Presentation of Technical Memoranda

Preliminary Evaluation of Health Effects for Hypothetical Exposures to Contaminants from the Interim Waste Containment Structure

and

Radon Assessment

Niagara Falls Storage Site (NFSS)
Formerly Utilized Sites Remedial Action Program

Lewiston, New York
March 28, 2012
Slide 2 - Corps
Welcome to the public workshop for the Radon Assessment and Health Effects Technical Memoranda. This is the agenda for this evening.
Slide 3 - Corps

The Corps has responsibility to conduct the Feasibility Study investigation and any cleanup of the site under the Formerly Utilized Sites Remedial Action Program. The Corps has overall responsibility for maintaining the site and ensuring public safety until the cleanup activities are complete.

The Corps has put together a team to conduct the Feasibility Study—the team includes:

- SAIC is a technical contractor to the Corps that developed the Radon Assessment technical memoranda (or TMs) we will be discussing tonight. They will be used in conducting the Feasibility Study.
- Argonne National Laboratory is a national lab under the DOE that served as contractor to the Corps for the Health Effects TM we will be discussing tonight.
- The technical facilitator, Doug Sarno, was hired by the Corps to serve as liaison between the Corps and community members on technical issues associated with the preparation and development of the IWCS Feasibility Study.

The DOE will be the long-term steward of NFSS once the Corps completes remedial action.

The U.S. Environmental Protection Agency (EPA) and New York State Department of Environmental Conservation (NYSDEC) are environmental regulators who provide comment and input to the Corps, but do not have a direct regulatory authority at the NFSS.

U.S. Department of Energy (DOE) is available to answer questions on the recently released Knolls Atomic Power Laboratory (KAPL) report.
The purpose of this workshop is to provide the public with the results and conclusions from two of the TMs that have recently been released for public review and comment. They are the Radon Assessment TM and the Preliminary Health Effects TM. Both address the wastes placed in the Interim Waste Containment Structure (referred to as the IWCS) at the NFSS. In addition, a meteorological technical report was issued; this report supports the modeling and evaluations in the technical memos.

The Radon Assessment TM and the Preliminary Health Effects TM focus on the potential health effects that could result from exposure to materials in the IWCS. To cause exposure, the materials would have to be released from the IWCS, meaning that the cap on the IWCS would have to be breached by some mechanism, such as opening it up for removal of waste. As explained later in the presentation, the potential health effects will be used in the Feasibility Study to analyze potential remedial alternatives.

Also, the U.S. Department of Energy (DOE) is available to discuss the recently released Knolls Atomic Power Laboratory (KAPL) report which evaluates the potential for KAPL waste to be present on NFSS and properties surrounding the NFSS, known as vicinity properties. The DOE will be available during the table discussions.

Please note:

- The reports discussed tonight are informational and do not present specific choices or proposals for public input.
- Instead, this information will be critical to building the remedial alternatives in the Feasibility Study.
The formal presentation tonight will be a general overview of the purpose and results of each TM followed by time for table discussions. In this way, an opportunity is provided to the community to ask the Corps and the report authors the questions they may have based on particular interest, specific aspects of each report, and/or portions of tonight’s presentation.

Additionally, all three reports are available online for your review.
Slide 6 - Doug Sarno

The formal presentation tonight will be a general overview of the purpose and results of each TM followed by time for table discussions. In this way, an opportunity is provided to the community to ask the Corps and the report authors the questions they may have based on particular interest, specific aspects of each report, and/or portions of tonight’s presentation.

Additionally, all three reports are available on line for your review.
The IWCS is one of three key projects (or operable units) that make up the remedial program for the NFSS. The IWCS contains the vast majority of the contamination and will likely be the most complex and costly of the three. The Balance of Plant (BOP) operable unit (OU) will look at soils and other materials that are located outside the IWCS. The groundwater OU will then explore contamination in the groundwater. A separate feasibility study will be prepared for each of the three OUs. A separate Feasibility Study means that the cleanup decision will be made to ensure that each OU is protective of human health and the environment.
Slide 8 – Doug Sarno

This is a figure showing the CERCLA process that you have seen before and is in a number of Corps’ reports. The Corps has completed the Remedial Investigation at the NFSS and is currently working on several technical memoranda in support of the Feasibility Study (shown on the top line); the Corps is now in the feasibility study stage for the IWCS OU. Each OU will have its own Feasibility Study and decision process. The Feasibility Study for the IWCS OU will continue for the next year and a half and involve a number of steps and reports which we will discuss next.

At the end of the Feasibility Study, the Corps will evaluate a range of remedial alternatives and propose one of them in a Proposed Plan. This Proposed Plan will be released for formal public comment, the comments will be considered and necessary changes made and the final decision recorded in a Record of Decision or ROD.

The Feasibility Study process on the other two OUs could begin during the Feasibility Study for the IWCS OU, however, those final decisions will be directly dependent on the decision for the IWCS OU and cannot be evaluated until after the IWCS OU decision is made.

Any actions proposed will then be implemented through a detailed remedial design process and remedial action. It is possible that remedial action for some or all of the OUs will be done in a coordinated manner.

Once remedial action is complete and all objectives met, the site will go through closeout and enter long-term stewardship at which point it will be transferred to the US DOE for management under its long-term stewardship program if long-term stewardship is needed.
**Slide 9- Doug Sarno**

To help explain and communicate key concepts throughout the Feasibility Study process and to also generate public and agency input, the Corps has identified five TMs that will explore key aspects of the Feasibility Study. The first TM was released in July of 2011 and a public meeting regarding that TM was presented in September 2011.

Tonight’s workshop looks at the second and third of these memoranda; the Radon Assessment TM and Preliminary Health Effects TM.

The last two TMs will be released during the summer of 2012.

Taken together, these TMs will inform the initial portions of the Feasibility Study, and public input and discussion will be a key part of the TM process.

The full Feasibility Study report will be released in 2013 and present the overall evaluation of alternatives.

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**Technical Memoranda for IWCS OU Feasibility Study**

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**Questions:**

- Where could IWCS wastes be permanently disposed?
- What levels of radon gas could be emitted from the IWCS?
- What would be the health effects from potential releases of IWCS material to people on or near the site?
- What laws and regulations are applicable or relevant and appropriate to the IWCS wastes?
- What are the remedial alternatives being evaluated?
Each remedial alternative presented in the feasibility study is evaluated against threshold criteria and balancing criteria. The modifying criteria are considered after the proposed plan is released.

If the remedial alternative does not meet the threshold criteria, which are protection of human health and the environment and compliance with regulatory requirements, then it is not considered further.

If the remedial alternative meets the threshold criteria, it is further screened against the five balancing criteria (long- and short-term effectiveness, reduction of toxicity, mobility and volume through treatment, implementability, and cost) in the detailed analysis in the Feasibility Study.

Following a comparative analysis among the alternatives in the Feasibility Study, a preferred alternative is selected and identified in the proposed plan which is published for public and state review and comment.

The modifying criteria, state and community acceptance, are considered as part of the final selection of the remedial alternative defined in the Record of Decision.
Before we discuss the modeling results we will go through a brief review of the background and design of the IWCS, with emphasis on describing where the majority of the radioactivity is within the IWCS.
In 1942, the U.S. Government acquired approximately 7,500 acres of land in order to create the Lake Ontario Ordnance Works (LOOW), which is shown here in tan. Just to orient you, the site is located along Pletcher Road, a few miles east of this building we are in.

The government produced TNT at the LOOW for one year before they shut down production.

In 1944, the Manhattan Engineer District (MED) was granted use of a portion of the LOOW for storage of radioactive residues. This area was identified as the Niagara Falls Storage Site (NFSS), which is shown in light blue.

During and after WWII, the MED contracted with processing facilities in other parts of the country to extract uranium from ore to create the uranium metal needed to develop atomic bombs. The unused ore material left after the extraction process is called residues. These residues also contained radionuclides that were in the original ores that were not needed for atomic warfare, mainly radium.

Between 1944 and 1954, the MED and its successor agencies periodically shipped the residues from the processing facilities to the NFSS for storage.

Starting around 1980, the government began a series of actions to consolidate all the residues and other wastes that had been shipped to NFSS into one place on the site. From 1983 to 1986 the Interim Waste Containment Structure was built and residues and contaminated soil throughout the NFSS and the LOOW were placed within this structure.
For those of you who have never seen the IWCS, this is what it looks like today.

The key objective of the construction of the IWCS was to provide engineered barriers to restrict radon emissions, infiltration of water from precipitation, and prevent the migration of contamination to groundwater. Monitoring has shown that it is operating as designed. The site is maintained to ensure that the protection continues.
The primary interest is in what is inside the IWCS. Particularly, where are the residues?

The primary storage areas for the residues within the IWCS are identified on this photo from the 1970s. At the top of the photo - the northern portion of the IWCS - is the R-10 residue pile. At the bottom of the photo - the southern portion of the IWCS - are the former LOOW water treatment buildings where the higher activity residues were transferred during construction of the IWCS.

Over the next several slides we are going to walk through the filling and construction of the IWCS.
This historic photograph shows a closer look at the original LOOW water treatment plant. Buildings 411, 413, and 414 are the current location of the residues within the IWCS.
SLIDE 16 - Samantha Pack

As in the previous slide, this historic photograph shows the southern end of the IWCS. This is during early construction of the IWCS, zooming in on the three buildings that were used to store the residues. The building with the grid-like structure is Building 411. You can see the grid-like beams that supported the roof and building structure. Buildings 413 and 414 are the round structures at the top of the photo.

The other buildings in these photos were demolished as part of the IWCS construction and were added to the IWCS. They are part of the waste that we designate as “contaminated rubble/debris”.

Also shown in the photo is a clay cutoff wall and clay dike that was constructed to surround the entire perimeter of the IWCS. An initial cutoff wall was constructed to isolate the R-10 residues and soil pile in the northern end of the IWCS. It was extended to isolate the south end of the IWCS, including the Building 411, 413, and 414 area. We will discuss the construction of the cut-off wall in a later slide.
This photo shows the inside of Building 411 prior to transferring the residues. Building 411 originally was a reservoir built to hold water; this reservoir now helps to contain the wastes and residues stored within the IWCS.

The structure was built into the Brown Clay unit, and it is underlain by the highly impermeable Gray Clay unit. The Gray Clay unit acts as the bottom of the IWCS to reduce migration of contaminants. Permeability testing of the clays during construction showed that these clay materials met the low permeability design requirements identified for the IWCS.
As indicated in a previous slide, a clay cutoff wall and clay dike surrounds the entire IWCS. It was originally built to isolate the R-10 wastes. The southern containment area cut-off wall and dike was added later as part of the consolidation of the residues into Building 411.

On the left is a schematic of the clay dike/cutoff wall that surrounds the entire IWCS. The cutoff wall was constructed into the Brown Clay unit, and an important fact to understand here is that the wall extends about 1.6 ft down into the Gray Clay unit. The Gray Clay unit is natural clay with low permeability. The cutoff wall is an engineered barrier to migration of containments from the IWCS. The design requirement for the cutoff wall was effectiveness for 200-1,000 years.

On the right is a photo showing the installation of the cut-off wall around the IWCS. The clay cut-off walls were compacted during construction to achieve very low permeability.
And now we will walk through the placement of wastes into the IWCS. The orientation of the historical photo on the left is duplicated in the schematic of the constructed IWCS on the right. The residues are in the R-10 pile and were put into Building 411, 413, and 414.
This figure shows the locations of the key residue waste streams placed in the IWCS.

The low-activity residues, known as the R-10 pile, are located in the northern end of the IWCS. These residues are significantly less radioactive than the residues in the buildings.

The higher-activity residues are in the buildings in the southern portion of the IWCS. These residues were put into the buildings as part of IWCS construction.

A key message we want to convey to you is that it is well known where the high activity residues are in the former buildings.

The following slides show more detail.
In the northern half of the IWCS are the R-10 residues. They were received from the Linde Ceramics Plant in Tonawanda, NY between 1944 and 1949. For several years the R-10 residues were stored on open ground north of Building 411. In 1972, contaminated soil (15,000 yd³) collected from remedial actions conducted at the NFSS were placed on top of the R-10 residues.

The R-10 pile was stored on open ground for years with no cover, as a result some runoff and leaching of contaminants occurred. In order to isolate the R-10 Soil Pile, the 1981 remedial action reconsolidated the R-10 pile within the dike and cutoff wall.

The R-10 pile was present before the IWCS was constructed. The construction involved putting contaminated soil around and on top of the R-10 pile and then finishing the IWCS with a protective clay cap. The contaminated soils came from several on- and off-site remedial actions between 1982 and 1991.
The highest activity residues were placed in the bottom of “bays” in Building 411. Other residues were placed in the bottom of Buildings 413 and 414.

Because we know the building dimensions, we know the volume of materials within the buildings. Knowing this volume reduces one of the key uncertainties that many feasibility studies have to deal with.

Other wastes that were placed in the southern end of the IWCS include contaminated rubble and debris from the demolition of other former LOOW buildings. These wastes also include contaminated rubble and debris from remediation activities associated with the transfer of the K-65 residues from Building 434 and the demolition of Building 434. Building 434 was used to store the K-65 residues prior to their placement in Building 411. Based on historic records, the primary location of the rubble and debris is south of Building 411. There is also a smaller volume of contaminated soil excavated from on-site and off-site remediation that was placed above and surrounding the buildings to form the shape of the IWCS.

In a moment you will see a schematic of a cross section of Building 411. The line of cross section is shown in yellow on this figure. We also have an “animation” that walks through the placement of the residues within the buildings. When you see that cross section and the animation, keep in mind the small size of Bay A.
This cross-section shows the bays of Building 411. The K-65 residues—the highest activity residues—are in Bay A and Bay C. L-30 and F-32 residues were placed in Bays B, C, and D, and the L-50 residues were placed in the round Buildings 413 and 414. The residues in Bay D were covered with the Tower Soils (from Building 434 remedial actions).

Once the residues were in place, contaminated soil from the on-site and off-site remedial actions were placed on top of the residues.

The IWCS was completed by a cover that includes three layers, shown in a brown color in this figure. First, a 3-foot layer of compacted, low-permeability clean clay was placed over the contaminated soil, forming the principal barrier to precipitation infiltration and radon emanation.

Then, a one-foot layer of loosely compacted soil was added to act as a protective cover to the clay layer. This was followed by a 0.5-foot layer of topsoil, prior to adding a final cover of shallow-rooted turf grass shown in green) to control erosion and minimize frost-heave damage.

It is important to note that the bottom and sides of the IWCS were designed for an effective life of up to 1,000 years. The protectiveness of the cap, however, was estimated to be between 25 and 50 years. Given the current high level of maintenance on the cap, it will likely be protective for at least 50 years.
The total volume of waste in the IWCS is estimated to be 372,905 yd³; this includes 14,580 yd³ of high-activity residues and 59,500 yd³ of R-10 residue/soil. The majority of the volume is 248,100 yd³ of contaminated soil from on- and off-site remedial activities.

In the pie chart on the top right, you will see that the K-65 residues represent only 1 percent of the total volume of material in the IWCS.

In the pie chart on the bottom right, you will see that the K-65 residues represent 94% of the total radioactivity in the IWCS.

Therefore, a very small portion of the waste within the IWCS causes most of the potential radon and health effects at the site. Those potential effects will be discussed after we look at how the residues were placed in the buildings.
Before we end the discussion of IWCS construction, let’s walk through an animation of the process of filling the bays.
Now that we have described the construction and waste placement within the IWCS, let’s move on to the discussion of the TMs.

The Radon Assessment TM presents the results of modeling we performed to evaluate what is happening to radon, both inside the IWCS now and what could happen if we start excavating the waste. To do this we evaluated potential release rates as we dig deeper, and then evaluated how radon could move through air once it was released.

The information from this assessment feeds into the Feasibility Study in 2 key ways: a) it helps us identify what types of engineered controls, like barriers and shielding, we will need to design into any remediation effort, and b) it also helps us understand what types of worker protections we will need.

The Health Effects TM went beyond looking at radon and looked at all potential contaminant-related hazards that could be encountered during remediation. This included exposure to non-radiological contaminants in the IWCS. This TM looks at potential risk to both workers and the public. The information will be used in the Feasibility Study to help select the best remedial alternative – we are required to evaluate the short-term risks for each alternative– and it is also used to identify needed controls.

In addition, one of the reviewer comments we received on the Radon Assessment TM was that the Corps should evaluate Radon using a second model that EPA endorses. EPA has two key models they use for this type of effort - CAP88 and AERMOD. Those two models use different meteorological data - which is mostly data about wind speed and wind direction. So the Corps decided to repeat the radon modeling with the AERMOD model to make sure we are estimating the most likely conditions. This was done in the Meteorological Data Tech Report. The evaluation validated the Radon Assessment TM results, and showed that AERMOD and meteorological data from CWM should be used for the Feasibility Study.

All of this information is extremely important for designing and estimating the protectiveness and cost of all potential alternatives - the more radiation protection controls we will need, the higher the cost will be for an alternative.
What are the potential health effects associated with the IWCS?

- The design of the IWCS controls releases and prevents exposure.
- Potential exposure to radiation from IWCS materials if the cap was breached.

SLIDE 27 - Harry Fatkin

Now that we have presented the basics of the history of the IWCS, and the construction and placement of wastes in the IWCS, let's discuss the main radiation risks and exposures that are associated with the IWCS.

Damaging radiation is the greatest health concern, as was learned when the IWCS material was placed. Because of this, the IWCS was designed to reduce the potential for health effects from radiation to acceptable levels. However, if the cover or cap on the IWCS is breached or opened, the potential for health effects would increase.

The primary concerns affecting human health and safety are the release of radon gas and gamma radiation. Impact from chemicals within the IWCS material are assumed to be negligible when compared with effects from radionuclides.

In the following slides, we will be discussing the basics of radon gas and gamma radiation, and explain how the intact cap on the IWCS inhibits their release to the atmosphere.
There are two main types of radiation, non-ionizing and ionizing.

Non-ionizing radiation is common, such as radio waves and light. The energy in this type of radiation is relatively low and does not interact with materials they may strike. As a result, most non-ionizing radiation poses very little health risk.

Ionizing radiation has a high energy which is sufficient to strip electrons from atoms they may strike. In general it has a higher potential health risk.
Radioactive decay is a source of ionizing radiation.

Radioactive decay occurs when the parent atom (nuclide) has an unstable nucleus. Ionizing radiations are emitted in an attempt to reach a more stable nucleus in the atom.

Generally, the emission of an alpha or beta particle also includes emission of a gamma ray. The parent nuclide is transformed into the daughter nuclide with a different nucleus. As the parent nuclide transforms, the parent no longer is a source of radiation and levels of radiation are reduced over time.

If the daughter nuclide is also unstable, it may decay (transform). Additional decays will occur until a stable nucleus is reached. The sequence of nuclides and decays is referred to as a decay chain.
Ionizing radiation is blocked or absorbed by whatever material it goes through. Some materials are more effective at stopping ionizing radiation than others.

Each type of ionizing radiation has specific characteristics that impact how effective a material is in stopping the radiation.

An alpha particle is a large particle with an electrical charge that can be stopped with a piece of paper. Alpha particles are mainly a health problem if they are inhaled or ingested, and thereby can deliver radiation directly to the body.

A beta particle is a smaller charged particle that requires a thicker material in order to be stopped. Beta particles may also be a health problem if they enter the body.

A gamma ray has the ability to travel long distances through the air, and can even penetrate through lead. Gamma rays are mainly a health problem if an individual spends time near the source of the rays.

There are three basic ways to decrease the health effects from ionizing radiation. These are: 1) reduce the time a person is exposed, 1) increase the distance from the source, and 3) place shielding material between the person and the source. Although lead is shown here, water also can be an effective shield against gamma rays.
In the IWCS, a major source of radiation is radium-226, which is concentrated in the residues. In the decay chain for radium-226, radium-226 decays to form radon gas by emission of an alpha particle and gamma ray. The radon gas then decays by alpha particle emission to form several daughter nuclides before reaching a stable nuclide of lead. The radium decay process (and this decay chain) is currently occurring within the IWCS, and is the primary source of the radon gas in the IWCS.

The number in parentheses in this slide is the half-life—we’ll talk about that later.
As discussed previously, radioactive materials decay, transforming into other nuclides. The half-life is the amount of time it takes for half of the atoms in a sample to decay.

Radium has a half-life of 1,600 years, with continuous decay to produce radon gas. One radium half life ago, it was the year 410 AD. Looked at another way, if you had a pound of radium in 410 AD, there would be ½ pound left today.

Radon gas has a half-life of 3.8 days. An individual radon atom has a less than 1% chance of surviving more than 27 days (equal to about seven half lives).

So why is there any radon-222 in the IWCS, which was built 20 years ago? Because radium-226 constantly decays to produce radon-222 gas, so radon-222 is always being generated in the IWCS. This will continue until all of the radium-226 is gone.

However, the radon-222 is constantly decaying really quickly. So the radon-222 gas doesn’t “build up” in the IWCS because it decays as it is produced.

It is important to note that radon-222 also comes from natural radium-226, and that is why it is present at low levels naturally.
As mentioned previously, ionizing radiation has the ability to remove electrons from atoms they may contact. Losing an electron can cause changes in the material struck by the radiation. Radiation striking cells in living organisms can cause damage to cell function. This kind of damage can cause disease. The primary concern with cell damage from ionizing radiation is the risk of cancer.
Sources of Ionizing Radiation Associated with IWCS Materials Addressed in the TMs

- Radon gas release and migration
- Direct gamma exposures
- Radioactive particulate emissions

SLIDE 34 - Harry Fatkin

As mentioned in previous slides, the Radon Assessment TM and Health Effects TM discussed in this presentation focused on potential risks associated with direct contact or airborne releases from the IWCS materials. The primary risks are from radon gas release and migration and direct gamma exposures, mostly from radium-226. Although an important risk in some situations, for the IWCS the radioactive particulate emissions were not significant risks as compared with radon and direct gamma. For this reason, the focus of the remainder of this presentation is radon/gamma radiation exposure.
SLIDE 35 - Harry Fatkin

Let's look at radon-222 gas as it relates to the IWCS.
Radon gas, or radon-222, is a naturally occurring, colorless, odorless gas with a decay half-life of 3.8 days.

Exposure to radon comes from many natural sources in our environment. Most radon comes from decay of naturally occurring uranium and thorium ore in soil and rocks. Because it is heavier than air, it may accumulate in confined spaces such as a basement. Under certain conditions, radon concentrations (and consequently health risks) can be higher than average inside unventilated basements. If radon is released into the open air or if air is circulated, the potential for health effects can be reduced. Radon exposures also come from medical procedures, and from consumer products (TVs, building materials, tobacco, etc.).

Radon gas is part of the long decay chain for uranium-238. Uranium-238 decays to radium-226 which decays to radon-222. Because the residues stored in the IWCS contain a lot of radium-226, radon-222 is a significant concern for the IWCS. If the residues were exposed, high levels of radon-222 could be released and might pose a health risk.
Gamma Radiation

- What is it?
- Where does it come from?
- Why is it a concern?

SLIDE 37 - Harry Fatkin

Let's look at gamma radiation as it relates to the IWCS.
SLIDE 38 - Harry Fatkin

Gamma rays are one type of electromagnetic radiation. They are bundles of energy that can travel long distances through air (up to several hundred meters), body tissue, and other materials.

Examples of gamma rays include cosmic rays and X-rays.

Gamma rays have a high energy. A gamma ray can pass through a material without hitting anything, or it may hit an atom and give that atom all or part of its energy. Because a gamma ray is pure energy, it no longer exists once it loses all of its energy. The capability of a gamma ray to do damage is a function of its energy.

Gamma radiation comes from a number of natural sources. Unavoidable exposure to gamma (ionizing) radiation comes from cosmic rays and some natural material. Human exposure to natural radiation is responsible for a certain number of health effects each year.

Because the IWCS residues contain high concentrations of radium-226, gamma radiation exposure would be a concern from a breach in the IWCS cap or from excavating wastes from the IWCS.
The design of the IWCS is the key to understanding how exposures to the radiation that causes the primary health concerns is prevented. Remember that the primary health concerns are radon gas and gamma radiation. The IWCS was designed to shield against release of radon gas and direct gamma radiation exposures.

First and foremost, the placement of the residues inside the concrete structures provided containment and shielding.

Secondly, the layering of contaminated soil above the residues and wastes followed by another layer of clean clay soil minimizes the release of radon gas and gamma radiation. The seepage of radon gas is slowed by the dense, low permeability clay layers. The gamma radiation is absorbed by the same clay layers. The radon gas moves slowly through the clay and decays (due to its short half life) to solid radioactive particulates before reaching the surface of the IWCS. Radon does not “build up” within the IWCS in any measurable amounts. The gamma rays are absorbed by the clay layers because they encounter the dense clay solids.

In much the same way that clay prevents the migration of radon to the surface, the low-permeability clay layer also minimizes infiltration of rain water into the lower layers of the IWCS.

The vegetative cover is designed to act as a protective cover to the clay layer and to control erosion and minimize frost-heave damage.
The Environmental Surveillance Program conducted at the NFSS monitors performance of the IWCS cap using radon-222 flux monitoring, external gamma radiation monitoring, and radon gas monitoring.

**Radon-222 Flux Monitoring**
- Radon flux monitoring is the most direct indicator of cap performance and integrity; it is measured using 183 radon flux canisters placed directly on the IWCS surface. One of these canisters (top left) and the locations where they are placed on the IWCS (bottom left) are pictured here.
- Radon-222 levels are comparable to background levels and demonstrate the continued effectiveness of the IWCS cap in reducing the potential for radon migration and exposure.

**External Gamma Radiation Monitoring**
- External gamma radiation is monitored using radiation detectors located around the IWCS and at the perimeter of the site. One of the contributors to gamma radiation is radium-226.
- An external gamma radiation detector is pictured here (bottom right, right-hand side). The detectors are used to measure external gamma radiation dose rates and are switched out twice a year.
- External gamma results continue to be at or near background levels and are well below the Department of Energy guideline level (100 mrem/year) for all pathways, excluding radon.

**Radon Gas Monitoring**
- Radon gas monitoring is performed at 5.6 feet above ground level, that height is used to represent the human breathing zone. Inhalation is the most serious pathway for exposure to radon.
- Radon gas monitoring is conducted using a Radtrak® detector, which is the white canister shown in the lower right-hand picture. The top right photo shows one of the detectors being changed.
- Results of the radon gas monitoring continue to be well below the Department of Energy off-site limit of 3.0 pCi/L above background.

All monitoring indicates that the IWCS is performing as designed to control health effects. The monitoring program is ongoing to confirm that the IWCS continues to perform effectively.
Because there are sources of radiation other than IWCS materials, it is important to understand these ubiquitous sources and their significance. The chart above shows the contribution of naturally occurring radon on the overall dose a person might receive from exposures to common sources. The findings indicate that radon is a common source of background radiation. In addition, radon from natural sources results in significant exposure to the average member of the public.
Corps Health Protection engineers demonstrate the presence of background radiation.
### Overview of the Technical Memoranda

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<td>• Estimates related radon releases to atmosphere</td>
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<td></td>
<td>• Estimates potential worker and public health effects from exposed IWCS materials</td>
<td>• Evaluate potential risk at off-site locations for remediation or accidents</td>
</tr>
<tr>
<td></td>
<td>• Used air dispersion modeling in Meteorological TR</td>
<td></td>
</tr>
<tr>
<td>Met Data/Dispersion TR</td>
<td>• Uses EPA air dispersion model (AERMOD) and CWM meteorological data to compare with CAP88 results</td>
<td>• Analyses will use AERMOD and data from CWM</td>
</tr>
</tbody>
</table>

#### Supporting Technical Report

**SLIDE 43 - Harry Fatkin**

Now let’s take a look at the specifics of the TMs. The purpose of the Radon Assessment TM and Health Effects TM were to provide an estimate of the potential exposures and risks associated with the IWCS waste under short-term conditions. This information will support the development and the evaluation/comparison of the remedial alternatives in the Feasibility Study. During the implementation of any remedial actions, these estimates would also be used to develop protective measures, such as respirators for remedial workers.

The Radon Assessment TM used computer modeling to predict potential radon concentrations in air at various on-site and off-site locations. The Health Effects TM used computer modeling to assess potential health risks and exposures and also broadened the analysis to consider other radionuclides and non-radionuclide (chemical) risks.

To run these models, you have to set up hypothetical conditions for release of the contaminants (primarily radon gas and gamma radiation), think about who could be exposed (the receptors), and how the receptors might be exposed (pathways). These are discussed in the following slides.
So why do this modeling about hypothetical exposures? This information will support the development and the evaluation/comparison of the remedial alternatives in the Feasibility Study. During the implementation of any remedial actions, these estimates would also be used to develop protective measures, such as respirators for remedial workers. Thus, this information is critical to evaluating what actions can be taken at the IWCS and how they would need to be designed.
Two types of exposure scenarios were modeled, intrusion and excavation. They form the basis for calculating what would be released and how the releases would impact human health and safety if the IWCS cap was breached.

The intrusion scenarios modeled include damage due to heavy equipment, a burrowing animal, and drilling into the residues. The primary rationale for assessing the intrusion scenarios was to support the No Action alternative in the Feasibility Study. Although this is an unrealistic scenario because the Corps is committed to continued monitoring and maintaining controls, this type of scenario is required by the EPA to evaluate “baseline” risk conditions (i.e. absence of any remedial actions). Consequently, the intrusion scenarios evaluate “uncontrolled conditions” at the IWCS where all or a portion of the IWCS contents remain on-site. Uncontrolled conditions assume the absence of access controls, site security, environmental monitoring, and maintenance. The results of the intrusion scenarios will also be used to evaluate the long-term effectiveness of any remedial alternative that involves leaving all or a portion of the IWCS contents in-place.
Three hypothetical excavation scenarios were identified to examine possible releases from the IWCS during remedial activities. The three excavation scenarios included the removal of K-65 residues, removal of all residues, and removal of the entire contents of the IWCS.

The rationale for the assessment of these excavation scenarios is to support the development and evaluation of removal action alternatives in the Feasibility Study. The assessments in the Radon TM and Health Effects TM quantify releases to air so that proper air emissions control equipment can be designed to reduce emissions to safe levels for the protection of remedial workers and the public.

It is important to note that the Health Effects TM evaluated hypothetical exposures based on assumed excavations—these may not match the excavation evaluated in the far more detailed Feasibility Study.
Several hypothetical receptors were identified for the modeling. On-site receptors include the maintenance worker and remediation worker at the NFSS as well as a potential trespasser scenario. The trespasser was assumed to be a teenager who would repeatedly enter the site despite the access controls and spend a portion of his or her time close to the IWCS. This same scenario could also be appropriate for a trespasser hunter, or campground visitor that disregards access controls. Additionally, several locations at the boundary of the NFSS were established.

Many offsite locations were modeled at various distances from the center of the IWCS. These include receptors in sixteen directional locations from the IWCS (i.e. north, west-northwest, west, etc.) and from 100 yards to 45 miles from the IWCS.

Additionally, specific receptor locations were estimated including the Lewiston Porter School District, a resident to the west-southwest, the landfill workers to the east, and campground visitors. The primary receptors evaluated in the Health Effects TM were the closest resident and industrial worker to the IWCS. These include the south-southwest resident adult and child and the east-southeast off-site landfill worker as an outdoor worker.
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Shown here are the approximate receptor locations that were evaluated as part of the TMs; note that the closest receptors (resident and outdoor worker) were selected from the locations closest to the center of the IWCS.

The on-site receptors are remedial/monitoring workers and trespassers.

The nearby receptors included monitoring workers and trespassers.

The distant receptors included residents and off-site workers. Some of the distant receptor locations are beyond the borders of this map.
In the Health Effects TM, the following exposure pathways were identified as potential routes of exposure from the IWCS residues and wastes.

Radon gas poses a risk primarily due to inhalation. This is the dominant pathway and dominant concern. The radon gas progeny (decay products) can also be transported as airborne particulates that may be deposited on the ground. Individuals can inadvertently ingest soil by transferring it from hands and fingers to food or cigarettes, or simply by wiping the mouth. Radioactive decay may then occur within the digestive system where tissues, such as the stomach lining, would be exposed. Because of the existing access controls at the NFSS, ingestion would be considered to be an incidental and much smaller risk to site remediation workers as compared to inhalation pathway.

The high levels of radium-226 in the IWCS residues could also pose a risk by direct external gamma radiation emitted from the residues if anyone was near the IWCS when the residues were exposed. The dose from external gamma radiation is limited to the time that the individual is in the gamma radiation field.

The potential health concerns from these exposure pathways include both carcinogenic and non-carcinogenic effects if exposures continued over a long period of time. However, exposure to particulates of chemicals or radionuclides (other than radon) were significantly lower than radon.
At the NFSS, previous site activities included moving the K-65 residues into the silo and sluicing the residues from the silo into the IWCS. When the residues were moved in a dry state and with limited shielding, exposure to workers was significant. When the residues were sluiced, the presence of water shielded the gamma radiation and absorbed the radon gas, resulting in much lower worker exposures.

The modeling in the Radon Assessment TM and Health Effects TM shows the same thing—exposure of the residues could result in significant risk to workers, unless engineering controls are put in place.

Thus, the modeling in the Radon Assessment TM and Health Effects TM can be used for planning and evaluating the remedial alternatives in the Feasibility Study.
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The results of the Radon Assessment TM and the Health Effects TM found that the primary risks associated with the IWCS are currently controlled by the existing IWCS cap. Ongoing surveillance and maintenance of the cap is required to continue to ensure the effectiveness of the IWCS. Additionally, ongoing environmental monitoring will be required to demonstrate protection of workers and public health.

The results of the evaluations also determined that if the IWCS were opened in order to remove the residues, then a comprehensive worker protection program would need to be implemented. Worker protection would include worker training and monitoring, protective equipment, and engineering controls to reduce radon and gamma radiation exposures. Additionally, a radon abatement system would be needed to control radon emissions for workers and so that no off-site releases would occur.
We will take a 15-minute break and rearrange the room before we start the Table Discussions. But before we break, please allow me to explain the way that the table discussions will be conducted. We want to be able to provide you with an opportunity to have more in-depth dialogue regarding specific matters. We want to hear your questions and your concerns regarding this information. There will be three facilitated discussion groups on the following topics:

Table 1. Health Effects and Radiation: All topics related to the potential effects of materials in the IWCS, radiation, radon, worker safety, neighbor safety

Table 2. Risk and Risk Models: All topics related to how models were applied including hypothetical scenarios, hypothetical receptors

Table 3. IWCS and Engineering Controls: Design and construction of the IWCS and how it contains materials, use of engineering controls during any material removal

You will have an opportunity to visit each of the three sessions in the time remaining for the workshop tonight. We would ask that in each table discussion a community spokesperson be identified. At the end of the evening, we would like to have the spokesperson summarize the concerns or comments discussed at their particular sessions.

Additionally, please remember that the DOE is available during these table discussions to discuss the Knolls Atomic Power Laboratory reports results.

Ok, so let's break for about 15 minutes while we set up the room to allow for the table discussions.
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