ANL-12/02 (Summary)

Summary Site Environmental Report

for Calendar Year 2011

Environment, Safety, and Quality Assurance Division

About Argonne National Laboratory

Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC under contract DE-AC02-06CH11357. The Laboratory's main facility is outside Chicago, at 9700 South Cass Avenue, Lemont, Illinois 60439. For information about Argonne, see www.anl.gov.

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A MESSAGE FROM THE STUDENTS

STUDENTS FROM LEMONT HIGH SCHOOL

Front row, from left: *Miranda Neumann, Kaila Korosec, Alexandra Laniewski, Kimberly Walsh, Katherine Lynch, Katherine Klein, Carly Motto, Lauren Pustulka.*

Back row from left: *John Dillenburg, Stephen Tuscher, Kyle Hamann, Kevin Lindgren, Ms. Karen Aleman (teacher)*

Not shown: *Alexa Rios*

Every year, Argonne scientists conduct studies and collect data to determine the environmental status of the site. This information is published each year in the Site Environmental Report and summarized in a Summary Site Environmental Report. This year the advanced placement (AP) Environmental Science class from Lemont High School in Lemont, Ill., was selected to summarize Argonne's Site Environmental Report. The students were fortunate enough to have visited Argonne while working on the report. The whole class was impressed by Argonne's facilities and developing technologies. Seeing things first hand really helped us understand more of what the AP Environmental Science class was writing about. Each group of students was responsible for different sections of the summary report. The students were given the challenge of helping the general public fully grasp the results of the environmental studies that Argonne makes of its own campus and facilities. This class was selected due to our environmental knowledge that came from studies taking place in our classroom.

The class researched their sections for the summary report to the best of their abilities. There was an extensive amount of work put into completing this task. When the class was first given the project, the class was more than excited to embark on this journey with Argonne. At the beginning of this process, some Argonne scientists came to the classroom and explained about the environmental protection, sustainability, and research programs being conducted at Argonne. The scientists explained how the student's task was to write the summary in a simplified way so that a broader audience could fully understand what is being done at Argonne. They also gave the class tips on how to successfully complete this project. Mrs. Karen Aleman, the teacher of this class at Lemont High School, said, "I am excited for my class to receive the opportunity to write their first publication, to gain life experience, and enhance college applications." Some of the students were intimidated by the size of the project, but they were also eager to live up to Argonne's expectations. Carly Motto, a junior at Lemont, stated, "I was willing to accept the challenge even though it was a great responsibility and time consuming." Overall, the students were proud to gain recognition by being offered this opportunity.

This summary report contains a brief explanation of what Argonne does to reduce and improve their overall environmental footprint. Also, the booklet discusses projects Argonne has accomplished or intends to accomplish over the next years to improve its sustainability. Some examples are: greater use of alternative fuel sources for automobiles; the use of geothermal energy to heat and cool their visitor center; and the increased use of solar, wind, and hydro power. All these things help achieve Argonne's overall goal of decreasing carbon dioxide emissions and reducing climate change.

The whole AP Environmental Science class would like to give a big thanks to the scientists at Argonne who showed the class the ways in which the world is changing. Another thanks goes to the Argonne staff, Lawrence Moos, Devin Hodge, and David Baurac, who came into our classroom and presented the class with the necessary information regarding the summary report. The class would like to thank their teacher, Mrs. Aleman, who helped the students through the whole process.

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For more information about Argonne's Site Environmental Report, contact Theresa Davis, 630.252.6077 or tmdavis@anl.gov

For more information about Argonne and its programs, visit the laboratory's website at www.anl.gov or contact Communications, Education & Public Affairs at 630.252.5575.

The text was edited by David Baurac. Photos by George Joch. Graphic design by Michele Nelson.

KYLE HAMANN AND STEPHEN TUSCHER

WHAT IS ARGONNE?

The origin of Argonne National Laboratory dates back to 1942 and the University of Chicago's Metallurgical Laboratory (Met Lab), which created the world's first self-sustaining nuclear reaction in the Chicago Pile-1 (CP-1) reactor underneath the University of Chicago's Stagg Field. Argonne and the Met Lab have strong ties to Enrico Fermi, noted for winning the 1938 Nobel Prize in physics, for his demonstration of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons. Argonne was officially chartered as a national laboratory by the U.S. Atomic Energy Commission on July 1, 1946, to conduct research in nucleonics, the study of the atomic nuclei and uses for nuclear energy. Argonne's mission has changed over the years from nucleonics to integrating a wide range of world-class scientists, engineers, and user facilities to deliver innovative research and technologies. Their goal is to create new knowledge that addresses the scientific and societal needs of our nation. Some notable Argonne discoveries include developing the first automated system to grow human cells in culture, developing the concepts and prototypes for nearly all the world's commercial nuclear power plants, and most recently, developing cathode materials used in the battery for Chevy's popular electric vehicle, the Volt. Argonne National Laboratory has come a long way from its humble start.

Aerial view of the Argonne National Laboratory

continued... What is Argonne?

Because it is funded by the U.S. Department of Energy (DOE), many of its research facilities are open for use by outside researchers from industry, universities, and other national laboratories; Argonne is home to six such national user facilities. More than 5,000 researchers conduct experiments at their user facilities annually. The funding for these facilities comes primarily from the U.S. Department of Energy's Office of Science. Other funding comes from U.S. Department of Transportation, other government agencies, and private industry.

Today, Argonne has a budget of 794 million dollars and a workforce of 3,456 employees consisting of 1,250 scientists and engineers. Argonne also hosts 350 post-doctoral scholars, 650 graduate and undergraduate students, 157 joint faculty, and 5,204 faculty users. It is managed by UChicago Argonne, LLC, for the U.S. Department of Energy's Office of Science.

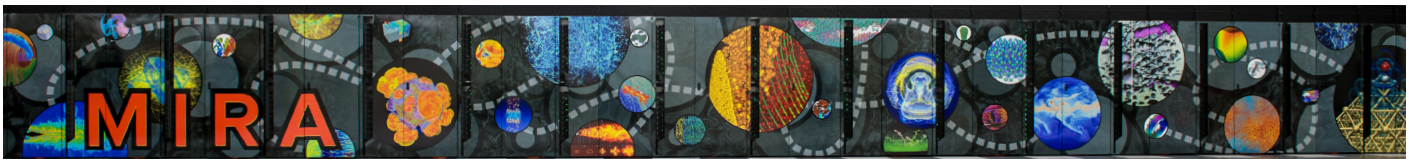
Argonne occupies 1,500 acres in DuPage County. The site is 27 miles southwest of downtown Chicago and 24 miles west of Lake Michigan. Argonne's terrain is gently rolling, partially wooded, former prairie and farmland. Incorporating many ponds, streams and wetlands, the land drains mostly to Sawmill Creek, which empties into the Des Plaines River that flows into the Kankakee River and later into the Illinois River.

Argonne is committed to renewable energy and sustainability, and this commitment starts on their own property. The laboratory has erected a wind turbine that feeds directly into the Argonne power grid and supplies power to one of their facilities. Also, there is a compost site that breaks down organic waste from the Argonne cafeteria, creating rich soil for landscaping. Perhaps a more technologically advanced source of sustainability comes from their visitor center, which is heated completely through a geothermal system, dually equipped with motion-sensor-controlled meeting room lighting and low water-use toilets. Argonne has also put otherwise unusable land to great use by installing solar panels to generate energy for their power grid. Other solar panels supply energy to charging stations for their fleet of fully electric cars.

KYLE HAMANN

CURRENT RESEARCH

Argonne National Laboratory is at the forefront of scientific research. The research Argonne performs is related to observing and understanding matter and energy. Argonne's research programs are organized into directorates that focus on broad fields of research. These directorates are Computing, Environment, and Life Sciences (CELS); Energy Engineering and Systems Analysis (EESA); Photon Sciences (PS); and Physical Sciences and Engineering (PSE).

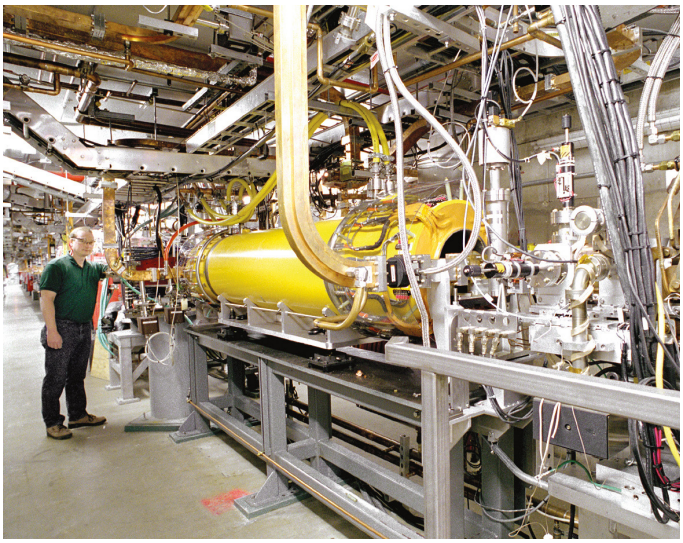


Argonne's Mira Computer

The mission of CELS is to combine research in the life and environmental sciences with the power of high-performance computing. This combination can produce critical information and technology for today's world. CELS is further divided into several divisions: the Argonne Leadership Computing Facility, the Atmospheric Radiation Measurement Climate Research Facility, Biosciences, Computation Institute, Environmental Sciences, Institute for Genomics and Systems Biology, and Mathematics and Computer Science. The shining gem of the CELS division is Mira, the third fastest super computer in the world. Mira uses 786,432 processing cores on 48 racks and at peak performance is capable of 10 quadrillion floating-point operations per second. Mira makes it possible to make complex calculations and simulations quickly.

EESA develops the technology needed to make groundbreaking discoveries in the field of energy and sustainability. The goal for this directorate is innovation for a sustainable future. This directorate developed advanced cathode technology used in the battery for the Chevy Volt and advanced technology for testing and removing harmful chemicals from the environment. Research divisions under EESA include Decision and Information Sciences, Energy Systems, Nuclear Engineering, and Intelligence and Analysis.

Chevy Volt Battery



Linear Accelerator in the Advanced Photo Source

PS deals with the movement and behavior of energy, primarily in the form of photons, and the use of those photons for research and technology development. The pride and joy of PS is the Advanced Photon Source (APS), which dozens of companies, universities, and other government laboratories use for their research. The APS is the Western Hemisphere's most powerful source of storage ring-generated X-ray beams for research. Some goals of PS are to operate a highly reliable third-generation synchrotron X-ray radiation source, enhance the power and capabilities of the APS, and maintain an organization that provides a rewarding environment that fosters professional growth. The PS is further divided into three divisions: Accelerator Systems, APS Engineering Support, and X-ray Science.

The goal of PSE is to create new materials and chemicals and to advance the science of accelerator physics. This directorate focuses primarily on physics research but also ventures in other directions, such as microscopy, solar energy, and material sciences. Divisions within PSE include Physics, Chemical Sciences and Engineering, High Energy Physics, Materials Science, and Nanoscience and Technology.

KATIE LYNCH

ENVIRONMENTAL MANAGEMENT SYSTEM

Argonne's management team uses an Environmental Management System (EMS) to effectively manage and monitor the laboratory's impacts on the environment and to identify ways to improve their environmental performance. Argonne's EMS certification was received on June 19, 2009, and signifies that Argonne's EMS program conforms to the standards of the International Organization for Standardization (ISO) Standard 14001:2004, Environmental Management Systems. The Argonne EMS is part of the Integrated Safety Management System (ISMS), which includes programs for environmental protection, safety, and health. The ISMS describes controls that are necessary for managing work that could potentially endanger a worker, the public, or the environment. These controls are implemented by Argonne's work planning and control processes. By following the National Environmental Policy Act (NEPA) environmental review process, Argonne can identify, assess, and minimize any potential environmental risks associated with the laboratory's work.

The Argonne environmental policy is available to all through the laboratory's website. The policy states that Argonne is committed to environmental improvements, pollution reduction, and waste prevention. This policy applies to all activities that could or currently have an impact on the environment. To support this policy Argonne:

- Ensures that it meets environmental permit expectations and regulatory requirements,
- Actively minimizes and prevents pollution,
- Builds internal and external partnerships to sustain the environment, and
- Corrects conditions promptly to eliminate potential impacts.

The EMS allows Argonne to minimize and eliminate adverse impacts. This process catalogs and ranks all of the ways in which Argonne impacts the environment. To determine which environmental aspects are significant, Argonne uses a scoring methodology to rate each for regulatory compliance, environmental consequence, mission consequence, and the likelihood of occurrence. All facilities that have significant aspects are required to have controls in place to reduce or eliminate their negative impacts.

Argonne's Electric Vehicles and Solar Charging Station

Argonne monitors the environmental regulations to ensure that the staff is aware of changes or proposed changes in regulations. Sources such as the U.S. Environmental Protection Agency (EPA), Illinois Environmental Protection Agency (IEPA), and U.S. Department of Energy (DOE) web sites and newsletters are monitored to identify new information regarding regulations. Other ways to obtain this information include attending workshops and seminars and participating in organizations and conferences.

Through the annual establishment of EMS objectives and targets, Argonne can improve environmental performance. The objectives are measurable goals concerning how Argonne can address each significant aspect. Targets are documentable actions with due dates that contribute to achieving one of the goals. All Argonne divisions are encouraged to establish environmental targets for their programs. The objectives for 2011 were completed as scheduled. They focused on developing sustainable practices, achieving full compliance with applicable environmental regulations, and assessing opportunities to prevent pollution.

Argonne's program to implement environmentally sustainable practices covers five major areas: transportation, energy and water conservation, renewable and clean energy, pollution prevention, and employee involvement. Sustainable transportation efforts include making Argonne's vehicle fleet green, promoting a healthy work environment and cutting down emissions from employee transportation. The energy and water conservation strategies include saving water, using green buildings, and reducing the use of steam and electricity. Water conservation strategies include requiring low-flow fixtures, replacing steam traps, and reducing the need for industrial makeup water. Energy initiatives include getting at least 7.5 percent of the lab's total energy from clean and renewable sources, developing large-scale clean energy approaches, and purchasing renewable energy credits. The development of bio-fuel combustion capacity, evaluating wind power feasibility, and implementing geothermal technology are some of the ways Argonne meets these goals. As for pollution prevention, Argonne has implemented a site-wide program that tracks the generation of waste and recyclable materials from the laboratory's work. This program also monitors progress toward the goals of the site's sustainability plan.

Argonne's comprehensive solid waste recycling program recycles a wide range of materials. For example, in 2011 Argonne received approximately $31,000 for recycled mixed office paper and scrap metal. Materials recycled on the Argonne site are shown in the table on the next page.

Lemont High School students discuss Argonne's sustainability program with Argonne staff

Programs such as the Argonne Property Excess System allow employees and contractors to minimize waste and reuse available materials. The Argonne Chemical Management System helps Argonne reuse surplus chemicals rather than purchase new chemicals. To promote its efforts, Argonne educates and informs its employees and the public about their programs. The Argonne Communications, Education and Public Affairs organization fosters communication to build and maintain trust within the community.

RECYCLED MATERIALS (2011)	
MATERIAL	AMOUNT RECYCLED (TONS)
Mixed office paper	222
Aluminum (70%), steel (10%), glass (10%), and plastic (10%)	77
Asphalt, concrete, and construction debris	786
Scrap metal	286
Computer components (PCs)	26
Computer monitors	25
Toner cartridges	4.6
Batteries	0.2
Engine lubricating oils	8.6
Fluorescent lightbulbs	1.2
Lead/acid batteries	3.1
Transparencies	0.01
Athletic shoes	0.01

Argonne has received many awards for its environmental work. In 2011, the Fugitive Emissions Working Group, of which Argonne is a part, received the Secretary of Energy's Achievement Award for reducing emissions of sulfur hexafluoride, a potent greenhouse gas. At Argonne, these emissions have been reduced 78 percent since 2008. Argonne's sustainability program received the 30th annual Federal Energy and Water Management Award. Also, the Illinois Sustainable Technology Center presented Argonne, along with 24 Illinois companies, with the Governor's Sustainability Award.

Winners of the 2011 Secretary of Energy's Achievement Award

ALEXA RIOS AND CARLY MOTTO

CLEAN AIR ACT

The Clean Air Act is a federal statute that addresses the emission of regulated air pollutants, hazardous air pollutants, and ozone-depleting substances. It defines the U.S. Environmental Protection Agency's responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer. In 2007 the Supreme Court ruled that greenhouse gases were categorized as regulated air pollutants. The program that is established by the Clean Air Act is implemented by individual states through a State Implementation Plan that describes how that state will ensure compliance with air quality standards. The act includes emission limits that facilities must meet; these limits are enforced by the Title V permit that restricts the amount of pollutants a facility may emit. Under this permit Argonne must identify all emissions of regulated air pollutants and must pay annual fees based on the amount of regulated pollutants they are allowed to emit.

ASBESTOS EMISSIONS

Asbestos was originally used as a heat-resistant and fire-retardant material in many products, but we now know it can cause serious health problems. Many buildings on Argonne's site contain large amounts of asbestos-containing material (ACM). This material is removed only when necessary, for example, during renovations or maintenance of equipment and facilities. The removal and disposal of ACM is overseen by the National Emission Standards for Hazardous Air Pollutants (NESHAP) program, which is part of the Clean Air Act. Argonne maintains an asbestos management program to ensure compliance with the regulatory requirements. ACM is removed from the site by personnel or outside contractors licensed by the Illinois Department of Public Health. All this work is done in accordance with the NESHAP and Occupational Safety and Health Administration requirements. During 2011 almost 3,000 cubic feet of ACM was removed from Argonne.

Worker Removing Asbestos Insulation

RADIONUCLIDE EMISSIONS

The NESHAP program also sets standards for radionuclide emissions from DOE facilities, which include limiting the release of radionuclides other than radon to the air and requirements for monitoring, reporting, and recordkeeping. Numerous emission points at Argonne fall under these standards and operate in ways that comply with the requirements. The amounts of radioactive material released into the atmosphere from Argonne emission sources are incredibly small. The maximum potential off-site dose of radioactive material to the air for 2011 was 0.0036 mrem, which is more than 2,000 times smaller than the 10 mrem allowed under the EPA standard.

CONVENTIONAL AIR POLLUTANTS

The Argonne site contains numerous sources of conventional air pollutants, including a steam plant, gasoline and ethanol/gasoline blend fuel-dispensing facilities, waste handling facilities, an engine test facility, a surface treatment facility, a number of diesel generators, and a wastewater treatment plant. All these facilities are operated in compliance with the regulations and permit conditions. The Title V permit requires continuous opacity and sulfur dioxide monitoring of one of the boiler house smoke stacks when that boiler is burning coal rather than natural gas. Landfill gas monitoring is conducted quarterly, and this provides information on whether methane is migrating from the landfill. In 2011, no methane was detected above the action level of 2.5 percent methane in the landfill perimeter gas sampling wells. Argonne submitted an annual compliance certification to the Illinois EPA for 2011 detailing any deviations from the Title V Permit. There were no deviations identified in 2011. Argonne submits an emissions report to the IEPA each May 1, for the previous year.

GREENHOUSE GAS REPORTING

Argonne is required to report the amount of greenhouse gas it emits. The laboratory submits one report to DOE headquarters and a second report to the EPA. Greenhouse gasses that are reported include carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons and perfluorocarbons.

WHAT ARGONNE DOES TO HELP

One of Argonne's goals is to protect and improve the environment. By complying with laws, permits, and regulations, the laboratory is taking the proper precautions to improve our environment. To demonstrate their compliance, Argonne sends annual reports to the IEPA and USEPA to list air emissions and to document that the standards are met. Complying with the CAA helps Argonne meets its goal of protecting our environment from damage.

ALEXANDRA LANIEWSKI AND MIRANDA NEUMANN

SURFACE WATER MONITORING

THE CLEAN WATER ACT OF 1977

The Clean Water Act (CWA) was established in 1977 as an amendment to the Federal Water Pollution Control Act of 1972. An ultimate goal of this act is to restore and maintain "fishable and swimmable" water quality in all waters throughout the country. This act also established the National Pollutant Discharge Elimination System (NPDES). The NPDES issues permits for discharge of wastewater from discharge points (outfalls). The NPDES permitting process in Illinois is administered by the Illinois Environmental Protection Agency (IEPA). The IEPA issues permits that specify special and general requirements, including sampling, analysis, reporting, and recordkeeping requirements. Argonne's current permit was issued in August of 2011. NPDES permits are revised every five years.

SURFACE WATER

Surface water is sampled at several locations across the Argonne campus by the environmental monitoring and surveillance program. Samples of wastewater discharged into on-site streams and Sawmill Creek are routinely collected as required by the permit. The results of wastewater sampling are compared with the permit limits for each outfall to determine whether they comply with the permit. The results are sent to the IEPA each month in a Discharge Monitoring Report (DMR).

To supplement the permit-required monitoring, Argonne voluntarily analyzes other samples collected from the combined treatment plant effluent (Outfall 001). Argonne collects samples from Sawmill Creek and the Des Plaines River downstream from the campus and compares them to samples collected upstream. These samples are analyzed for a number of inorganic chemicals and radiological parameters and the results are compared to water quality standards established by the IEPA. While Argonne is not directly required to meet these standards in the combined effluent or Sawmill Creek, they help determine the cleanliness of the effluent and Sawmill Creek. It turns out that Sawmill Creek water is cleaner when it leaves Argonne than when it arrives.

PROTECTING CLEAN WATER

Argonne uses two different independent treatment systems to collect and treat wastewater; the sanitary system and the laboratory system. The sanitary system collects wastewater from bathrooms, the cafeteria, and office buildings. This wastewater is treated in the sanitary treatment system, which consists of primary settling tanks, trickling filters, secondary settling tanks, and slow sand filters. Wastewater that is generated during research-related activities is processed through the laboratory system. It generally flows to a series of retention tanks located in many of Argonne's buildings and is pumped to the laboratory wastewater sewer after it is tested and found to be free of radioactivity. Treatment in the laboratory wastewater treatment plant (LWTP) consists of aeration, solids-contactor clarification, and pH adjustment. If an exceedance of any permit limit occurs, it is reported by telephone to the IEPA within 24 hours, and a written explanation of the exceedance is submitted with each DMR. During 2011, there were 12 exceedances of NPDES permit limits out of approximately 1,800 measurements. Nine of these exceedances occurred at Outfall 001, the combined wastewater discharge, while three exceedances were reported at Outfall 006, a stormwater discharge point. Most of the exceedances were caused by using road salt in the winter, which causes high levels of total dissolved solids (TDS) and chloride in the wastewater. Argonne anticipates fewer exceedances in 2012 due to changes in the permit that occurred in 2011 which removed several parameters from outfall monitoring or reduced the number of samples required (including TDS, total suspended solids , and total residual chlorine) and reclassified several of the outfalls from industrial wastewater to storm water only, which does not require monitoring.

Argonne Employees Sampling Sawmill Creek

JOHN DILLENBURG

GROUNDWATER MONITORING

WHAT'S THE CONCERN WITH GROUNDWATER?

Groundwater is water from above the Earth's surface (snow, ice, rain) that seeps down into the ground, goes on its own long journey, being filtered through sand, gravel, and porous rock, picking up some materials along the way. It ends its journey stored in a saturated zone underground, also known as an aquifer.

As groundwater moves through the earth it can pick up contamination that is present in the soil. The major concern about groundwater is understanding what might contaminate the groundwater, and figuring out how we can stop it. Once groundwater is contaminated, it is difficult to clean it up. There is little dispersion and dilution of groundwater in the aquifer, so groundwater stays contaminated a long time. Groundwater can be an important source of drinking water, and we all need to care about protecting it, even though we cannot see it.

HOW DOES GROUNDWATER GET CONTAMINATED?

Groundwater may be contaminated by chemicals and substances buried underground. Some toxic materials are naturally present in the soil and can affect groundwater quality, just as human activity can pollute groundwater. In addition, radioactive materials and other hazardous materials may seep into the groundwater from activities on the surface above.

HOW DO THEY KNOW ARGONNE GROUNDWATER IS SAFE?

Argonne's research uses hazardous materials that could be released to the ground if not properly managed. Such a release could be harmful to the public. Argonne respects its obligation to the public, so it carefully manages these operations and take samples of groundwater from many groundwater monitoring wells several times a year to make sure it is clean.

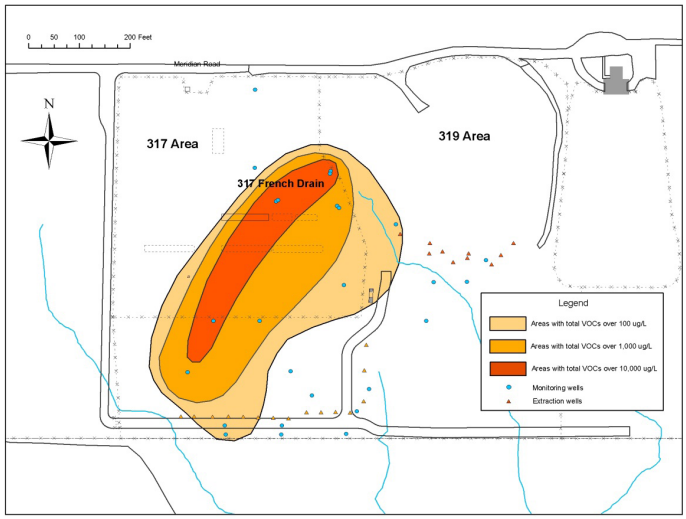
WHAT'S THE GROUNDWATER AT ARGONNE LIKE?

The groundwater at Argonne meets or exceeds most groundwater quality requirements set by the Illinois Environmental Protection Agency for Class I groundwater (which is groundwater that may be used for human consumption). These standards provide the necessary criteria to ensure groundwater safety. The exception is the 317/319 area in the southeast corner of Argonne's campus. This is the only area that has chemical contamination greater than the groundwater standards. The following figure, taken from the Argonne Site Environmental Report, summarizes the groundwater conditions in the 317 Area during 2011. This figure shows the amount of volatile organic compounds (VOC) in the 317/319 Area groundwater, which ranges from areas with no VOCs detected to areas with concentrations over 10,000 µg/L.

Argonne Employees collecting groundwater samples

HOW IS ARGONNE PROTECTING THE GROUNDWATER?

There are many different methods that Argonne uses to prevent contamination of groundwater and to clean up contamination that is already present. One method is a groundwater extraction system, which is a series of 15 wells with screens used to remove contaminated groundwater so it can be treated. Another method is creating barriers made with clay placed over buried waste in landfills to prevent rainwater from coming into contact with the waste. Also, Argonne uses phytoremediation, which is the use of plants to extract the groundwater and release contaminates into the air.



Region of impacted Groundwater at Argonne

Lemont High School Students Examining a Groundwater Extraction Pump

WHAT DOES THIS MEAN FOR YOU?

Groundwater is a hidden underground reservoir filled with clean drinking water for you and the wildlife above it. This is why Argonne is trying so hard to keep it as clean as possible by protecting its clean groundwater, monitoring the wells frequently, and cleaning up contaminated groundwater, all for the greater good of our planet.

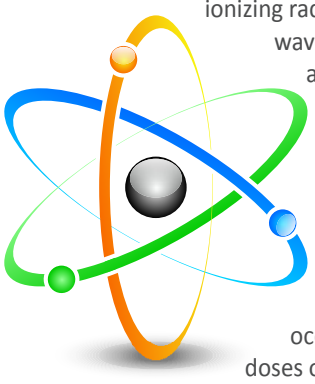
KIMBERLY WALSH

RADIATION

Although radiation is present in everyone on earth, it is sometimes feared as a major health hazard. Radiation is the transfer of energy through space in the form of subatomic particles, waves, or vibrations. Unstable or radioactive atoms (called radionuclides) give off energy to become stable, and that energy is called nuclear radiation. Humans can release nuclear radiation into the environment through the detonation of nuclear weapons or the use of technology that incorporates or creates unstable atoms, such as X-ray machines, medical isotopes, and nuclear reactors.

IONIZING RADIATION

Ionizing radiation is strong enough to damage cells. What sets ionizing radiation apart is that the particles and waves have enough power to destabilize and break down biological molecules in living cells by knocking an electron from its orbit around the nucleus. This causes the atom to become electrically charged, or ionized. Radiation sickness results from extremely high doses of this kind of radiation. Radiation sickness occurs when cells are killed by large doses of radiation coming into contact with them, causing some organs or the entire body to shut down. With low levels of exposure over a long period of time, cancer could result.



Most alpha radiation is stopped by the skin because the alpha particle, which consists of two protons and two neutrons, is large compared to the other forms of radiation. Beta radiation particles, which consist of highly energized electrons, are much smaller than neutrons and protons; their small size means they can penetrate more easily than alpha radiation but they can be stopped by clothes. Gamma radiation consists of a high energy photon, which is essentially a wave of energy that can penetrate deep into material. All ionizing radiation types have the ability to cause radiation poisoning or cancer, but only if the exposure is high enough. Because the penetrative ability of alpha and beta radiation is weak, they cause harm only when the source of the radiation is very close to the cells. Gamma radiation can cause damage throughout the entire organism and over large distances. Neutrons are another form of radiation but they are rarely present in the environment since they occur only near a nuclear reaction or a particle accelerator. X-rays are also a form or ionizing radiation, but are rarely found in the environment.

MEASUREMENT OF IONIZING RADIATION

One of the many devices to measure ionizing radiation is a film badge. Film badges give information on the amount of radiation encountered over a period of time. A personal dosimeter, or personal radiation monitor device, can give personal exposure information in real time. In the United States, the curie is a commonly used unit for measuring the amount of radiation present. For very small amounts of radiation, another unit, the picocurie (pCi) is used. This unit represents one trillionth of a curie. The risk that radiation exposure poses to humans is measured in rems, short for roentgen equivalent man, which measures how much damage is done to a biological organism as a result of exposure to ionizing radiation. Environmental exposures are very low, so a different unit, a millirem (mrem) is used. This unit is one-thousandth of a rem.

SOURCES OF IONIZING RADIATION

Humans experience 624 mrem of background ionizing radiation per year on average. Half, or about 311 mrem of that radiation, comes from a variety of natural sources. It is estimated that humans receive 29 mrem internal dose per year from food. Various sources from outer space bombard the planet with radiation regularly, causing a person who lives at sea level to receive 33 mrem from those sources per year. About 21 mrem come from radioactive elements in the earth itself. The remaining 228 mrem of natural radiation come from radon, a radioactive gas produced by certain rocks and soils, in the atmosphere. In addition to about 311 mrem of natural radiation, there is also about 313 mrem that come from man-made radiation including smoking, medical X-rays, construction materials, and common items such as TVs, pottery, and smoke detectors. Medical X-rays account for about 300 mrem of man-made radiation, while living near a nuclear power plant adds less than 1 mrem per year. The DOE determines how much radiation is safe to release to the environment. Argonne produces much less than the allowable limit established by the DOE of less than 100 mrem per year. The estimated maximum radiation dose to a hypothetical individual living near Argonne in 2011 was 0.015 mrem/yr.

NON-IONIZING RADIATION

Non-ionizing radiation is all other ways that energy is transferred through space, such as radio waves, microwaves, heat, and all forms of light. Although non-ionizing radiation is all around us in unexpected places, it can still pose a risk in large doses. Sources include any natural or technological device that emits heat, light, or radio waves. Exposure to small amounts of non-ionizing radiation usually has a negligible health risk.

RADIATION AND YOU

In our everyday lives, we receive only a tiny fraction of the huge dose necessary to give us radiation sickness. Our bodies can handle these low doses without any health problems. The technology around us may slightly increase the risk of cancer later in life, but the benefits of having that technology outweigh the small, unconfirmed risks. Radiation surrounds us; it is in the food we eat, the air we breathe, and the sun that warms our skin. In fact, life would not exist without it.

KAILA KOROSEC

RADIATION MONITORING

Many people wonder about the safety of nearby radiation sources, how much of that radiation could be absorbed, and how much radiation is unhealthy. While Argonne scientists do research with radiation, they are careful when they handle it, following government rules and regulations to minimize the release of radioactive materials to the environment. Argonne monitors and measures the release of the radioactive material to the air, water, and soil. Argonne also measures gamma radiation near the site boundaries. The laboratory even ensures the safety of employees and their children by monitoring for airborne releases near the Argonne Child Development Center. Argonne manages its use of radiation with the support of the DOE and other government organizations that help protect the public and our environment from radiation.

The DOE requires that an environmental monitoring and surveillance program be conducted to monitor and document any releases of radioactive material. It also establishes limits for safe amounts of different types of radiation in the environment. Argonne complies with these requirements to guarantee radiation does not exceed the permissible limits.

The radiation most people receive comes mainly from natural sources; however, Argonne also releases small amounts of radiation from man-made sources. Argonne measures the amount

of radiation in the air, water, and sediment. Argonne measures the radioactive content in the air by collecting and examining air filter samples at locations on and off campus. Any significant difference between the two would indicate that a release had occurred from Argonne. There are 11 sampling locations on campus and four off. The filters are changed weekly and analyzed. The sampler air flow rates are verified and adjusted yearly. The dose limit for members of the public from man-made radiation released to the air is 10 mrem/yr. In 2011, Argonne's releases to the air would have resulted in only 0.009 mrem/yr to a hypothetical nearby resident, more than a thousand times smaller than the safe limit.

Liquid wastewater from buildings or facilities that use or process radioactive material is collected in retention tanks. Whenever a tank is full, it is sampled and examined for radioactivity. If the radioactivity exceeds the release limits, the tank is classified as radioactive waste. If the amount of radioactivity is below the regulatory limit, it is pumped into the sewer and is treated at the Argonne's wastewater treatment plant. The treated wastewater is discharged into Sawmill Creek, a small creek that flows across the Argonne campus. The creek is sampled upstream from the campus and downstream of the point where Argonne discharges wastewater into the creek to determine whether radioactivity was added to the stream by Argonne wastewater or stormwater drainages. Sawmill Creek is actually cleaner when it flows off the Argonne campus than when it arrives.

The Des Plaines River is sampled twice per month downstream and once per month upstream of the mouth of Sawmill Creek to determine whether the radioactivity in the creek had any effect on the radioactivity in the river. Monitoring during 2011 showed that Argonne wastewater could have contributed approximately 0.005 mrem/yr radiation dose to a hypothetical individual, but only if that individual used Sawmill Creek as his or her only source of drinking water throughout the year.

The radioactive content of bottom sediment was measured in Sawmill Creek upstream and downstream of the Argonne site. When the results were compared it showed that measureable amounts of plutonium and americium were found downstream of the site, indicating they came from Argonne wastewater; however, the concentrations found were very low, and they do not present a hazard.

Phytoremediation is being performed in one area of the campus to clean up groundwater. This process uses woody and herbaceous plants to extract groundwater containing chemical substances from the soil. The process releases water to the air as the trees remove moisture from the soil. This groundwater also contains very low concentrations of hydrogen-3, a radioactive isotope of hydrogen. The amount of radioactivity released from the phytoremediation system was estimated to result in only 0.00000006 mrem/yr of radiation exposure, an extremely small amount compared to the limit of 10 mrem/yr.

Argonne Employee Collecting Air Sample

Argonne compared the amount of radiation released to the environment with the allowable dose limits in a dose summary. The doses from the air totaled 0.009 mrem/yr, compared to the standard of 10. Water totals were 0.005 mrem/yr compared to the standard of 4 established for drinking water. For direct radiation the Argonne estimate was only 0.001 mrem/yr compared to the standard of 25. This shows how little radiation Argonne releases. It also proves that the emissions do not endanger the health or safety of those living on or near the site.

Argonne also took a close look at the amount of radiation resulting from the Fukushima nuclear power plant accident in 2011 to help determine if it would have any effect on people in the United States. The laboratory established an air monitoring program to determine the time the radiation arrived in the Chicago area and measure the amount of radiation that reached us. Argonne was able to detect the radiation about 10 days after the accident, but the amount was very low: 10,000 times less radiation than a chest x-ray, and less radiation than you get from eating a single banana. This shows that barely any radiation reached us.

In conclusion, Argonne is well prepared for preventing radiation releases, as well as monitoring for radiation in the environment. This is because Argonne follows many rules and regulations to protect their employees and nearby residents. There is little chance that the laboratory will release dangerous amounts of radiation.

Lemont High School Students Inspecting the Transportation Research Facility

KEVIN LINDGREN

WASTE MANAGEMENT

There are many different kinds of wastes generated by humans. These can include recyclable material, biodegradable waste, non-biodegradable waste, and hazardous waste. Because hazardous waste can be extremely dangerous, it needs to be disposed of properly and safely. Strict rules and regulations in the Resource Conservation and Recovery Act (RCRA) and the Toxic Substances Control Act (TSCA) control the disposal of hazardous or toxic waste. Argonne National Laboratory must comply with these rules if they are to stay in business. In order to demonstrate that Argonne complies with these acts, they must send an annual hazardous waste report to the Illinois Environmental Protection Agency (IEPA). The IEPA reviews this report, checking to make sure that all of Argonne's hazardous wastes were managed according to the standards. One part of the Toxic Substances Control Act that Argonne must follow is the management and disposal of PCBs. Waste materials containing PCBs are shipped to an off-site commercial waste management facility, where they are handled carefully and properly disposed of.

Argonne Employee Packaging Hazardous Waste

To ensure their hazardous waste is carefully managed, stored and disposed of properly, Argonne has 15 hazardous waste management units. These include nine storage units, one liquid waste tank storage unit, three miscellaneous waste treatment units, and two chemical treatment units.

Argonne produces quite a large amount of waste every year. However, they ensure that all of these wastes get sent to appropriate disposal or recycling centers and are not disposed of illegally. Argonne recycles most of its reusable materials. Most waste material that cannot be recycled is sent to landfills. Because of the large amount of waste they recycle, Argonne not only saves the laboratory thousands of dollars in waste disposal fees, but they also earn money from the material that is recycled, giving Argonne more money to spend on useful purposes like energy research and safety and sustainability programs.

Shipping Argonne's Radioactive Waste to an Off-site Disposal Facility

A small amount of Argonne's waste is radioactive. This waste gives off radiation, often in the form of gamma rays. The long term health effects of radiation are a concern, creating the need to properly store and manage this type of waste. Some of these wastes contain radioactive elements whose half-life is often thousands of years, meaning it takes thousands of years for half of the radioactive material to decay into other stable atoms. If not properly stored and disposed of, this waste could affect people's health, and it could keep on affecting people and the environment until it all decays away, which will be far in the future. Before they can dispose of waste, Argonne must conduct tests in order to determine how much radiation is present. There are many rules that govern disposal of radioactive waste that Argonne follows.

Argonne measures the amount of radiation being released from the waste being managed at their site. They use radiation monitoring devices at 17 locations near Argonne waste management areas, at the Argonne site boundary, and several other locations relatively close to Argonne. They also monitor for radiation released from research facilities. They then compare Argonne's readings to DOE's and EPA's standards. The measured amount of radiation from waste in 2011 was far under the limits, indicating that Argonne is safe to work at and live near. After collecting and analyzing the results, Argonne publishes the results in the Annual Site Environmental Report. They also submit the results to the IEPA and the EPA.

KATY KLEIN AND LAUREN PUSTULKA

WILDLIFE AND HABITAT MANAGEMENT

Is the wildlife habitat surrounding Argonne as important as anything else? Of course! Argonne has numerous wildlife and habitat management programs that help protect the fragile plants and animals in and around Argonne.

ENDANGERED SPECIES ACT

The Endangered Species Act of 1973 (ESA) is a federal law to protect animals, plants, and critical habitats from the damaging effects that humans may have on them. The U.S. Environmental Protection Agency (EPA) and the State of Illinois have produced lists of threatened or endangered species that are protected. This law requires that the managers of federally owned sites identify any wildlife, fish, or plants that are on the threatened or endangered species lists and critical habitats for these species. Before development plans are approved, Argonne has to consider endangered and threatened species and their habitats and find ways to reduce impacts. When a potential risk to an endangered species is identified, state and federal stakeholders must be contacted to identify ways to minimize the impact.

No federally listed endangered or threatened species are present at Argonne, but there are two endangered species and one threatened species in the Waterfall Glen Forest Preserve that surrounds Argonne's campus. The endangered species are the Hine's emerald dragonfly (Somatochlora hineana) and the leafy prairie clover (Dalea foliosa). The threatened plant species is the lakeside daisy (Tetranuris herbacea). The endangered Indiana bat (Mytois sodalis) is also thought to be present in the vicinity.

There are some species that are not on the federal list but are on the State of Illinois' list as endangered. The following state-listed endangered species can be found on or near the Argonne site:

- Blanding's turtle (Emydoidea blandingii),
- Eastern massasauga (sustrusus catenatus catenatus),
- Tennessee milkvetch (Astragalus tennesseensis),
- Tuckerman's sedge (Carex tuckermanii), and
- Yellow-crowned night heron (Nyctanassa violacea).

Several state-listed threatened species are also found:

- Buffalo clover (Triflium reflexum),
- Kirtland's snake (Clonophis kirtlandi),
- Marsh speedwell (Veronica scutellata), and
- Shadbush (Amelanchier interior).

LAND MANAGEMENT AND HABITAT RESTORATION

Conservation of wildlife habitat, preservation from damage by development, and protection from invasive species are increasingly important in the Chicago area. Argonne's plan for managing the undeveloped areas of its campus is based on the need to mitigate future damage, restore the environment, and diversify landscaping. These goals are achieved through the increased use of cost-saving native species and the elimination of non-native plant species. Steps have been taken to return some areas within Argonne's boundaries to more natural, self-sustaining habitat types, such as prairie and savannah. Another initiative is to combat invasive species in remaining areas of high-quality habitat. In developed areas around the campus, Argonne is increasing plant diversity and the use of native plants for landscaping. Each year Argonne restores 3-5 acres of prairie and controls invasive plants on 30-60 acres.

Argonne does not have major problems with flooding, although there are flood plains along Sawmill Creek and some other small streams on campus. The waterways and floodplains on and near the campus are used for conservation and wildlife habitat rather than the development of new facilities. To construct a project in a floodplain, Argonne must show the DOE that there is no alternative to the floodplain location. Unless approved by DOE, no construction activity is allowed in the floodplain zones due to the huge impact that can occur.

Wetlands are habitats for many species. The Argonne campus has 35 wetlands that total about 50 acres. Past pollution and human activity have had a major impact on the wetlands, and Argonne has intervened and repaired damage to return some of these areas closer to their natural state. Moving wetland plant and animal species to new wetlands helps balance out the loss of other wetlands.

WILDLIFE MANAGEMENT AND RELATED MONITORING

The Argonne campus has two species of deer that require management, native white-tail deer and exotic all-white fallow deer, imported from Europe before Argonne took control of the land. Deer management efforts are coordinated by DOE and the Forest Preserve District of DuPage County to preserve and enhance biodiversity at Argonne and the Waterfall Glen Forest Preserve. DOE has an agreement with the U.S. Department of Agriculture to manage the numbers of white-tailed and fallow deer on the site. The number of deer needs to be managed to reduce traffic safety hazards and ecological damage caused by too many deer. From 1995 through 1997, more than 680 white-tailed deer were removed to reduce the deer densities to 20 deer per square mile. In 2001, DOE lowered its target density for white-tailed deer to 15 deer per square mile to reduce deer and vehicle collisions, allow oak trees to regenerate, and allow other plants to grow. The white-tailed deer population is managed each year to maintain the herd to the desired density. Over the last few years the fallow deer population has significantly decreased.

Argonne White Fallow Deer

STEPHEN TUSCHER

CURRENT ENVIRONMENTAL INITIATIVES

In recent times, the environment has become a more and more important topic of research around the world. The quality of our environment has been decreasing, but fortunately, places like Argonne are helping to come up with solutions. Their environmental programs help solve the nation's environmental problems and promote responsible environmental stewardship throughout society. Research programs include energy and water conservation, electric and hybrid vehicles, and alternative energy. Argonne has also created a core team of support and research staff to increase the sustainability of its own day-to-day activities. Current environmental research initiatives include renewable energy, nano traps, and phytoremediation.

RENEWABLE ENERGY

One of Argonne's goals is to use renewable resources to supply 7.5 percent of the site's annual electricity consumption. With a photovoltaic solar power system, a 10-kilowatt wind turbine, and several combined wind and solar powered streetlights, Argonne exceeds the DOE's requirement of having at least one renewable energy generating system.

Lemont High School Students Inspecting Argonne's Wind Turbine

Student authors in their classroom at Lemont High School

NANO TRAPS

A new type of nanoscale molecular trap makes it possible for industry to store large amounts of hydrogen in small fuel cells. The traps are also able to capture, compact, and remove volatile radioactive gas from spent nuclear fuel in an affordable way. The unique things about these traps are the spaces through which gas enters. Once pressure is applied, these 'windows' are distorted to trap the gas inside. Being able to compress large amounts of gas into small volumes is a crucial step to developing hydrogen gas as an alternative fuel for engines.

PHYTOREMEDIATION

Phytoremediation is a natural process in which trees and other plants extract contaminated groundwater and chemical substances from subsurface soil, degrade harmful organic materials, and transpire water vapor into the atmosphere. Argonne planted approximately 800 poplar and 200 willow trees in 1999 to aid in cleanup of contaminated soil and groundwater in an old waste management area.

Environment, Safety, and Quality Assurance Division
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 201
Lemont , IL 60439
www.anl.gov

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