INDIAN POINT GROUNDWATER INVESTIGATION

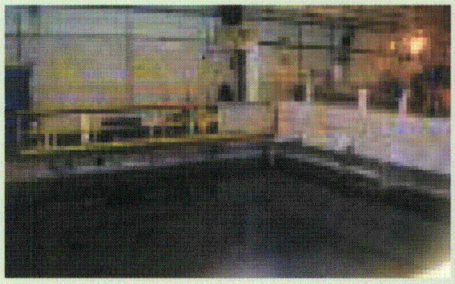
OVERVIEW

In early 2005 a moist hairline crack was discovered on an outside wall of the Indian Point Energy Center Unit 2 spent fuel pool. Initial analysis of the moisture showed the presence of tritium and other radionuclides characteristic of spent fuel pool water. An examination of historical records of contamination events was initiated as well as an inspection of numerous pipes, sumps, valves, tanks and other pieces of equipment that could be a source of contamination. A series of monitoring wells were drilled in strategic locations across the site. These types of activities have evolved into an extensive multi-million dollar program to investigate the source(s) of leakage, characterize the radioactive content, make repairs to stop the leakage, assess any existing or potential release of radioactive contamination and develop and implement remediation strategies. Experts in hydrology and hydrologic modeling, dose assessment, remediation, radiochemistry and civil and structural engineering have been assembled into a team to accomplish this task in a thorough and expeditious manner. Entergy is committed to completing this investigation and remediation in full and open cooperation with the Nuclear Regulatory Commission the New York State Department of Environmental Conservation, state and local government officials, and the public.

No permitted limits have been exceeded. Entergy is going above and beyond the NRC and DEC regulations because we take our responsibility as stewards of the environment very seriously and because we will not tolerate unplanned releases.

WHAT IS TRITIUM?

Tritium is a radioactive form of hydrogen that is produced naturally in the upper atmosphere. Low background levels of tritium are all around us in the air we breathe and the water we drink. Tritium is also produced commercially for use in self luminescent devices such as wristwatches and exit signs. ***Tritium is a low hazard radionuclide because it emits weak radiation that does not penetrate the skin. People could be harmed by tritium only through internal exposure caused by drinking water with high levels of tritium over many years.*** Notably, drinking water for the community surrounding Indian Point is supplied by surface water reservoirs, not groundwater so the public is further distanced from any risk.

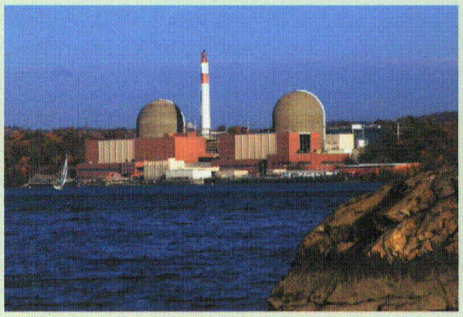


The Unit 2 spent fuel pool walls are 4-6 feet thick of steel-reinforced concrete, lined with 1/4" stainless steel liner. A hairline crack poses no threat to the structural integrity of the pool.

COMPARISON OF H_3 AT IPEC TO NRC AND EPA LIMITS

The standard unit for measuring tritium is the pico Curie (pCi) per liter, a very tiny amount of radioactivity. The NRC considers quantities less than a billion pCi (1,000,000,000) of tritium exempt from licensing regulations and the EPA allows up to 20,000 pCi/liter in drinking water. By comparison, the levels of tritium seen in samples of Indian Point groundwater are many orders of magnitude smaller than the exempt quantity limit (in 1 liter) and samples from many wells are much less than even the drinking water limit.

No tritium other than natural background levels has been found offsite.



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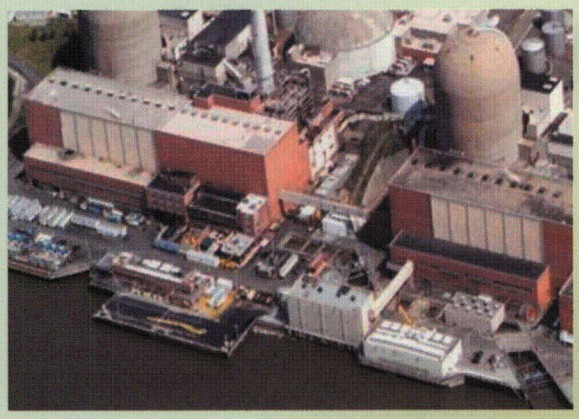
Entergy

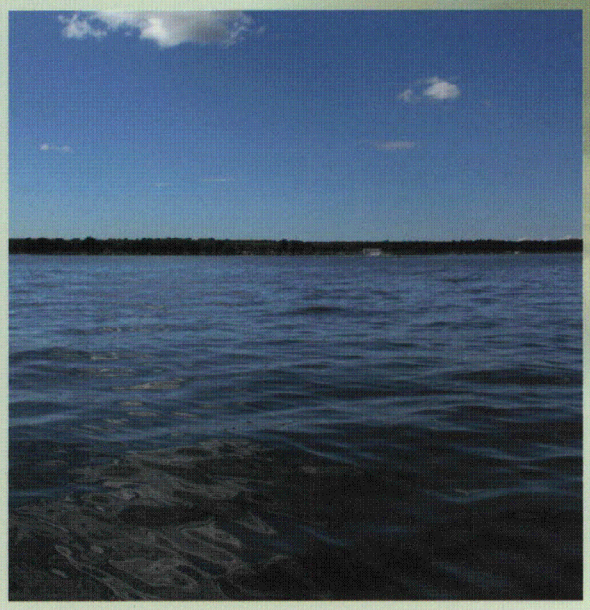
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM



Entergy, the DEC and NRC have sampled the Hudson River (water samples, fish and sediment samples) and have not detected radioactivity above normal expected background.

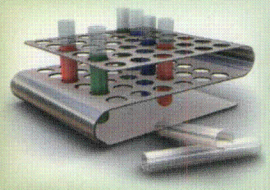
WHAT IS Sr- 90?

Strontium-90 is a radioactive isotope that is produced in nuclear power plants. About 99 percent of the Sr-90 in the environment comes from weapons testing fallout. Sr-90 is used as a radioactive tracer in medical and agricultural studies and as a light-weight power supply for items such as navigational beacons, weather stations, and space vehicles. If ingested, Sr-90 tends to mimic calcium when it is in the body and therefore becomes concentrated in calcified tissues such as bones and teeth.



Drinking water supplies for Indian Point and the surrounding communities come from surface water reservoirs, rather than groundwater. However, as a precaution, local wells are tested at the Lafarge Plant, the Trap Rock Quarry and the Algonquin outfall and samples have come back negative for radioactivity.

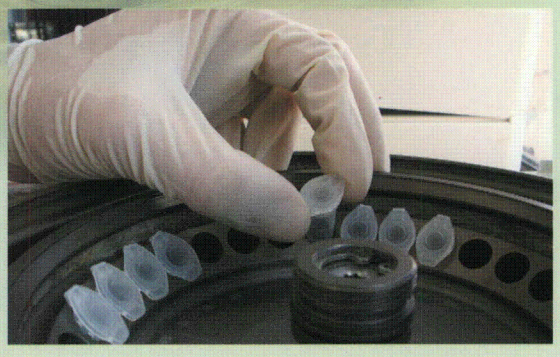
Radiation protection professionals at Indian Point Energy Center routinely conduct extensive monitoring of radiation levels in and around the plant and surrounding environment. Plant design, operations and procedures focus on preventing unplanned releases. If one should occur, plant management, operators and radiation protection staff take immediate steps to stop and contain the release, monitor it and remediate. In this case, nearly 35 new monitoring wells have been installed across the Indian Point site to determine the extent of groundwater contamination that has occurred. Tritium has been found in some of these onsite monitoring wells. Several wells located near the discharge canal also contained low levels of Strontium-90, a radioactive fission product. Well sampling and data analysis indicate that there are two plumes on site. The first is a tritium plume from the Unit 2 spent fuel pool. The second containing Sr-90 is coming from the Unit 1 spent fuel pool, which has had a known leak for some years. Experts in hydrogeological modeling are using data from the wells to develop a 3D representation of the soil, rock, groundwater and structures in IPEC's foundation from ground level to hundreds of feet below. This model will help clarify where the contamination is coming from and traveling to, as well as how best to remediate.



Independent (split) samples from both onsite and offsite locations are routinely taken by the NRC, Entergy and the DEC. The samples are analyzed at different laboratories and compared and are in agreement.

COMPARISON OF Sr-90 AT IPEC TO NYS AND EPA LIMITS

The NYS Department of Health considers quantities less than 100,000 pCi of strontium-90 per liter exempt from licensing regulations and the EPA allows up to 8 pCi/liter in drinking water. By comparison, the levels of Sr-90 seen in samples of IPEC groundwater are orders of magnitude smaller than the exempt quantity limit and samples from onsite wells range from below detection limits to about 30 pCi/L.



No Sr-90 other than background levels has been found offsite.

The amount of Sr-90 released onsite at Indian Point is analyzed by several different independent labs. Resulting dose to the public is too small to measure but is calculated to be less than 0.1% of the legal limit.

GOVERNMENT REGULATIONS

The main regulatory agencies for Indian Point Energy Center operations and effluent releases are the Nuclear Regulatory Agency and the New York State Department of Environmental Conservation. The NRC and DEC oversee IPEC's response to the leakage issues on a routine basis. The NRC governs and enforces the laws and limitations with regard to radiological effluent releases while the DEC focuses on non-radiological releases. Although the levels of tritium released to groundwater are well within NRC's permitted limits for monitored releases and do not pose a threat to public health and safety, the NRC in response to public input, has enhanced its inspection program at IPEC. IPEC's processes to monitor releases and inspect and assess programs, equipment and structures that have the potential to leak are under increased scrutiny by the NRC. They have dispatched additional specialists to Indian Point to assist the full-time resident inspectors. The NRC has also established a "lessons learned" task force to address inadvertent, unmonitored liquid releases of radioactivity from other plants. They conduct bi-weekly information sessions for state and local public officials and other stakeholders, and continue to monitor progress of the investigation very closely.

Onsite and offsite samples are routinely taken and analyzed independently by the NRC, DEC and Entergy at three independent laboratories. Analytical results are in agreement for the split samples and indicate no offsite release of tritium or strontium.

The nuclear energy industry is enhancing its system to prevent inadvertent radiological releases, and voluntarily reporting them when they do occur.

INDUSTRY INITIATIVE

Public safety and environmental protection are the foundation of a new comprehensive industry-wide initiative to enhance the detection and management of inadvertent releases of substances such as tritium and strontium into groundwater. The nuclear power industry has been working with the Nuclear Energy Institute since December 2005 to explore better ways of preventing and responding to inadvertent releases. A new industry policy has been developed that requires every company operating or decommissioning a nuclear power plant to put in place site-specific action plans to help ensure public notification, timely detection and effective response to situations involving inadvertent radiological releases in groundwater. Companies will voluntarily submit a 30-day report to the NRC for any sample of onsite groundwater that is, or could be, a source of drinking water, if it exceeds the criteria in the company's existing radiological monitoring program. Prompt notification of lesser spills to local officials is also required.

LOCATING AND ISOLATING THE SOURCE

Entergy engaged a specialty underwater construction firm and video inspection firm to perform an inspection of the Unit 2 spent fuel pool liner. In this inspection, about six anomalies in the pool's stainless steel liner were noted. Divers were sent into the pool to leak test those areas on the liner using a vacuum box technique. Although the vacuum box test did not reveal any through wall leaks, the areas were covered with a special epoxy as a precaution. Additionally, Entergy has sampled the storm water drains on site and curtain drains around Unit 1 and the Unit 2 primary auxiliary building sump. Entergy has also reviewed historical records, searching for clues regarding the source(s) of leakage. All of this data is being compiled for expert analysis by our multi-disciplinary team and will ultimately help to characterize the leak(s) and develop a strategy for remediation.

The EPA has calculated that ingesting water with a concentration of 20,000 pCi/L of tritium continuously over the course of a year will produce a total effective dose equivalent of 4 millirem. By comparison, your average annual dose from natural background radiation is about 360 millirem. If you smoke, your average annual dose is increased by 2000 millirem.

INDIAN POINT GROUNDWATER

8/05 9/05 10/05 11/05 12/05 1/06 2/06 3/06

Phase 1

Phase 2

UNIT 2 SPENT FUEL POOL

August 2005 Workers note a hairline settlement crack during excavation for new crane in Unit 2 Spent Fuel Building. Wall evaluated by structural engineers as sound. Large area soil samples collected near crack showed no contamination. Work stopped while hazard evaluated.

September 2005 Samples collected from the crack indicate radioactivity including tritium. Entergy assembles expert team to investigate the extent of tritium contamination by analyzing additional water samples and obtaining soil samples.

October 2005 Entergy begins high resolution video inspection of spent fuel pool stainless steel liner.

November 2005 Divers performed vacuum box testing of two locations in the spent fuel pool. The inspection showed no through wall leaks but we applied epoxy coating as precaution.

January 2006 Entergy installs a permanent leak collection box in the spent fuel pool to prevent contaminated water from reaching the environment. Total water volume is about a cup per week.

January 2006 - date Entergy continues video inspection of spent fuel pool liner and collection of water from crack location. The volume dropped significantly over the summer.

September 2006 A test recovery well is installed in fuel storage building to test removal of tritium from the source close to the pool. Initiation of the pilot test, beginning with baseline data collection, began at the end of September.

REGULATORY AND PUBLIC INVOLVEMENT

September 2005 Entergy informs NRC about crack in spent fuel pool. NRC sends inspection team to Indian Point Energy Center to oversee investigation. The NRC issued a special inspection charter to track and report on investigation activities.

September 2005 - date NRC hosts government and agency bi-weekly conference calls to keep stakeholders informed about groundwater investigation and NRC inspection results.

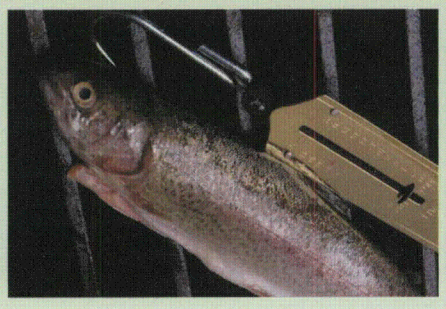
November 2005 Entergy hosts an on site briefing with representatives from local county government, New York state agencies and state and federal government. Participants could view the spent fuel pool wall and monitoring well locations.

January 2006 NRC reviews the results of phase 1 monitoring well program.

February 2006 Entergy hosts a groundwater investigation seminar at Indian Point where experts in remediation share information on best practices.

March 2006 NRC holds public meeting in Peekskill where Entergy, DEC and NRC discuss various aspects of the groundwater investigation.

Ongoing Entergy holds twice weekly conference calls with NRC and DEC to report on sample results and other aspects of the investigation program. NRC and DEC have representatives on site periodically to collect samples and provide feedback on the investigation program.



Indian Point has had an extensive environmental monitoring progam since before the plant went into operation. Samples are obtained from the shoreline sediment, vegetation around the site and fish and other aquatic organisms from the Hudson River. As part of the groundwater investigation, additional samples have been taken in the vicinity of the site. Several of these samples have been included in the split sampling program with NRC and DEC.

INVESTIGATION TIMELINE

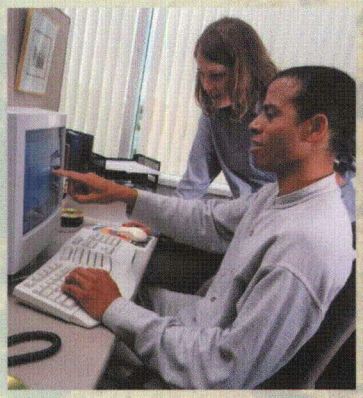
4/06 5/06 6/06 7/06 8/06 9/06 10/06 11/06

Phase 2A

UNIT 1 SPENT FUEL POOL

Samples collected adjacent to the Unit 1 spent fuel pool detected strontium-90, a fission product isotope that is found in the Unit 1 spent fuel pool water. While the levels of Sr-90 are low, Entergy expanded the well monitoring program to help characterize Sr-90. Entergy also installed a special demineralizer system to remove Sr-90 and other radioactive isotopes from the Unit 1 spent fuel pool water. Early results have shown this technique to be an effective means of limiting the release of Sr-90 to the groundwater.

Unit 1 ceased operation in the early 1970s. Ultimately, the fuel rods stored in the pool will be removed to dry cask storage and the pool water drained to stop this source of leakage.



Using computer models and samples results, radiation protection professionals can estimate the potential dose to the public from the groundwater contamination on site. Calculations have to be used because the potential doses are too small to be measured in the environment. Conservative estimates indicate that potential doses are indeed very small, less than 0.1% of allowable federal limits. Health and radiation protection experts agree that there is no impact to public health and safety from the levels of tritium or strontium at Indian Point Energy Center. Nevertheless, Entergy is committed to finding the sources of the contamination and taking every step to stop the leak and clean up the groundwater.

WELL MONITORING PROGRAM

October 2005 Entergy samples existing onsite wells and finds tritium in one well in the Unit 2 transformer yard

October 2005 Entergy engages experts in groundwater hydrology and remediation to develop groundwater monitoring program

November 2005 Entergy begins drilling phase 1 wells, which are located near Unit 2 spent fuel pool and transformer yard. The well locations were selected to help understand the geology and groundwater hydrology near the Unit 2 spent fuel building.

November 2005 Entergy, NRC and the New York DEC take the first round of monitoring well split samples. Split samples are analyzed at different laboratories to provide independent assessment of sample results. Water samples were also obtained from nearby drinking water sources such as the Croton Resevoir and local wells. **No radioactivity has been detected off-site.**

January 2006 Entergy begins installation of phase 2 monitoring wells. The phase 2 wells are more widely dispersed over the site and are designed to help determine the spread of contamination onsite.

April 2006 Test results from two wells along the site's discharge canal and one well in the Unit 2 transformer yard indicate the presence of Sr-90. The wells are downstream of Unit 1.

May 2006 Entergy expands the well monitoring program to drill nine additional wells near Unit 1. The pattern of sample results indicates that Unit 1 is the source of Sr-90 contamination.

July 2006 Entergy begins construction of a recovery well in the Unit 2 spent fuel pool. The recovery well is part of a pilot test program to determine the effectiveness of a groundwater pumping remediation program for tritium.

On-going Samples are routinely obtained from the various monitoring wells on site and at off-site locations. These test results are being used to establish baseline levels of tritium and Sr-90.

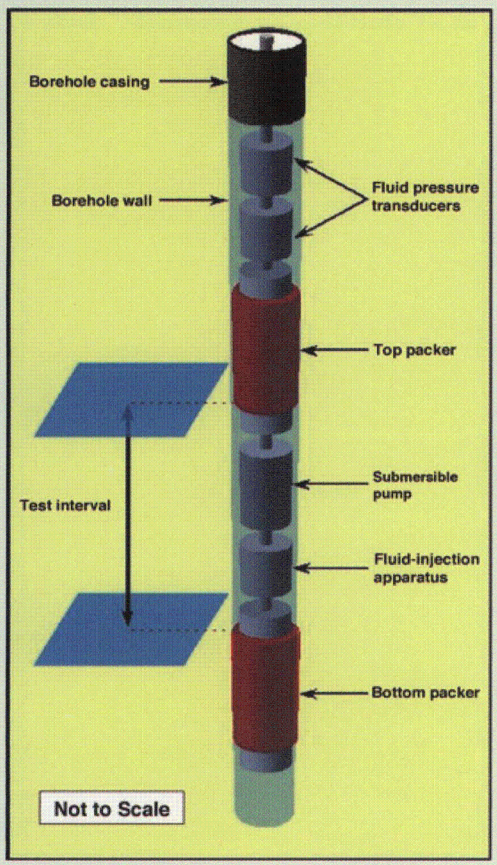
HYDROLOGY AND WELL CONSTRUCTION

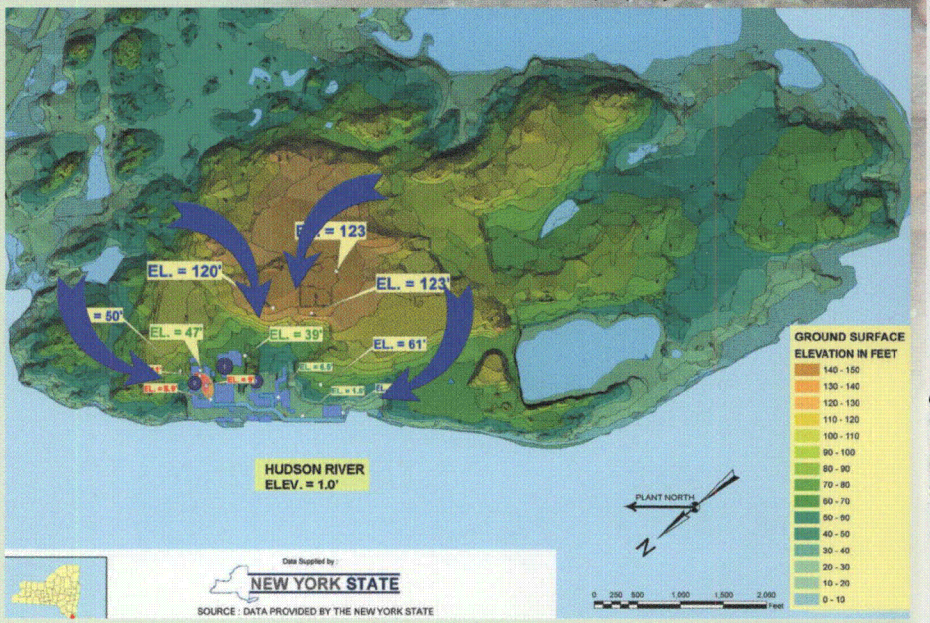
A state-of-the-art well monitoring program has been instituted to help detect the source(s) of leakage at Indian Point Energy Center. Designing, drilling and installing test wells has proved to be an enormously complex and resource-intensive task, but one Entergy is fully committed to. A consulting firm, GZA GeoEnvironmental, Inc was hired for their expertise in groundwater investigation and remediation. Over 35 wells have been strategically located throughout the site for the investigation and modeling. The wells are positioned to help determine if specific tanks, pools or sumps are potential sources of leakage.

Well drilling rig (above) and multi-level sampling components (below). No offsite wells have shown any tritium or strontium above background levels and many onsite wells have shown no radioactivity or very low levels of radioactivity.

Extensive safety precautions have been taken, particularly for the wells that were developed in and near the Unit 2 fuel storage building. One of those wells is over 200-feet deep and needed to be drilled through very hard rock formations containing marble, granite and limestone. Two other wells are located inside the Unit 2 turbine building, which presented a number of challenges in order to lift the heavy drill rig past scaffolding and high voltage equipment. In some of the locations there are underground service lines that had to be avoided. A special vacuum drilling technique was needed to remove the first 5-7 feet of surface so that workers were not endangered by buried utilities. Ground penetrating radar was also used to ensure the area was clear of hidden metal objects. In a number of instances wells had to be relocated because of obstructions that were encountered.

Drill rigs must often bore through marble and limestone to install the test wells properly.





Entergy's hydrology consultants have reviewed well monitoring results, existing site drawings and previous groundwater studies and developed a conceptual model of how water flows on site. As shown by the blue arrows, groundwater flows inward toward the site from surrounding areas and once onsite, flows generally west towards the discharge canal and river.

LOCATION OF MONITORING WELLS

New wells have been installed in three phases. Nine phase 1 monitoring wells were drilled near the Unit 2 spent fuel pool, and the transformer yard between November, 2005 and March, 2006. The locations of these initial wells were based on a conceptual site model developed at project initiation using existing information. The first well was MW-30, located in the Unit 2 spent fuel building about 6 feet from the crack location. The data from the phase 1 wells was then used to locate phase 2 wells and to address data gaps. Between January and April, 2006, 14 phase 2 wells were located and installed near Unit 1 and Unit 3 and at site boundary locations. Again the conceptual site model was refined based on the new data and 12 phase 2A wells are being drilled to help further quantity groundwater flow around Unit 1, help characterize the locations and extent of Sr-90 contamination on site, and help identify injection and monitoring locations for tracer tests.

Placement, depth and sampling regimes for the wells are determined by expert hydrologists. Construction involves not only drilling, but also installation of pressure transducers, pumps, packers, and fluid injection apparatus. To obtain qualified environmental samples, the wells must be flushed and equalized before drawing samples. From drilling to the initial sampling, the process can take several weeks or even months.

SAMPLING AND ANALYSIS

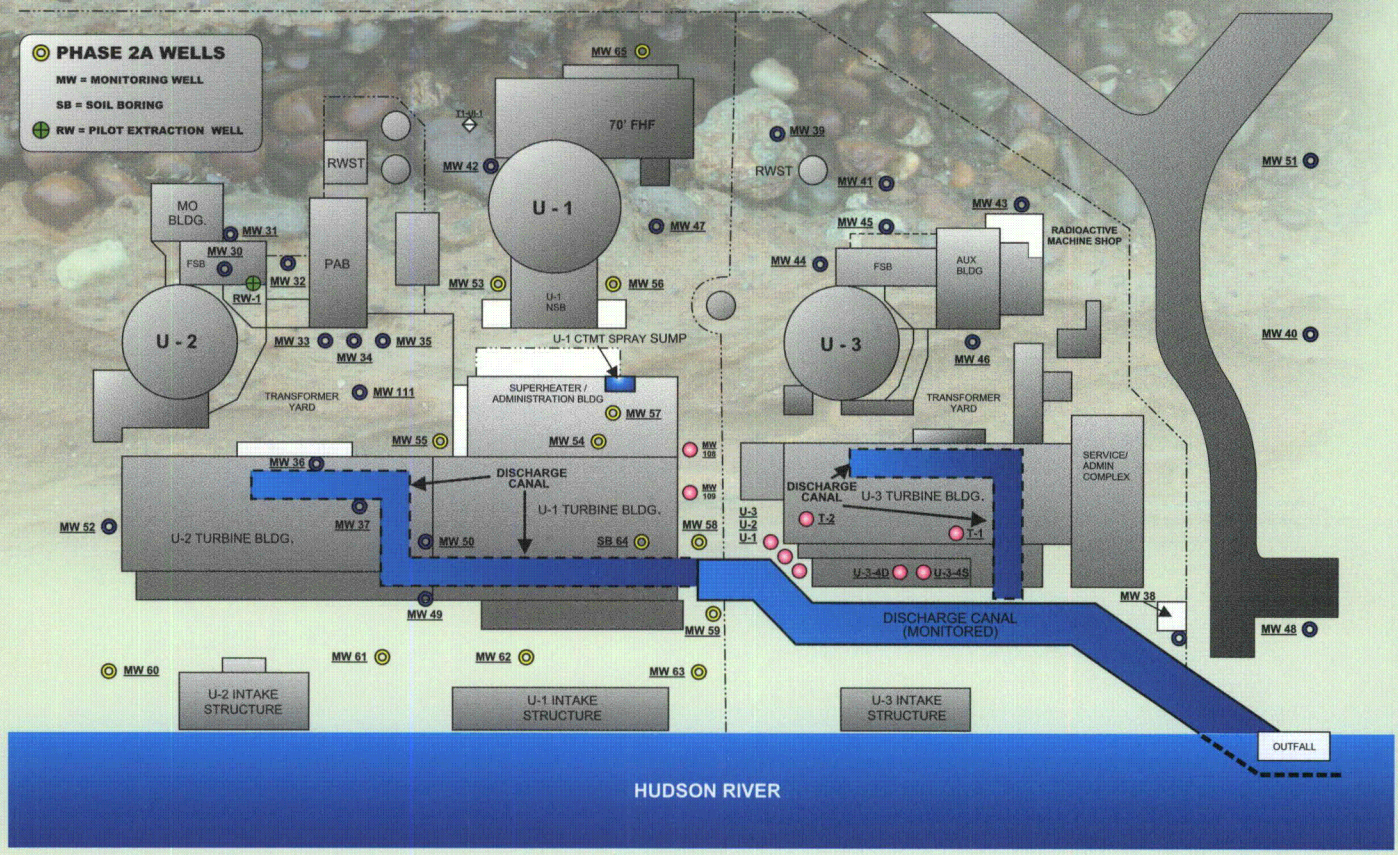
Once a new well is drilled, it is sampled at various depths and analyzed for Sr-90, tritium and other isotopes. Since August 2005, a total of more than 1,000 water samples have been taken. The tritium data for the entire site show that by far the higher concentrations are all located in the vicinity of the Unit 2 spent fuel pool. In addition, the most current tritium concentration detected at each well is now typically less than the highest concentration detected previously.

The strontium data indicate that the likely source is the Unit 1 spent fuel pool. The highest groundwater concentrations have been detected in the immediate vicinity of Unit 1 and the other locations where Sr-90 exceeds the drinking water limit are near the discharge canal downgradient of Unit 1.

REMEDIATION AND RECOVERY

Entergy is currently developing possible remediation strategies for NRC review and approval and subsequent implementation. To date, a 200 foot deep, six inch diameter pilot test groundwater extraction well has been drilled and developed immediately adjacent to the Unit 2 spent fuel pool. This test will be done to allow the collection of data critical to determining the feasibility of extracting contaminated groundwater from the Unit 2 spent fuel pool.

CONCEPTUAL SKETCH OF IPEC PHASE 1, PHASE 2, AND PHASE 2A MONITORING WELL LOCATIONS



The 35 new monitoring wells installed to sample and analyze for tritium and Sr-90 are shown above. Well sampling and analysis data show that the higher tritium concentrations are clustered around the Unit 2 spent fuel pool. Strontium-90 data indicate higher concentrations around the Unit 1 spent fuel pool. Further data collection will continue to help refine these characterizations and develop remediation strategies.

Entergy has made a high priority commitment to identify and repair the leak(s), characterize the groundwater flow on site, assess the level of contamination resulting from the leak(s) and develop and implement remediation strategies.

AFFECT ON THE PUBLIC

Neither local residents nor workers onsite receive radiation dose from the groundwater as a result of the spent fuel pool leak since there are no drinking water sources on site or in the surrounding properties. Conservative dose calculations show that the annual dose from these releases is less than 0.1mrem, a number so low that is difficult to measure accurately. There is no public health or safety threat from these releases. Doses to the general public from all liquid releases are limited by regulation to 3mrem per year whole body and 10 mrem per year to any critical organ, such as the lungs or bone. In comparison, smoking cigarettes exposes a person to about 2000 mrem per year. And the average annual dose in this area, due to natural background, is about 360 mrem or 1 mrem per day.

RISK IN PERSPECTIVE

What is the risk to you and your family due to the leakage of these minute quantities of radioactivity into the groundwater at Indian Point Energy Center? The NRC has determined there is no significant threat and no significant pathway of potential exposure. Using conservative, worst case assumptions, Entergy has calculated the radiation dose to the maximally exposed individual (someone living at the site boundary) from the amount of tritium and strontium-90 entering the Hudson River, to be about .00002 mr per year (a dose far too low to measure). By comparison, the average New Yorker is exposed to a dose of 360 mr a year from natural radiation sources. In addition, man made sources, such as medical procedures, contribute another 60 mr per year. In fact, a chest x-ray (about 10 mr) would expose a person to 500,000 times the radiation the maximally exposed individual could receive from the tritium and strontium-90 leakage over the course of a year. **Because of these compelling facts, the NRC has found that there is no threat to public health or safety from the leaks.**

Indian Point routinely discharges tritium and strontium in amounts that are orders of magnitude larger than those we are seeing in the groundwater monitoring test wells. And those normal, planned discharges are only a very small fraction of what is allowed by law. The issue, therefore is not about exceeding legal limits as we are well within regulations. The issue is about our commitment to stop the leaks and clean up the contamination.

EDUCATIONAL OUTREACH

Entergy is committed to operating in openness, keeping the public informed, as we complete our groundwater investigation. Information is published on our safesecurevital.org web site and a status report with regular updates is sent 4-5 times/week to about 150 officials in the tri-state area. The NRC along with Entergy and DEC held a public meeting on the groundwater project in March, 2006. Reporters and photographers from local newspapers and TV have been to Indian Point Energy Center to report on the situation. Indian Point has hosted stakeholder briefings on the groundwater investigation for local public and elected officials. In these briefings, our experts have reviewed the results of monitoring well samples, dose calculations, the hydrogeologic model of the site, and various inspections. We also participate in regular conferences, hosted by the NRC, with key representatives of the four-counties, congressional delegation, local officials and state representatives. We hosted an industry seminar where best practices, state-of-the-art detection and remediation techniques were discussed.

If you have questions or would like further information about this or other Indian Point Energy Center initiatives, please contact Kathleen McMullin, Manager, Communications at 914-271-7132 or via email to kmcmull@entergy.com.

Entergy