Closure

The Fargo landfill currently earns between $2-7 million dollars annually by selling the methane produced to Cargill. Thirty years or so post closure, the landfil will no longer be monitored for methane and will stop selling it, since it should no longer be produced by then.

Cost Associated with the Implementation of This Project

It would be impossible to calculate exactly the cost of this remediation strategy. An educated guess estimates around $100 million dollars. This price tag would include the excavation of the entire landfill, the construction of a grinder and incinerator, greenhouses,the construction of a research and development building, the wetland construction, the vegetative materials, the millions of earthworms and other animals to be introduced, and the trail system.

It should be noted the City of Fargo is planning on the construction of an incinerator anyway, so this would eliminate the neccessity of including it in the price tag.

Another important point would be the leakage factor. By the time the landfill would begin to leak, the remediaiton process would be long complete. Therefore, if it leaked, it would just be a natural part of the Fargo groundwater flow and would pose no threat of pollution

Revenue Associated with the Implementation of This Project

While this project will require an enormous amount of money to complete, it will be able to more than make up for itself.

The incinerator on site will be able to power 20,000 homes daily. The sale of electricity will more than make up for the loss of revenue from selling methane.

The new recycling program will divert all yard and food wastes to the Fargo Composting Site. The size of the composting operation will increase tenfold, producing the most reusable natural fertilizer in the area. This compost can be sold to local farmers to use in place of chemical fertilizer and will replace lost or depleted topsoil.

The landfill will no longer be a landfill. It will become re-usable and adaptable to change. It could become anything. The city will be able to sell the land to developers and tax it for years to come. This will add tens of millions of dollars to the city's bank account.

Finally, the landfill will pose no risk to the residents of Fargo. There will be no contamination of soil, air, or water created by the landfill. No one can put a price tage on their health.

What Could the Remediated Fargo Landfill Become?

A cranberry bog

Two states in the U.S. produce the entire cranberry crop; Wisconsin and Massachusetts. We even import cranberries from other countries to fill the demand. Cranberries will grow in the North Dakota climate as long as they are seasonally flooded. The landfill will have a wetland system in place already, so it could easily be converted into a cranberry bog. This idea is a little far out there, but it is to illustrate the vast scope of possibilites available to the landfill post remediation.

Cranberry Bog Harvests
images obtained from the Internet

Expansion of the Industrial Park

One of the most likely scenarios for the landfill post remediation would be to develop it as more industrial park. What will be different about this addition to the industrial park is that it will have a stromwater system in place at the time of construction. Employees will be able to stroll about the grounds on breaks, and the city will not have yet another rectanguar detention pond lined with turfgrass. The industrial park addition could be developed in such a way as to still maintain habitat for most species on site. It would be a model for sustainable development. My vision for the types of businesses to locate here would be biopolymer manufacturing, ethanol manufacturing, and other businesses making products created in the research and development building located in my plan.

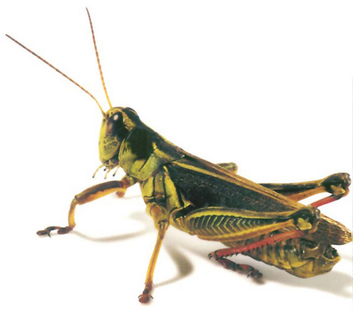
Industrial Park Creates Jobs
images obtained from the Internet

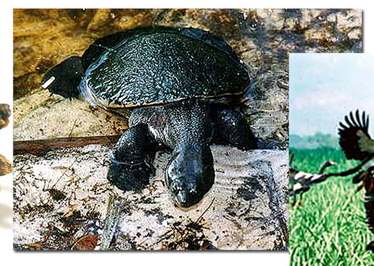
A Wind Field

Due to the topography created at the old landfill, it would lend well to becoming a wind field. The 160 acres the landfill comprises could be filled with enough winmills to power the entire city of Fargo-Moorhead, and West Fargo. In fact, we would have ample electricity to sell to other areas and increase revenue further. The wind field idea could be used in conjuction with any development idea, as they don't take up much space horizontally. Fargo is one of the windiest places in the area, due to the areas flatness. We could take advantage of that and create clean energy that is renewable.

Windmills Creating Electricity
images obtained from the Internet

Leave the landfill as Habitat/Parkland





Another idea would be to leave the landfill as a new gem in the system of Fargo Parks. The area is currently devoid of parks; the nearest one is a few miles away. A lot of land in this area is used by humans for development or for agriculture. A 160 acre wildlife preserve/park in the city could benefit the residents and city not in monetary value, but in educational opportunities, and in providing more space for people to be outside amongst nature. The pond could easily be expanded into more of a lake, for residents to fish in, or the annual influx of butterflies could become a new city holiday.

Cities Can Support Ecosystems
image obtained from the Internet

A Snowmobile Track

The people of this area are accustomed to long winters. One of the activities that is very popular amongst all ages is snowmobiling. The topography at the landfill will create amazing jumps for riders to attempt. The landfill is large enough to provide interesting snowmobiling for many riders at once. The idea could even be expanded to include snowmobile races and trick shows. The people of Fargo currently have to travel long distances in search of good sites to ride, so this would allow the residents of Fargo to remain here, rather than leaving for vacations.

Topography Spurns Good Snowmobiling
images obtained from the Internet

A Housing Development

A housing development on an old landfill in an industrial park would have seemed like a stretch prior to remediation. However, with the remediation comes amenities. The site will have a large pond with streams, mature vegetation, and topography...something very valued in this area. The site is also close to three main thoroughfares: 12 Ave, 45 St., and 7 Ave. Access to and from the site would be very convenient. A housing development here would be perfect for people who worked in and around the industrial park, as well as college students due to its proximity to North Dakota State University. The development would also increase the property taxes available for the development, providing more funds for the city.

Housing Developments Increase Property Value
images obtained from the Internet

Various Outdoor Activities

People in the northern midwest are notorious for appreciating the different seasons provided by our climate. This is why an area such as the landfill could be designed as an outdoor adventure park of sorts. Everything from mountain biking, to frisbee golf, to paintball could all be included on one site. A family, or group of friends, or even co-workers could all go together and participate in whichever activity suits their fancy. This option could provide substantial revenue with tournaments for each sport, and even through renting equipment. This idea would also allow a good majority of wildlife to stay at the landfill as well.

Residents of Fargo Getting Exercise Outside
images obtained from the Internet

Where Do We Go From Here?

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Waste is a Terrible Thing to Waste