GROUNDWATER TRITIUM

STATUS REPORT

WATTS BAR NUCLEAR PLANT

August 2005

FF-1

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A. EXECUTIVE SUMMARY

In August 2002, low levels of tritium were detected in a scheduled sample drawn from an onsite radiological monitoring well (Monitoring Well 1) at the Watts Bar Nuclear Plant (WBN). The well is included in the WBN Radiological Environmental Monitoring Program and is routinely sampled. This data was reported in the WBN 2002 Annual Radiological Environmental Monitoring Operational Report. Subsequent samples also detected similar low levels of tritium.

As part of planned plant modifications to produce tritium for the U.S. Department of Energy, TVA committed to modify the Radiological Environmental Monitoring Program by installing additional monitoring wells around the Watts Bar and Sequoyah Nuclear plants. Four additional monitoring wells (wells A-D) were installed at Watts Bar along the existing liquid effluent and cooling tower blow down lines. These wells were installed in December 2002.

Groundwater samples collected from the new monitoring wells in January 2003 indicated the presence of tritium in three of the new wells.

The Nuclear Regulatory Commission Site Resident at WBN and the Tennessee Department of Environment and Conservation - Department of Radiological Health were notified and are being kept informed as investigations continue. No tritium or other radionuclides have been detected at levels exceeding background in water samples from off-site wells, public drinking water supplies, or the Tennessee River.

In March 2003, a team consisting of both site and corporate TVA personnel was established to locate the source(s) of the tritium and eliminate the path(s) to groundwater. Potential sources were identified based on tritium concentrations in the component or system, location within the plant, and relative tritium concentrations in the groundwater samples.

Internal and external plant sumps, effluent and blow down lines, and tanks were evaluated as possible sources. Through this effort, the liquid effluent line was found leaking and repaired. The Unit 2 Fuel Transfer Tube (FTT) was found to be leaking. This leakage found its way into the groundwater through the 1" seismic gap between the Auxiliary Building and the Unit 2 Shield Building. The bellows and part of the transfer tube were removed and sealed. The leaking effluent line was isolated and temporarily bypassed. Subsequently, a new liquid effluent line was installed and placed in service in May 2005. The Fuel Transfer Canal (FTC) was also coated in 2004 to eliminate leakage through the liner as a source.

ARCADIS, Inc. was retained in January 2004 to aid TVA in identifying the source(s) of tritium, define groundwater movement and tritium extent, and support remedial planning. Their investigation concluded that based on the distribution of tritium in groundwater and refined understanding of groundwater flow conditions, the tritium plumes observed at the site are likely associated with two separate sources; the Rad Waste Line and the Unit 2 FTT. Their recommendations included the replacement of the leaking liquid effluent (radwaste) line and prevention of water from entering the FTT sleeve. As noted above, the radwaste line has been replaced and the FTC liner has been coated.

ARCADIS concluded that tritium from the radwaste line leakage is partially controlled by inducing groundwater flow to the plant buildings by the French drain and actively pumping the groundwater sump. If desired, a hydraulic control system could be used to capture the entire plume by installing recovery wells in the down gradient leading edge of the plume, south of the plant. Leakage from the Fuel Transfer Tube seismic gap is completely contained by the French drain and actively pumping the groundwater sump. The extent of tritium in groundwater due to this source has likely been influenced by moderate to large storm events and underground infrastructure. Nevertheless, the plume around the Unit 2 Shield Building remains focused and contained, and no additional remedial actions are needed.

In February 2005, monitoring of groundwater quality revealed a significant increase of tritium concentration in well D. This well is located in a down gradient position between the Yard Holding Pond (YHP) and the Intake Pump Station (IPS) for the facility. Historical concentrations of tritium in well D had averaged approximately 5000 pico curries per liter (pCi/L), with concentrations in late January 2005 increasing abruptly to 550,000 pCi/L.

In response to the increased levels in Well D, groundwater data has been collected from various wells, including a snapshot data set of groundwater quality and water levels to evaluate the tritium concentration in well D within the broader context of site conditions. Additionally, the frequency of samples from Well D was increased in order to monitor any further changes.

TVA investigated possible sources of the tritium, and discovered and subsequently repaired a leak at the connection of the temporary radwaste line with the permanent stainless steel radwaste line. ARCADIS, Inc., who conducted the initial groundwater investigation, was retained to assist in the investigation. The analysis of the data led the team to suspect that a new leak may have been present in the Cooling Tower Blowdown (CTBD) line downstream of the liquid effluent line tie-in, in addition to the connection leak that was found and repaired.

During the week of 02/28/2005, the discharge line was isolated and the pipe inspected. In general, the condition of the line is good with no apparent leaks. Based on inspections of the pipe and review of data collected, it was decided to clean and seal the 48" and 72" concrete joints from the carbon steel/concrete joint (northwest of the IPS) to the tee of the line to the Yard Pond. It was concluded, based on the inspection of the CTBD line, that the most likely source of the increase is the natural movement of the plume containing tritiated groundwater from the previous radwaste line leak that was isolated in 2004.

Subsequent to the investigation of well D, increases in tritium levels in well B have been observed and well D has continued to decrease. Well B is the next well down gradient of well D along the discharge line. This is consistent with the conclusion that the plume caused by the 2003 leaking radwaste line is moving along the path of the discharge line. It is expected that Well A will eventually show increased levels of tritium as the plume moves towards the river. Any tritium released to the river when the plume migrates that far will have been already accounted for in the total plant releases, since they were monitored as part of the normal plant effluent release monitoring program prior to release into the leaking plant liquid effluent line.

In summary, actions have been taken to reduce or eliminate the identified sources of leakage of tritium into the groundwater. In general, tritium concentrations are currently decreasing. Monitoring of tritium concentrations continues in order to assess the levels and extent of tritiated groundwater at the site.

B. CHRONOLOGY

On August 20, 2002, TVA detected 407 pCi/L of tritium in an onsite radiological monitoring well (Well 1) during a scheduled sampling event. This was the first indication of tritium in groundwater at the Watts Bar Nuclear Plant. Well 1 is sampled on a regular basis, as a part of the WBN Radiological Environmental Monitoring Program (REMP). Levels of tritium in Well 1 have remained low since the initial sample, with no subsequent samples exceeding a tritium concentration of 750 picocuries per liter (pCi/L).

As part of planned plant modifications to produce tritium for the U.S. Department of Energy under an Interagency Agreement, TVA committed to modify the Radiological Environmental Monitoring Program (REMP) by installing additional monitoring wells around the Watts Bar and Sequoyah Nuclear plants. Four new groundwater monitoring wells (wells A-D) were added to the REMP at Watts Bar. These wells were installed along the existing liquid effluent line and cooling tower blow down line at the WBN site. The additional wells were installed in December 2002, and tritium was detected in the initial baseline groundwater samples taken from three of these wells (B, C, and D) in January 2003.

Based on the tritium levels found in these newly-installed REMP wells, a team consisting of both site and corporate TVA personnel was established in March 2003 to locate the source of the tritium and eliminate the path to groundwater. The team's first task was to identify possible sources of tritium. Possible sources were identified based on tritium concentration in the component or system, location within the plant, and relative tritium concentrations in the groundwater samples. These possible sources underwent evaluations utilizing visual inspections, testing and sampling.

Following inspection and testing, potential sources were identified and corrective actions taken to eliminate the tritium leakage into the groundwater. Corrective actions were taken on the following plant components:

- Plant Liquid Effluent Line (Radwaste and Cooling Tower Blowdown Lines)
- Fuel transfer Canal (FTC)
- Fuel Transfer Tube (FTT)
- Spent Fuel Pool (SFP)
- Cask Loading Pit (CLP)
- Various Auxiliary Building tanks

In January 2004, ARCADIS, Inc. was retained to assist in the investigation and characterization of the tritiated groundwater issue. Their task was to assist in identification of sources, define the extent of tritiated groundwater, define groundwater movement, and support TVA in any required remedial planning.

Monitoring of tritium levels in installed wells continued throughout 2004 with no significant increases in levels. In February 2005, a significant increase in REMP Well D was observed, indicating either movement of the plume towards the Tennessee River or development of a new source of tritium in the groundwater. The TVA team and ARCADIS were mobilized to investigate and address the increased levels in Well D. After inspection and preventative sealing of joints of the Cooling Tower Blowdown Line, the team concluded that the increased levels in Well D were most likely caused by the movement of the groundwater plume towards the Tennessee River.

Watts Bar continues to monitor tritium levels in the site groundwater.

C. SOURCE IDENTIFICATION

Based on the tritium levels found in these newly-installed REMP wells, a team consisting of both site and corporate TVA personnel was established to locate the source of the tritium and eliminate the path to groundwater. The team's first task was to identify possible sources of tritium. Possible sources were identified based on tritium concentration in the component or system, location within the plant, and relative tritium concentrations in the groundwater samples. These possible sources underwent evaluations utilizing visual inspections, testing and sampling.

The following components were considered as possible sources of tritium in the groundwater:

- Liquid Effluent Lines (i.e., Radwaste and Cooling Tower Blow Down Lines)
- Fuel Transfer Canal (FTC)
- Fuel Transfer Tube (FTT)
- Refueling Water Storage Tank (RWST)
- Spent Fuel Pool (SFP)
- Cask Loading Pit (CLP)

In addition to the sources listed in section above, the following internal tanks which periodically contain water with tritium were potential tritium sources and were inspected:

- Holdup Tanks (HUT) A & B
- Floor Drain Collector Tank (FDCT)
- FDCT Sump
- Cask Decontamination Collector Tank (CDCT)
- Monitor Tank
- Tritiated Drain Collector Tank (TDCT)
- TDCT Sump
- Auxiliary Building Sump
- Turbine Building Sump

Upon inspection of the above listed tanks, no visible signs of leakage were observed from any of the tanks or sumps. Details of the tritium investigation and results for the potential listed above are provided in Section D, Field Investigation & Abatement

D. FIELD INVESTIGATION & ABATEMENT

Following identification of potential sources, field work began to identify the source of the groundwater tritium. This work included the following: leak testing of lines and storage components; evaporation calculations of the SFP and RWST; installation and sampling of groundwater wells; inspection of drain lines; and boroscopic investigation of SFP, CLP, and FTC leak collection system channels and drains.

A discussion of these actions and the results are presented below for the identified potential sources.

Liquid Effluent Line

The effluent line contains liquids from the radioactive waste system and steam generator blow down, as well as the condensate demineralizers drain. This line leaves various buildings in the plant and is routed to the cooling tower blow down line where it is diluted prior to discharging into the Tennessee River through two diffusers.

Because of the proximity of well C to the liquid effluent line, this line was suspected as the source of the tritium in this well. On March 24, 2003, the line was tagged out and pressure tested on March 28, 2003. Acoustic monitoring indicated two possible leak locations. The line was returned to service for steam generator blow down only on April 2, 2003, then tagged out again while soil samples were taken at suspected leak locations.

Soil samples taken on April 7, 2003, from both suspected leak locations indicated the absence of gamma activity. Well C, which is downstream and east of the effluent line, indicated a tritium level of 13,730 pCi/L on April 8, 2003. Excavation of the two possible leak locations began on April 14, 2003. Inspection of the piping did not reveal any leaks at either of the two suspected locations. A temporary hose was installed to allow steam generator blow down and liquid effluent to return to normal operation while leak detection continued.

On April 17, 2003, the line was pressurized to approximately 75 psig. At this pressure, testing indicated a leak rate of 2-2.5 gpm. During pressure testing, no leaks were detected at the two excavation sites where the acoustic monitoring previously had indicated leaks. A contractor with more advanced acoustic monitoring equipment was employed to inspect the line on April 23, 2003. Testing of the line indicated possible leaks in one or two different locations.

One of the potential leak locations was excavated on April 28, 2003. Water was found in the downstream collar (road tile) which surrounded the line. Two samples of the water indicated no tritium or other isotopes. The line was then pressurized to approximately 75 psig for two hours but no leakage in the area of the possible leak was observed.

Photo 1

Photo 2

Acoustical monitoring of the effluent line resumed on April 30 and May 1, 2003, and another potential leak was identified approximately 100' down gradient of the previous excavation. Excavation of the new location on May 1, 2003, confirmed a leak (see Photo 1) on the west side of the line. The leak appears to be caused by accelerated corrosion from the pipeline exterior due to a tear in the protective pipe wrap. The line was cut, inspected, and repaired on May 5, 2003. Internally, the pipe appeared to be in very good condition (Photo 2). The line was then pressurized to 80 psig with no further indications of leakage. The effluent line was returned to normal service on May 9, 2003. Within two months or so after this repair, increases in tritium concentrations in Well C indicated that this line may have another leak. The temporary hose was placed back in service on August 20, 2003. The temporary hose was returned to service while a new replacement line was completed. The new permanent radwaste line was completed and placed in service in May 2005.

Pressure testing resumed on August 25, 2003. Two additional potential leak locations were detected with acoustic monitoring equipment. Leak rate at the test pressure of approximately 75 psig was about 1.25 gallons per hour. The amount of leakage is significantly less than the leakage amount previously found. Given this small amount of leakage and the location of the possible leaks being down gradient of Well C, the influence of this leakage on Well C is probably small and another tritium source is likely influencing Well C tritium concentrations. The two locations were excavated on October 17, 2003, and no leakage observed. The line will be returned to service and replaced.

The Rad Waste Line leak, identified and repaired in May 2003, is suspected of being the primary source of tritium. A portion of the tritium originating from the leak location has migrated toward the south leg of the French drain system along preferential pathways associated with the Condenser Cooling Water (CCW) Lines and relatively permeable bedding material. Another portion of the tritium originating from the leak appears to follow major subsurface lines (i.e., Cooling Tower Blowdown Line, Waste Heat Lines, and storm drains) towards the Tennessee River. Again, this directional behavior is likely associated with preferential groundwater movement associated with the higher permeability bedding material surrounding subsurface piping.

When WBN was constructed, engineered fill was placed over a majority of the Site. The tighter hydraulic properties make the fill much more difficult for groundwater to flow through than the gravel packs surrounding the numerous pipe systems associated with facility infrastructure. Tritium migration towards the Turbine Building appears to be influenced by the south CCW discharge line running from the Turbine Building to Unit 1 Cooling Tower. Tritium migration toward the river is strongly influenced by the Cooling Tower Blowdown Line, Waste Heat Park Lines, and other piping infrastructure, as their position within the subsurface is coincident with the groundwater table along portions of their length. Based on calculations of tritium in the south leg of the French drain, it is likely that a majority of the activity is not being observed in groundwater monitor wells and is within the more permeable gravel packs of the discharge CCW Line and Raw Cooling Water Lines. A majority of the groundwater monitor wells has shown decreasing concentrations of tritium, indicating that the primary source has been eliminated.

Fuel Transfer Canal (FTC)

The fuel transfer canal (FTC) is part of the plant system used to move reactor fuel during a refueling outage. Because the FTC is only filled with water during refueling outages, any leakage from the FTC will be intermittent. Occasional FTC leakage has been identified over the past 5 – 6 years. These leaks have been repaired as they were discovered. Because monitoring of potential leakage during the time the FTC is filled is difficult, the team spent some time "brainstorming" possible methods to detect leaks in this area of the plant. All current methods of testing (pressurizing the back of the welds with air or nitrogen, etc.) were ruled out due to concerns over stressing the liner welds to the point of failure. Based on this, other physical inspections of the FTC would have to be performed in lieu of a pressure test.

During the inspections of the FTC drain system, it was found that, although some leakage was indicated (drips from line), blockage existed in the drain line. Upon removing this blockage, a large amount (~30 gallons) of water came out the drain line, indicating FTC leakage. A modification to the FTC, Cask Loading Pit, and Spent Fuel Pool drain systems was implemented in the fall of 2004 to allow easier access to the drain lines for inspection and cleaning in the future.

In early October 2003, a mobile camera (submersible) was used to record the condition of the FTC walls and floor. And after the fall 2003 refueling outage, the canal was drained and cleaned to a level to allow detailed inspection and repair. The FTC was drained down on November 20 for a detailed inspection and mobile camera videos were reviewed. In late December 2003, TVA met with Master-Lee to discuss leak repair/abatement methods and possible coating of the FTC. The FTC was coated by Master-Lee in the fall of 2004 (DCN 51653A). Following coating the FTC was filled with water for a 2 to 3 month period and monitored for leakage. No further leakage was identified during this monitoring period.

Fuel Transfer Tube (FTT)

As part of the equipment to refuel the reactor, a fuel transfer tube (FTT) is utilized along with other associated equipment to move fuel to and from the reactor. A bellows arrangement is utilized to separate the FTC and FTT from the reactor building.

In February 2003, it was identified that water was leaking into the Unit 2 Shield Building annulus through the Unit 2 FTT sleeve connection between the Auxiliary and Unit 2 Shield Buildings (see Photo 3). All of these units (SFP, CLP, and FTC) have the potential to be inter-connected behind the stainless-steel liner since the liner is not continuously bound in the concrete. A 1-inch seismic gap exists between the Auxiliary Building and Unit 2 Shield Building where the FTT passes through these buildings (Figure 1). Tritiated water, between the steel tube (20-inch diameter) and the concrete building, was observed flowing into the Unit 2 Shield Building annulus in February 2003. This water must flow across the seismic gap to get from the Auxiliary Building to the Unit 2 Shield Building, which provides a pathway to groundwater. This gap is filled with fiberglass and is glued on one side to the Unit 2 Shield Building. Potentially, water from the SFP, CLP, or FTC that has leaked behind the stainless-steel liner could migrate to the Unit 2 FTT sleeve and over the seismic gap.

Photo 3

A catch basin was erected to catch the leakage and the leakage was routed to the appropriate tank. A boroscopic inspection of this bellows was performed on April 29. The inspection confirmed that the bellows to transfer tube weld was leaking. A repair method was developed which included removing the bellows and a portion of the transfer tube inside the FTC and placing a plate over the remaining hole. This repair was completed in August 2003.

Leaks through the FTT sleeve and seismic gap have resulted in groundwater impact surrounding the Unit 2 Shield Building (Figure 1). Occasional FTC leakage has been identified over the past 5 to 6 years. The SFP and adjacent CLP, along with the FTC, have individual "tell tale" drain systems to detect leakage through the liner welds. Neither of these drain systems has exhibited recent leakage, although investigations indicated that the drains for the SFP and FTC were clogged, so evidence of leakage by this method is problematic. Subsequent efforts to clear these drain systems have resulted in a functioning drain system for the FTC. The SFP system continues not to drain and additional efforts are under way to free this drain system. The

Cask Loading Area drain system appears to be functioning as designed. Inspection of the "tell-tale" drain system is further complicated due to its piping configuration.

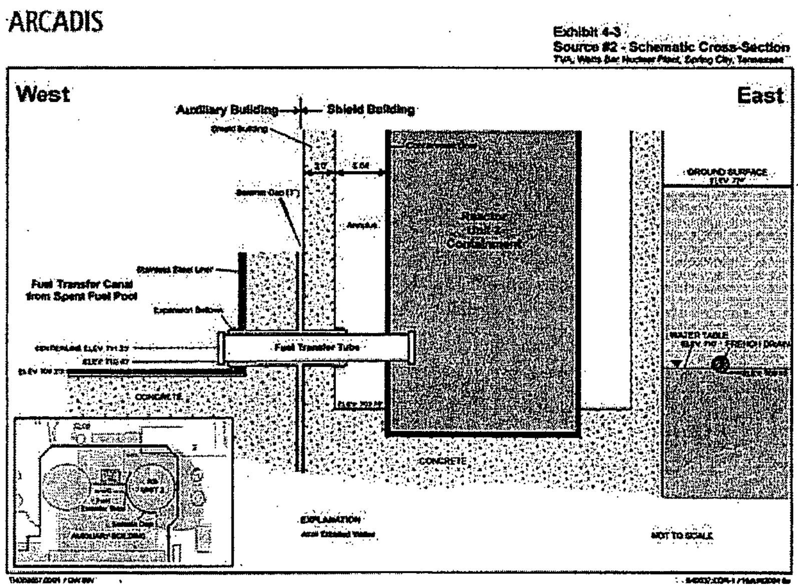


Figure 1

The difference in potential head between the bottom of the FTT sleeve and the French drain directly north of the seismic gap is approximately 1.25 feet, indicating that water would flow towards the French drain from this point (either to the north or to the east). Calculations using the tritium concentrations in these areas of nearly 100 million pCi/L indicate it would take a small volume of tritiated water to result in the concentrations being observed in the north leg of the French drain, and in groundwater monitoring points around the Unit 2 Shield Building.

Tritium found in geoprobes installed west of Unit 2 is influenced by the Unit 2 Fuel Transfer Bellows leak into the 1" seismic gap between the Auxiliary Building and the Unit 2 Shield Building as mentioned under the FTC discussion. Since the FTC has been coated and filled with water there has been no evidence of leakage in the U2 FTT sleeve. The seismic gap has been inspected with a boroscope and is covered with boron crystals.

Refueling Water Storage Tank (RWST)

The RWST (Photo 4) is a large source of water used during refueling outages and is also a source of water to the reactor should there be a loss of coolant accident. The water from the RWST is used to fill the fuel transfer canal and the reactor cavity during refueling outages and is returned to the RWST at the conclusion of the outage.

Because the RWST is a large volume of water with elevated tritium concentration (approximately 28 million pCi/l) the integrity of the RWST was reviewed. The RWST was found to be losing water at a rate of approximately 150 – 200 gallons per day (gpd). Several valves associated with the piping to/from the RWST were examined and found to be leaking. The valves were repaired, reducing the water loss to approximately 45 – 50 gpd.

A transducer was installed in the RWST and water level was tracked between November 4 and December 18, 2003. The data was given to Pacific Northwest National Laboratory (PNNL) to perform a rough evaporation calculation. Results from PNNL indicate that most of the level loss can be attributed to evaporation.

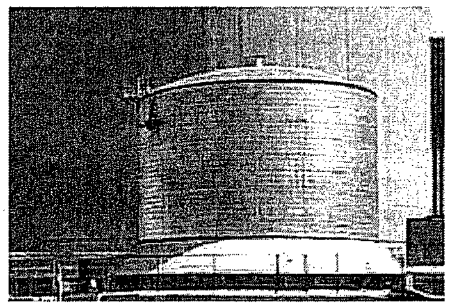


Photo 4

A geoprobe was installed near the RWST foundation between the tank and Auxiliary Building to determine if the tank was leaking into the groundwater on November 8, 2003. Results of tritium analysis for this location indicated less than minimum detectable for tritium.

Spent Fuel Pool (SFP) and Cask Loading Pit (CLP)

The SFP is a large concrete pool with a stainless steel liner and is the in-plant storage location for fuel after it has been removed from the reactor core. During refueling outages, the entire core is offloaded and stored in the SFP. Spent fuel which has reached the end of useful life remains stored in the SFP, while the remainder of the core, along with new fuel, is returned to the reactor vessel prior to restart. The tritium concentration in the SFP is approximately 95 million pCi/L. The SFP and the adjacent Cask Loading Pit have individual tell-tale drain systems to detect any leakage through the liner welds. Neither of these drains has exhibited any recent evidence of water leakage.

On June 16, 2003, boroscopic inspections were made of the drain lines for the SFP and the CLP to determine if there is any borated water leakage. Although the inspection area was limited due to piping configuration, the piping was not blocked and appeared to be free of any boron deposits. The CLP showed no signs of leakage while the SFP showed minor signs of past leakage near the isolation valve. No recent leakage indications were identified.

Over a period of one month, makeup to the SFP was compared to measured level loss and estimates from an evaporation calculation. Results of this effort revealed that the makeup rate was approximately the same as the evaporation rate.

In early December, an enhanced pressure transducer was installed in the SFP to measure level loss. PNNL prepared an enhanced evaporation calculation and compared the level loss with evaporation loss. PNNL results confirm that the SFP level loss and evaporation are essentially equal.

In February 2004 the SFP and FTC drain lines were cleaned of blockage a far as the piping layout would allow. Thirty-five gallons of water were poured down the leak channels. All five leak channels in the FTC drained as designed, while no water came out of the SFP drain line. A slug of crud and 30 gallons of water were removed from the SFP drain. Framatome ANP has analyzed the drain line blockage material and has determined that the material is mostly iron oxide. Attempts with a new clean-out tool to get further up the SFP 2" drain were fruitless. A modification was performed in the fall of 2004 to allow direct access into the 2' drain line for better inspection and cleaning capabilities. Video taken after the modification revealed that the drain is plugged. This line will be hydrolazed in the fall of 2005.

E. TRENDING AND MONITORING PROGRAM

Concurrent with the above source identification and abatement program, a program was established to better define the extent of the tritium in the groundwater. These efforts consisted of 1) installing and monitoring additional wells to better define the extent of the tritium in the groundwater and 2) sampling the groundwater sump that receives water from the French drain around plant buildings. These efforts are discussed below.

Monitoring Wells

As part of a systematic program to determine the tritium source(s), 34 additional monitor wells were installed during 2003 and early 2004 to further delineate the extent of tritium (see Figure 2 for well locations). These wells have been periodically sampled since their installation, with a maximum tritium concentration through 2004 of 353,700 picocuries per liter (pCi/L) occurring in October 2003 at groundwater Monitor Well K near the Radwaste Line, east of the Power Block (higher levels were detected at well D in February 2005. See Section G of this document for discussion of this increase) Tritium extends from this general area near the Unit 1 Cooling Tower, south toward the Tennessee River, and westward toward the Power Block. Relatively low concentrations of tritium were also detected around the Unit 2 Shield Building.

In March 2003, three additional monitoring wells (E, F & G) were installed to further assess potential sources of tritium in the site groundwater. Wells H through S were installed during September and October 2003 and wells T through X were installed during December 2003. These wells were typically drilled to bedrock and screened over the bottom 10-ft interval. Wells Y, Z, and AA through LL were installed using a direct-push Geoprobe rig. Geoprobe wells are ¾-inch inner diameter and 1-inch outer diameter polyvinyl chloride casings. Wells Y, Z, and AA through DD were installed during the final week of January 2004 and first week of February 2004. Geoprobe Wells EE through LL were installed at the end of February 2004. All Geoprobes were installed to refusal and screened over the bottom 10-ft interval.

Results from well F in early 2003 showed tritium levels similar to other nearby wells. Initial groundwater samples from Wells E and G indicated that tritium concentrations were below detectable levels.

Samples were also taken from perimeter monitoring wells (2,3,5,6 & G) on March 13,2003. The results from these wells were less than minimum detectable levels of approximately 550-580 pCi/liter. This confirmed that the groundwater tritium is localized to the area near the radioactive effluent and the cooling tower blow down lines.

Samples taken from Well E (less than minimum detectable) confirm that the source of the tritium in Well 1 is likely associated with the Yard Holding Pond (YHP). During the spring 2002 outage, slightly radioactive water was drained to the turbine building sump which discharges to the YHP. The tritium concentration in this water was approximately 1200 pCi/L.

Wells I and L were drilled and sampled in September 2003, and indicated tritium levels of approximately 32,000 pCi/L and 49,000 pCi/L, respectively. With this information, additional wells were installed to better define what might be a tritium plume. This included installing wells to surround the plant in close proximity to the south, west, and east sides.

Wells N, O, M and P, and Q were also drilled in September 2003 and sampled. All results were less than minimum detectable levels. These wells are located south and west of the plant. These sample results indicate that the tritium in the groundwater is located on the eastern side of the plant.

Wells K, J, and R and S, which are located to the east of the plant, were drilled in late September and early October 2003. The results of groundwater samples from these wells indicated 18,000 and 11,000 pCi/L of tritium in wells R and S. The results at Well K range from 350,000 to 92,500 pCi/L. Well J results were approximately 1,800 pCi/L.

Groundwater Sump

Tritium samples were taken in March 2003 from the groundwater sump which receives water from a perimeter drain system (French drain). The perimeter drain encompasses the entire power block area (i.e., reactor, auxiliary, control, turbine, and service buildings) and was installed at foundation depths. The highest elevation for the perimeter drain is located at the southwest corner of the service building. Hence, groundwater entering the drain moves by gravity in two directions from this corner. The groundwater drainage sump collects the water contained in the perimeter drain.

The groundwater sump has continually exhibited elevated tritium concentrations ranging from approximately 6,000 pCi/L to 12,000 pCi/L. This sump was designed to discharge via two sump pumps to the underground catch basin system which drains into the YHP. With elevated tritium concentrations, the outlet from this sump was routed to the station sump, which is a monitored release point in the WBN effluent monitoring program. A Design Change Notice (DCN) was issued and implemented which added timers to the groundwater station sumps, and the sump was added as a plant monitored release point for WBN. Following this, the sump pump discharge was routed back to the catch basin system and the sump is now sampled weekly. The tritium released via this pathway is now monitored and accounted for in the WBN annual effluent radiological report.

To further define the source of tritium, the two inputs were sampled. The northern perimeter drain input to the groundwater sump had more water input and a tritium concentration of approximately 4,500 pCi/L, while the southern input had much less water input and a tritium concentration 21,000 pCi/L. Based on this information, it appears that both legs of the drain system are collecting water with tritium.

Tritium levels in the groundwater sump have declined from the highest levels encountered (2003) and have remained relatively steady over the last year.

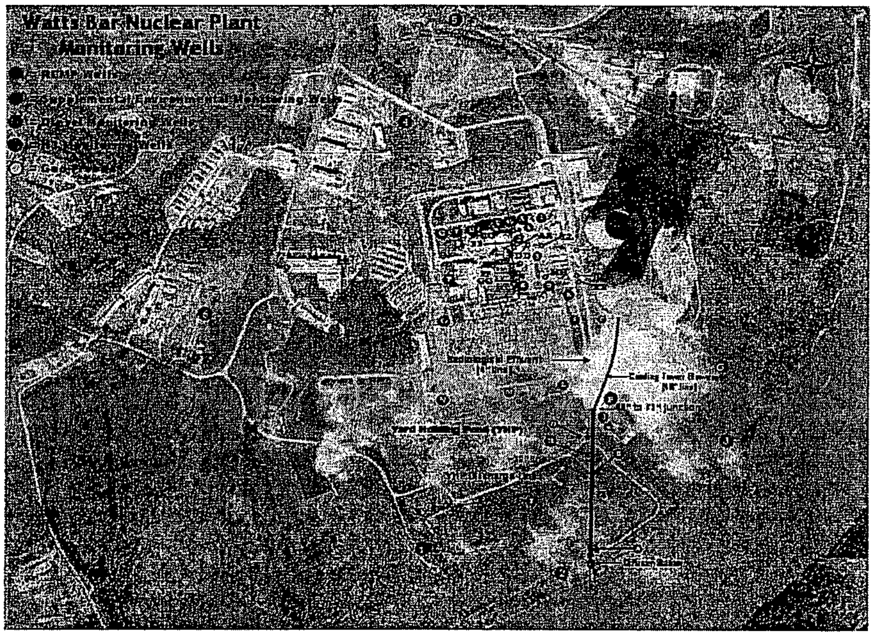

Watts Bar Nuclear Plant
Monitoring Wells
REMP Wells
Supplemental Environmental Monitoring Wells

Figure 2

F. ARCADIS ANALYSIS OF DATA & PLUME

In early 2004, ARCADIS, INC. was retained to assist TVA in identifying the source(s) of tritium, define groundwater movement and tritium extent, and support remedial planning. ARCADIS participated as a member of the team assessing the source and extent of the tritium in the groundwater. The results of their investigation are documented in a Groundwater Investigation Report prepared in August 2004.

The primary objectives of the investigation were to:

- Identify the potential source(s) of tritium releases;
- Characterize groundwater movement
- Determine the nature and extent of tritium in the subsurface environment; and
- Determine preliminary remedial options to address tritium in the groundwater.

A summary discussion of the investigation report data analysis and findings is provided below. For more detailed information, see the ARCADIS Groundwater Investigation Report. This information addresses the time period up to August 2004. Following this report, increased concentrations of tritium in well D were observed. This is discussed in Section G of this document.

Groundwater Investigation Data

The primary types of new environmental data collection included hydraulic and groundwater quality information from strategically placed monitor wells. Groundwater levels were measured over the course of the investigation to determine the direction of groundwater flow and potential preferential pathways of movement. In general, regional groundwater movement is southerly across the Site toward the river, with the exception of groundwater captured by a French drain system surrounding the Unit 1 and Unit 2 Shield Building, Auxiliary Building, Control Building, and Turbine Building. Groundwater dewatering provided by the French drain, described below, has resulted in a groundwater capture zone surrounding the Power Block.

The French drain surrounding the Power Block consists of an 8-inch porous concrete pipe bedded in a horizontal blanket of gravel. A sump collects groundwater from the French drain on the east side of the Auxiliary Building. This sump continuously receives flow from both the north and south French drain lines and periodically is pumped based on the level in the sump. The north leg of the French drain routinely exhibits a higher flow rate than the south leg.

As part of a systematic program to determine the tritium source(s), 34 additional monitor wells were installed during 2003 and early 2004 to further delineate the extent of tritium. These wells have been periodically sampled since their installation, with a maximum tritium concentration [353,700 picocuries per liter (pCi/L) in October 2003] occurring at groundwater Monitor Well K near the Rad Waste Line, east of the Power Block. Tritium extends from this general area near the Unit 1 Cooling Tower, south toward the Tennessee River, and westward toward the Power Block. Based on the monitoring network and collected data, detectable concentrations of tritium have not yet reached the river. Relatively low concentrations of tritium were also detected around the Unit 2 Shield Building.

Concentrations of tritium in the groundwater sump have been declining, which seems to have resulted from tritium abatement activities performed by TVA. The south leg of the sump continues to exhibit approximately twice the tritium concentration of the north leg. However, the total activity of tritium entering the sump is greater in the north leg (although a lower concentration) due to its higher flow rate. The presence of tritium in these two legs entering the sump suggests that two sources are likely.

Based on solute migration transport parameters and limited available information, it is estimated that the tritium plume movement is approximately 300 feet/year. Tritium is a radioactive form of hydrogen and decays with a half-life of 12.33 years, but is not susceptible to either biological or chemical degradation enhancement. Other natural attenuation parameters do not have a substantial impact on tritium retardation. That is, groundwater velocity and tritium migration are similar.

Source Assessment

Based on the distribution of tritium in groundwater and refined understanding of groundwater flow conditions, the tritium plumes observed at the WBN site are likely associated with two separate sources; the Liquid Effluent (or Radwaste) Line and the Unit 2 FTT seismic gap.

Source #1 – Radwaste Line

Documented leaks from the radwaste line appear to have resulted in tritium extending in a dual branch fashion west from the Well K vicinity to the southeast edge of the Turbine Building, and south from the Well K vicinity toward the Tennessee River (Attachment 1). The radwaste line, extending past Well K, was pressure tested, acoustically monitored, and excavated at several locations to identify potential leak locations. A leak was identified east of the Power Block after overburden was excavated on May 1, 2003. The leak appeared to be caused by accelerated corrosion from the pipeline exterior due to a tear in the protective pipe wrap. The line was cut, inspected, and repaired. Through the fall of 2003, possible additional leaks in the line were investigated, but no additional leaks have been found.

The radwaste line leak, identified and repaired in May 2003, is suspected of being the primary source of tritium. A portion of the tritium originating from the leak location has migrated toward the south leg of the French drain system along preferential pathways associated with the assumed relatively permeable bedding material surrounding the subsurface infrastructure piping. Another portion of the tritium plume originating from the leak appears to follow major subsurface lines toward the Tennessee River. Again, this directional behavior is likely associated with preferential groundwater movement associated with the higher permeability bedding material surrounding subsurface piping.

When WBN was constructed, engineered fill was placed over a majority of the Site. The tighter hydraulic properties make the fill more difficult for groundwater to flow through than the gravel packs surrounding the numerous pipe systems associated with facility infrastructure. Tritium migration toward the Turbine Building appears to be influenced by the south Condenser Cooling Water (CCW) discharge line running from the Turbine Building to the Unit 1 Cooling Tower. Tritium migration toward the river is strongly influenced by the Cooling Tower Blowdown Line, Waste Heat Park Lines, and other piping infrastructure, as their position within the subsurface is coincident with the groundwater table along portions of their length. Based on calculations of tritium in the south leg of the French drain, it is likely that a majority of the activity resides within the more permeable gravel packs of the discharge CCW Line and Raw Cooling Water Lines, because it cannot be fully accounted for with tritium observed in groundwater monitor wells. A majority of the groundwater monitor wells have shown decreasing concentrations of tritium, indicating that the primary source has been eliminated.

Source #1 is partially controlled by inducing groundwater flow to the plant buildings by the French drain and actively pumping the groundwater sump. This sump discharge is monitored as part of the plant effluent monitoring program. Repairs to the leaking radwaste line, followed by installation of a new radwaste line have eliminated tritium being introduced into the surrounding groundwater via this source. Tritium levels in, and migration of, the existing plume is being monitored.

Source #2 – Unit 2 Fuel Transfer Tube Seismic Gap

In February 2003, it was identified that water was leaking into the Unit 2 Shield Building annulus, through the Unit 2 FTT sleeve connection between the Auxiliary Building and Unit 2 Shield Building. A 1-inch seismic gap exists between the Auxiliary Building and Unit 2 Shield Building where the FTT passes through these buildings (Figure 1). Tritiated water, between the steel tube (20-inch diameter) and the concrete building, was observed flowing into the Unit 2 Shield Building annulus in February 2003. This water must flow across the seismic gap to get from the Auxiliary Building to the Unit 2 Shield Building, which provides a pathway to groundwater. This gap is filled with fiberglass and is glued on one side to the Unit 2 Shield Building. Potentially, water from the SFP, CLP, or FTC that has leaked behind the stainless-steel liner could migrate to the Unit 2 FTT sleeve.

Leaks through the FTT sleeve and seismic gap have resulted in groundwater impact surrounding the Unit 2 Shield Building (Attachment 2). The difference in potential head between the bottom of the FTT sleeve and the French drain directly north of the seismic gap is approximately 1.25 feet, indicating that water would flow toward the French drain from this point (either to the north or to the east). Calculations using the tritium concentrations in these areas of nearly 100 million pCi/L indicate it would take only a small volume of tritiated water to result in the concentrations being observed in the north leg of the French drain, and in groundwater monitoring points around the Unit 2 Shield Building.

Source #2 is completely contained by the French drain and actively pumping the groundwater sump. The plume around the Unit 2 Shield Building remains focused and contained, and no additional remedial actions are needed.

G. WELL D INCREASED LEVELS – FEBRUARY 2005

In February 2005 monitoring of groundwater quality revealed a significant increase of tritium concentration in well D. This well is located in a down gradient position between the Yard Holding Pond (YHP) and the Intake Pump Station (IPS) for the facility. Historical concentrations of tritium in well D had averaged approximately 5000 pico curries per liter (pCi/L), with concentrations in late January 2005 increasing abruptly to 550,000 pCi/L.

In response to the increased levels in Well D, groundwater data has been collected from various wells, including a snapshot data set of groundwater quality and water levels to evaluate the tritium concentration in well D within the broader context of site conditions. Additionally, the frequency of samples from Well D was increased in order to monitor any further changes.

TVA investigated possible sources of the tritium, and discovered and subsequently repaired a leak at the connection of the temporary radwaste line with the permanent stainless steel radwaste line. ARCADIS, Inc., who conducted the initial groundwater investigation, was retained to assist in the investigation.

TVA and ARCADIS evaluated newly collected data to determine whether additional leaks are present that contribute to the tritium discovered at well D. This investigation was targeted to determine whether a leak is present, or whether the existing tritium plume has migrated and is the cause of down gradient impact. The analysis of the data led the team to suspect that a new leak may have been present in the discharge line (in the Cooling Tower Blowdown Line downstream of the liquid effluent line tie-in) in a down gradient position, in addition to a contribution that occurred from a connection leak that was found and repaired in the temporary Radwaste line.

During the week of 02/28/2005, the discharge line was isolated and the pipe inspected. In general, the condition of the line is good with no apparent leaks. Following inspection, TVA consulted with ARCADIS, who had the following assessment of the Well D situation:

- From the description of the pipe, a large leak from the line is not likely. Buta leak in the line can not be completely ruled out as a contributor to the increases.
- The increases could be from movement of previous plume along the path of the discharge line.
- Based on review of additional data, the only correlation that can be made between Well D increases and plant discharges is the one sample on February 14
- No direct correlations could be made between Well D increases and either discharge flowrate or yard pond levels

Based on inspections of the pipe and review of data collected, it was decided to clean and seal the 48" and 72" concrete joints from the carbon steel/concrete joint (northwest of the IPS) to the tee of the line to the Yard Pond using Prime Gel 2200 Flexible Adhesive.

With the exception of one spike in Well D activity on February 15th, the trend of well D tritium has been generally and steadily declining. It is felt that the leak from the temporary hose nor the plant effluent line are likely sources of the increased levels in well D. The most likely source of the increase is the natural movement of the plume containing tritiated groundwater from the previous radwaste line leak that was isolated in 2004.

Subsequent to the investigation of well D, increases in tritium levels in well B have been observed and well D has continued to decrease. Well B is the next welldown gradient of well D along the discharge line. This is consistent with the conclusion that the plume caused by the 2003 leaking radwaste line is moving along the path of the discharge line. It is expected that Well A will eventually show increased levels of tritium as the plume moves towards the river. Any tritium released to the river when the plume migrates that far will have been already accounted for in the total plant releases, since they were monitored as part of the normal plant effluent release monitoring program prior to release into the leaking plant liquid effluent line

H. SUMMARY OF ACTIONS

A number of actions have been taken to better understand the extent of the tritium in the groundwater at WBN, including retaining ARCADIS to assist in the investigation and analyze data to help determine extent and characteristics of the tritiated groundwater. Additionally, several corrective actions to plant equipment have been taken. Data indicates that actions to reduce or eliminate the two sources of tritium have been effective. Groundwater will continue to be monitored to assess the concentrations of tritium, and actions will be taken as required to address identified problems or issues. A summary of actions taken to date is listed below.

Fuel Transfer Canal (FTC) - Drained and cleaned the canal to allow detailed inspection. Inspection included not only seam welds, but U1 bellows area. Fuel Transfer Canal liner has been coated

Liquid Effluent Line – Isolated the leaking radwaste line and provided a temporary path from plant buildings to plant discharge (CTBD) line. Permanently replaced the leaking line with a new liquid effluent line that was placed in service in May 2005.

Groundwater Sump (GWS) – The Groundwater Sump discharge was temporarily routed to the station sump where discharges are monitored. The Groundwater Sump discharge was subsequently returned to the catch basin system and was added to the plant's list of monitored release points.

Refueling Water Storage Tank - Investigated level loss. Repaired identified leaking valves. Installed wells near foundation of the tank to determine if the tank itself is leaking. Evaporation calculations revealed that level loss likely due to evaporation.

SFP and Cask Loading Areas - Developed necessary level measuring techniques to determine if there was a level loss other than evaporation. Level loss likely to be from evaporation.

Contact other utilities and outside organizations - Contacted other utilities with similar issues. Also, outside firms with experience were utilized as necessary.

Cooling Tower Blowdown Line- Inspected line for leaks during spring 2005 outage. No leaks were identified but sealed joints in concrete pipe as a preventative measure.

French Drain Sump

Bellows

SFP T - Canal:

H-3

Peak Jan 2000

13,000 pCi/l

Tell-Tales:

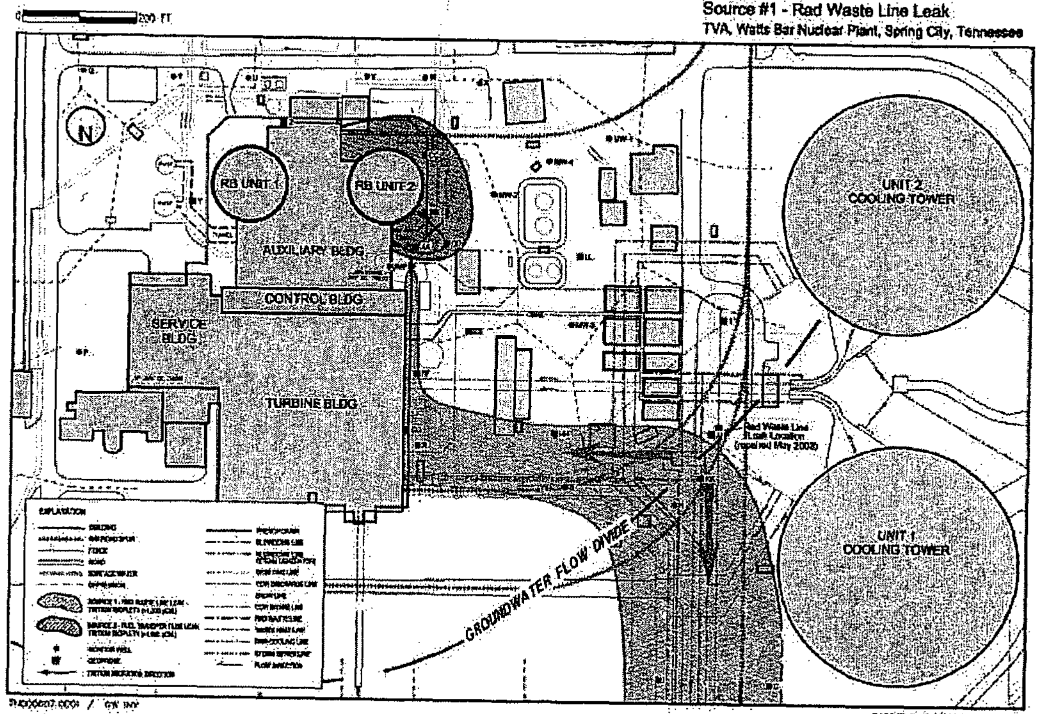
Will Hydrolaze -

Geoprobes

1,500 pCi/l

ARCADIS

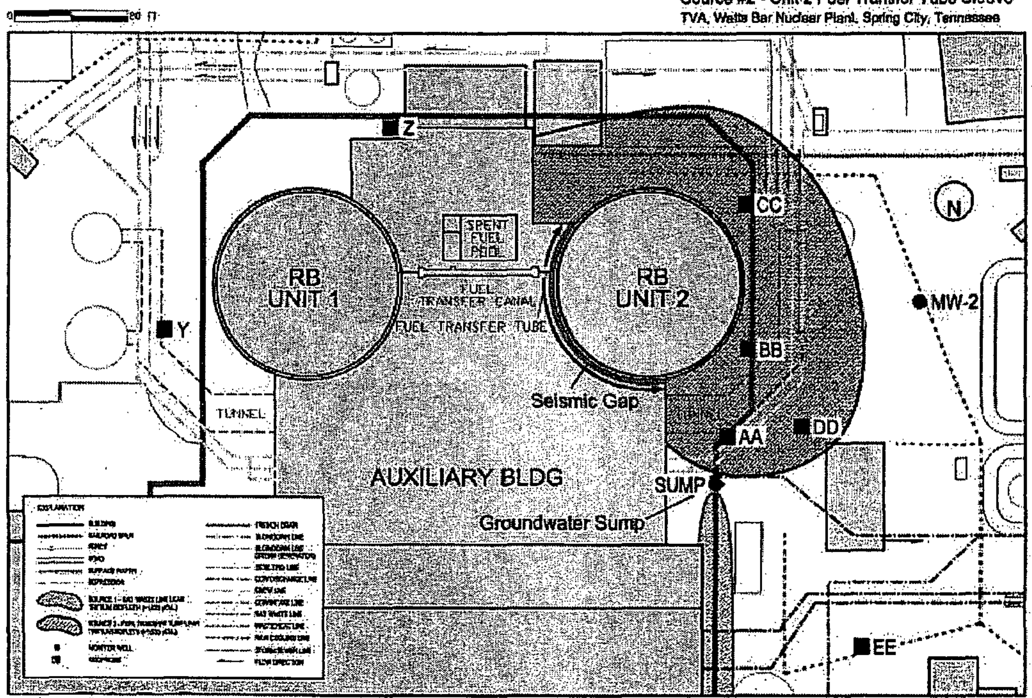
Figure 4-1
Source #1 - Rad Waste Line Leak
TVA, Watts Bar Nuclear Plant, Spring City, Tennessee



Attachment 1

ARCADIS

Figure 4-2
Source #2 - Unit 2 Fuel Transfer Tube Sleeve
TVA, Watts Bar Nuclear Plant, Spring City, Tennessee



Attachment 2