

THE TENNESSEE VALLEY AUTHORITY



# Clinch River Small Modular Reactor Site

## Groundwater Quality Monitoring Report

Anna B. Fisher

Revision 0 – 04/02/2015

Revision 1 - 04/20/2015

**This study has been prepared as a supporting document for the Clinch River Small Modular Reactor Site (CR SMR) Construction Permit Application Project and is being distributed for project use. The study provides a summary of documented groundwater quality present in CR SMR study area in Roane County, TN.**

**NOTICE** This electronic message transmission contains information which may be TVA SENSITIVE, TVA RESTRICTED, or TVA CONFIDENTIAL. Any misuse or unauthorized disclosure can result in both civil and criminal penalties.

## INTRODUCTION

The Tennessee Valley Authority (TVA) is investigating the feasibility of constructing modular nuclear reactors at the Clinch River Site (Site), in Roane County, Tennessee. The Site is approximately 5 miles east of the town of Kingston, TN, and approximately four river miles downstream of Melton Hill Dam.

To support the evaluation of the suitability of the Small Modular Reactor (SMR) site, TVA is monitoring groundwater to characterize the resources at the SMR site. A detailed and thorough description of the chemical monitoring is essential for the evaluation of potential impacts to the environment that may result from plant, construction or operation. Adequate monitoring (baseline and operational) is generally a prerequisite for the Environmental Review required for licensing and Environmental Impact Statement required by the National Environmental Policy Act (NEPA). The data will provide information to determine existing conditions for groundwater and will help TVA to determine the potential for direct, indirect, and cumulative effects from operating a small modular reactor at the Clinch River site.

The Site is bounded by the Oak Ridge Reservation (ORR). There are numerous issues concerning groundwater on the Site due to its proximity to the ORR. A conservative approach to characterizing the site will be taken to build a baseline and to answer questions that could arise based on the legacy contaminants that are associated with the neighboring Superfund site. The initial baseline sampling included sampling groundwater for laboratory analyses, performing field analyses, determining flow values, and observing visual characteristics of the groundwater. Figure 1 shows the Clinch River site with respect to the ORR site areas.

The ORR is currently on the National Priorities List (NPL) maintained by USEPA. The Department of Energy (DOE) is the responsible federal agency. Numerous contaminants are, or have been, present at the site. Types of contaminants include: base neutral acids, inorganics, metals, PAH, PCBs, persistent organic pollutants, pesticides, radioactive, and VOC. Oak Ridge is fairly large and complicated consisting of three main areas as seen on Figure 1: the Y-12 Complex, the East Tennessee Technology Park, and Oak Ridge National Laboratory. The cleanup process is ongoing and is expected to continue for some time.

Historical monitoring for groundwater quality at ORR have shown four primary contaminants at the Y-12 Complex: nitrate, VOCs, metals (arsenic, barium, cadmium, chromium, mercury), and radionuclides (Uranium and Tc99). The primary contaminants at the East Tennessee Technology Park at ORR have been identified as VOCs (tetrachloroethene (PCE), TCE, and 1,1-dichloroethane (1,1-DCA) and also historically chromium was detected. The Oak Ridge National Laboratory area has several site-related contaminants historically and intermittently detected in groundwater near the Clinch River including Sr90, tritium, uranium, and VOCs (DOE 2014). Groundwater monitoring, assessment and corrective action are ongoing at all the ORR sites. The proximity of the ORR plumes and the Clinch River site is shown on Figure 2, which is underlain by the geologic map of the region.

The data collection presented herein contains the preapplication monitoring program data as prescribed by the NRC preclicensing environmental review. The data are needed on a seasonal basis, and should be sufficient to characterize seasonal variations of groundwater throughout an annual cycle. Samples were collected quarterly for the past year.

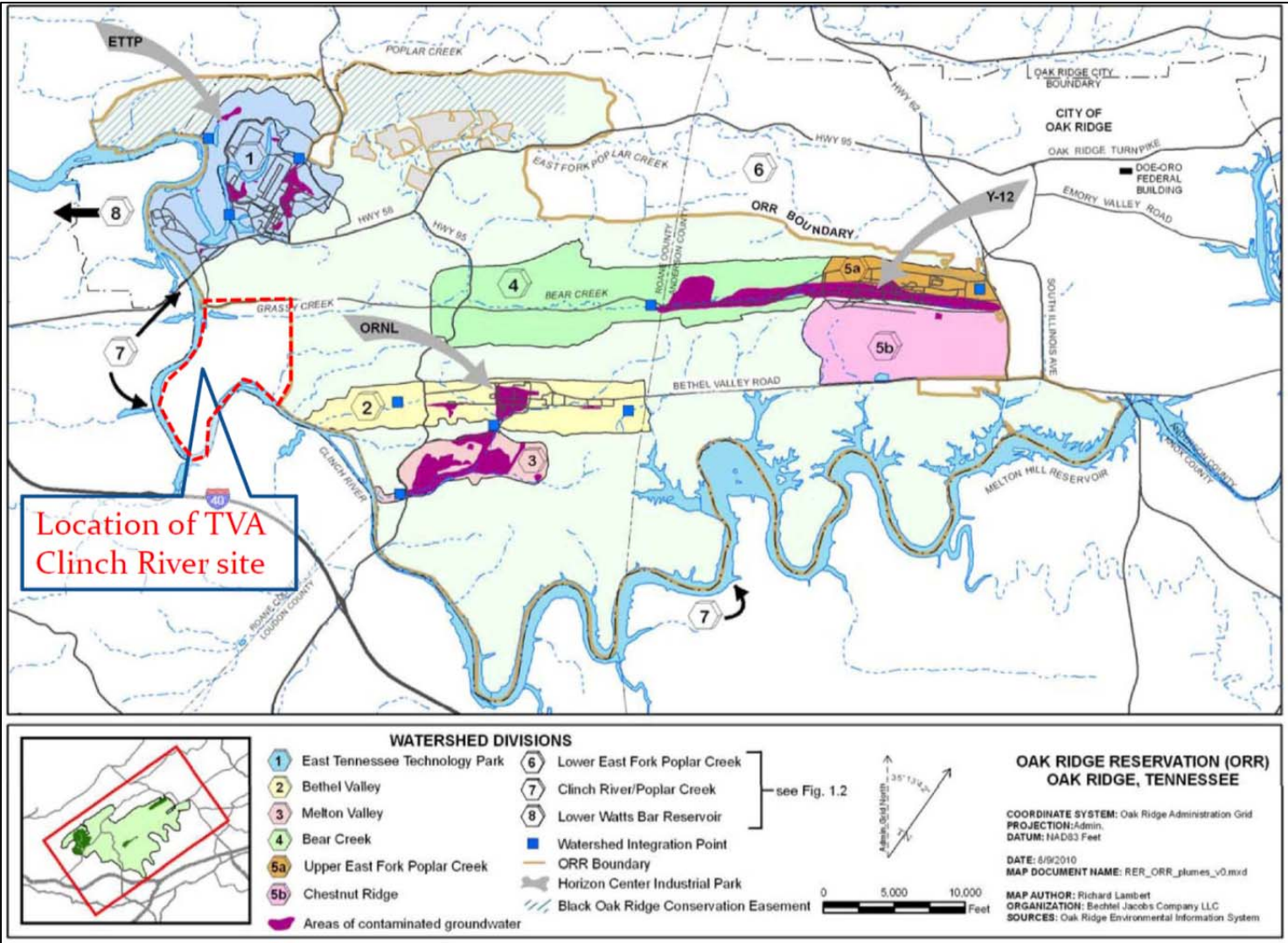


Figure 1: Location of Clinch River Site with respect to the Oak Ridge Reservation areas.

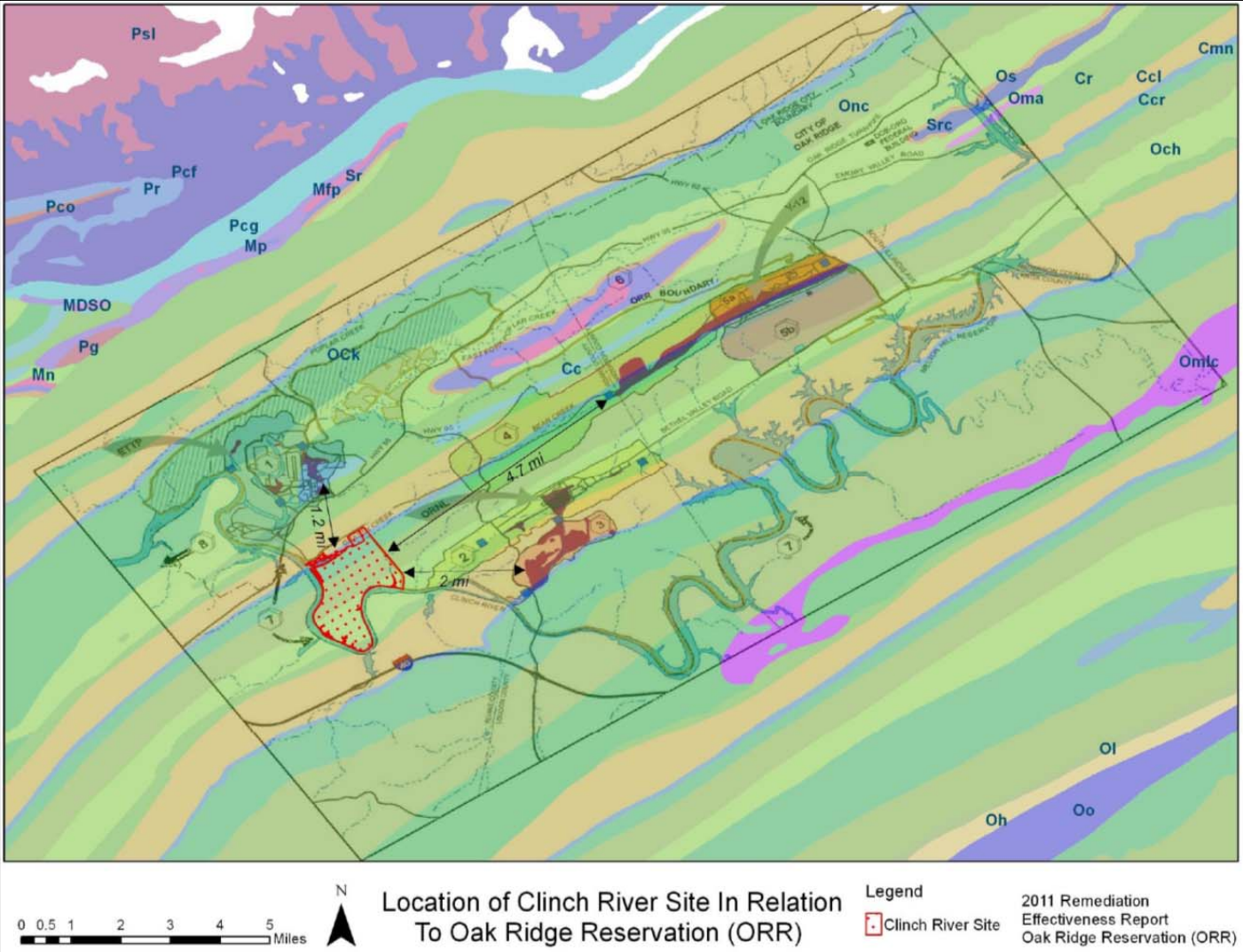


Figure 2: Proximity of TVA Clinch River Site to ORR plumes.

## MONITORING NETWORK

Groundwater sampling was conducted on a quarterly basis to satisfy requirements for the preapplication monitoring program. Sample events were performed in December 2013-January 2014, April 2014, August 2014, and November 2014. In fall of 2013, thirty-seven observation wells were installed, consisting of fifteen clusters of 2 to 3-wells each. Each cluster consists of an upper and lower well, with some clusters containing an additional deep well. Twenty-one wells listed in Table 1 were initially chosen as the groundwater monitoring wells. These wells are contained within nine of the fifteen clusters that are distributed around the area of the construction footprint. Table 1 also provides a summary of installation details, and copies of the well logs are presented in Appendix A. The well locations at the Site can be seen on Figure 3.

Sampling for the first quarter occurred on December 10, 2013, to January 13, 2014. Well CRS-OW420U did not have enough water to purge properly or perform field analysis. Laboratory samples were collected, but may be biased from high turbidity and the underdeveloped well conditions. Well CRS-OW429L also did not produce enough water to purge properly and also did not recharge after purging. This well was not sampled for field or laboratory analysis. Wells CRS-OW428D, OW428L, OW420U, OW419L, and OW401L all exhibited high turbidity readings.

Second quarter sampling occurred on April 15-24, 2014. Again, well CRS-OW420U did not have enough water to purge properly or perform field analysis. Some laboratory samples were collected, but may be biased from high turbidity and the underdeveloped well conditions. Well CRS-OW429L also did not produce enough water to purge properly, was not sampled for field analysis, but laboratory samples were collected, but may be biased from high turbidity and the underdeveloped well conditions. Wells CRS-OW401U, OW401L, OW416U, OW420U, OW428L, OW428D, and OW429L all exhibited high turbidity readings.

Third quarter sampling occurred on August 18-27, 2014. Similar to previous events, well CRS-OW420U was only able to be sampled for laboratory parameters. CRS-OW429L was removed from the sampling plan due to previous performance. Wells CRS-OW401L, OW401D, OW416U, OW420U, OW421U, OW421D, and OW428D all exhibited high turbidity readings.

Fourth quarter sampling occurred on November 4-12, 2014. Wells CRS-OW420U and 429L were both removed from the sampling plan due to previous poor sampling conditions. Wells CRS-OW421U, OW419L, OW416U, OW401L, and OW401U all exhibited high turbidity readings.

# Groundwater Quality Monitoring Report

TVA Clinch River Site

**Table 1: Monitoring well construction installation Information.**

| Observation Well ID | Formation            | Ground Surface Elevation<br>(ft NAVD88) | Top of Casing Elevation<br>(ft NAVD88) | State Plane Coord. |                    | Diameter<br>(inches) | Well Casing Schedule | Elevation Filter Pack |                       | Elevation Well Screen |                       | Well Depth<br>(ftbgs) |
|---------------------|----------------------|---|--|--------------------|--------------------|----------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|                     |                      |   |  | Northing<br>(feet) | Eastings<br>(feet) |                      |                      | Top<br>(ft NAVD88)    | Bottom<br>(ft NAVD88) | Top<br>(ft NAVD88)    | Bottom<br>(ft NAVD88) |                       |
|                     |                      |   |  | OW-401U            | Newala             |                      |                      | 817.39                | 820.48                | 571967.9              | 2447620               |                       |
| OW-401L             | Newala               | 817.22                                  | 820.57                                 | 571973.8           | 2447628            | 2                    | 80                   | 686.4                 | 657.9                 | 682                   | 662                   | 159.3                 |
| OW-401D             | Newala               | 818.17                                  | 821.28                                 | 571941.2           | 2447590            | 2                    | 80                   | 596.3                 | 566.5                 | 591.6                 | 571.6                 | 251.7                 |
| OW-415U             | Bowen/<br>Benbolt    | 784.13                                  | 787.22                                 | 569590.2           | 2448180            | 2                    | 40                   | 760                   | 733                   | 756                   | 736                   | 51.1                  |
| OW-415L             | Benbolt              | 783.65                                  | 786.75                                 | 569564.4           | 2448148            | 2                    | 80                   | 631.8                 | 606.3                 | 628.8                 | 608.8                 | 177.4                 |
| OW-416U             | Rockdell             | 809.54                                  | 812.82                                 | 569990             | 2447536            | 2                    | 40                   | 737.7                 | 712                   | 734.1                 | 714.1                 | 97.5                  |
| OW-416L             | Rockdell             | 809.43                                  | 812.73                                 | 569965.2           | 2447505            | 2                    | 40                   | 701.8                 | 676.4                 | 698.8                 | 678.8                 | 133                   |
| OW-418U             | Eidson               | 810.01                                  | 812.94                                 | 570526.8           | 2447065            | 2                    | 40                   | 719.9                 | 702                   | 715                   | 705                   | 108                   |
| OW-418L             | Blackford            | 811.44                                  | 814.41                                 | 570506             | 2447039            | 2                    | 80                   | 677.8                 | 651.4                 | 674.6                 | 654.6                 | 160                   |
| OW-419U             | Newala               | 799.98                                  | 803.13                                 | 571283.4           | 2446716            | 2                    | 40                   | 745.6                 | 720.4                 | 742.8                 | 722.8                 | 79.6                  |
| OW-419L             | Newala               | 799.75                                  | 802.72                                 | 571257.7           | 2446683            | 2                    | 40                   | 698.8                 | 673.3                 | 695.3                 | 675.3                 | 126.5                 |
| OW-420U             | Newala               | 802.85                                  | 805.7                                  | 572009.6           | 2446886            | 2                    | 40                   | 781.7                 | 754.4                 | 776.9                 | 756.9                 | 48.5                  |
| OW-420L             | Newala               | 803.07                                  | 806.15                                 | 572021.1           | 2446902            | 2                    | 40                   | 675.7                 | 650.7                 | 672.2                 | 652.2                 | 152.4                 |
| OW-421U             | Blackford            | 805.36                                  | 808.27                                 | 570557.7           | 2446472            | 2                    | 40                   | 754                   | 727.4                 | 750.4                 | 730.4                 | 78                    |
| OW-421L             | Blackford/<br>Newala | 804.78                                  | 807.81                                 | 570544.2           | 2446456            | 2                    | 40                   | 703.8                 | 676.8                 | 700                   | 680                   | 128                   |
| OW-421D             | Newala               | 802.49                                  | 805.2                                  | 570520.1           | 2446424            | 2                    | 80                   | 629.7                 | 604.5                 | 626.8                 | 606.8                 | 198                   |
| OW-428U             | Rockdell             | 804.33                                  | 807.78                                 | 570781.4           | 2448711            | 2                    | 40                   | 769.9                 | 741.3                 | 763.9                 | 743.9                 | 63                    |
| OW-428L             | Rockdell             | 803.86                                  | 807.06                                 | 570767.9           | 2448697            | 2                    | 40                   | 693.7                 | 665.9                 | 688.7                 | 668.7                 | 138                   |
| OW-428D             | Rockdell             | 803.73                                  | 807.03                                 | 570741.9           | 2448667            | 2                    | 80                   | 618.5                 | 590.7                 | 613.5                 | 593.5                 | 213                   |
| OW-429U             | Benbolt              | 796.21                                  | 799.17                                 | 569989.1           | 2448606            | 2                    | 40                   | 764.4                 | 736.2                 | 759.4                 | 739.4                 | 60                    |
| OW-429L             | Benbolt              | 796.26                                  | 799.49                                 | 569965.3           | 2448577            | 2                    | 80                   | 656.2                 | 628.3                 | 651.2                 | 631.2                 | 168                   |



Figure 3: Clinch River Site Groundwater Monitoring Wells

## WELL CLUSTER 422

As a part of the initial subsurface investigation on the Site, 3 observation wells - OW-422L, OW-422D and OW-422U - were drilled during the first week in August 2013. When well OW-422L was drilled, the drillers commented on a faint petroleum odor. On the morning of Thursday, August 15, 2013, the OW-422 well cluster was scheduled to be developed. As the subcontractor (AMEC) approached OW-422L, they noticed that the cap was slightly bulged outward, indicating some pressurization. Upon removing the cap, there was a distinct, strong petroleum odor. An absorbent cloth was lowered into the well and a sample was removed. The sample was clearly petroleum based and a bright yellow.

TVA environmental sampling personnel were on site the morning of Friday Aug. 16, 2013 to take a sample from the well and send it to the laboratory. Results from laboratory analysis were received on August 21 and showed that the product is likely a mixture of gasoline and diesel. As a precaution, a sample was also screened for radioactive material. The result was no radioactive material was detected. Additional sampling took place on Friday Aug. 16, 2013. Laboratory analysis included volatile organics, metals and petroleum derivatives, with gross alpha and gross beta from OW-422L.

On 08/23/2013, TVA personnel conducted a ground penetrating radar survey of the area around OW-422 to determine if there is an underground storage tank in the area. The results did not detect the presence of any type of underground tank or pipe in the vicinity of the OW-422 well cluster.

On Tuesday October 8, TVA staff accompanied by TDEC geologists performed another water and product level measurement at the 422L well, and collected additional samples for further analysis of both the product in the well and the water below the product. TDEC geologists recommended that TVA analyze the samples for some additional parameters such as Technetium 99, Strontium 90 and Tritium to try to obtain further information and assist in identifying the source of the contamination, and TVA staff recommended performing a gas chromatograph analysis of the product along with sodium and potassium. To collect enough product to meet sample volume requirements for analysis, TVA staff returned on Wednesday to collect additional product from the well along with the previously stored contaminant removed during previous sampling.

On 11/07/2013, TDEC/TVA collected what product we could for TDEC's PPID sample and TDEC used a bladder pump near the bottom of 422L to purge (all purge water was placed in a drum) then sample.

On 04/03/2014, Robert Bishop and Wesley White from the Tennessee Department of Environment and Conservation (TDEC) Department of Energy Oversight (DOE-O) Office met Katie Gassaway at the Tennessee Valley Authority (TVA) pump test location to sample OW422L at 0800. Once at OW422L, a measurement of the depth to product and depth to water from the top of casing (TOC) was performed. After measuring the initial water/product level, TDEC Department of Energy Oversight (TDEC DOE-O) staff collected the free product in the well. The method of collecting the free product was with a non-weighted bailer. Approximately one gallon of product was collected for analysis of strontium-89, strontium-90, technetium-99, thorium, uranium (isotopic), transuranics, and radium-224, -226, and -228. After, the initial free product was removed from the well. A new Teflon weighted bailer was used to collect the groundwater sample. On 04/09/2014 Department of Energy and their contractor (RSI) sampled 422D and 422L for VOAs, metals, and radioactivity. TDEC nor DOE indicated that the results of



any sampling correlated with ORR contaminants. The data collected from the various sampling events at the 422 cluster can be found in Appendix C.

On June 19, 2014 TVA met staff from DOE to remove well pumps from the 422 wells that they left in place to support anticipated additional sampling after completion of the aquifer pump test. DOE has opted not to collect any additional samples, therefore, once the pumps are removed there was no additional sampling or other activities at the three 422 wells. The SMR Project has no plans to perform any additional work at the 422 wells – the data they were intended to supply for the geological/groundwater work has been replaced by the 428 and 429 well clusters installed north and south of the 422 cluster.

It should be noted that no conclusive evidence or data was recovered to determine the source of the contamination in the 422 cluster. It is possible, however remotely that the well was sabotaged, or that ORR contaminants made it to this well through geologic pathways and fractures. It is recommended that further analysis of the data or the wells be conducted to ensure the material did not originate from ORR before using this site for the TVA Clinch River Modular Reactor Project.

## **SAMPLING METHODS**

Groundwater samples were collected using a submersible bladder pump placed below the water level in the selected well, above the screen interval. For wells which exhibited low yields, disposable Teflon bailers were used to collect sample volumes. Field parameters (i.e., temperature, specific conductance, pH, dissolved oxygen, oxidation-reduction potential and turbidity) were monitored during well purging using a flow-through cell and calibrated instruments. Each well was considered properly evacuated when field parameters remained stable after purging a minimum of three well volumes or after purging standing water in the well. Field data sheets completed during well sampling are included in Appendix B. Following sample collection in a temporary field container, water from each well was transferred to new pre-labeled sample containers with appropriate preservatives (where applicable). Sample containers were then sealed, necessary data were recorded on a chain-of-custody form, and samples were placed in iced coolers for transport. The samples were sent to Test America - Nashville. Field analysis was monitored using a flow-through cell. All groundwater sampling was conducted in accordance with TVA's Technical Instructional document for Groundwater Sampling EMA-TI-05.80.42.

## **ANALYTICAL RESULTS**

The list of parameters analyzed to characterize the groundwater at the Site included:

- Volatile Organic Compounds (VOCs)
- Semivolatile Organic Compounds (SVOCs)
- Pesticides/PCBs
- Total Petroleum Hydrocarbons (TPH)
- Metals, Cyanide, and Radionuclides, including some isotopes
- Acid/Base/Neutral Compounds, including Polycyclic Aromatic hydrocarbons (PAH)
- Field water-quality parameters.

All analytical testing was conducted within recommended sample holding times. Equipment and field blanks indicated no contamination of the samples. The laboratory reports from Test

America are provided in Appendix C. A detailed list of parameters for field and the lab analysis can be seen with the summary of analytical results in Appendix D.

## **EVALUATION OF MONITORING DATA**

Various reference values were used to compare the groundwater quality data, including Maximum Contaminant Levels (MCL) set by the state and EPA regional screening levels. The summary in Appendix C shows that no MCLs were exceeded for any of the data, however, some reporting limits were actually above the MCL, even though results were non-detect. These parameters were highlighted in the table. It is recommended that future analysis methods be adjusted to obtain reporting limits below the MCL or relevant groundwater protection standards (GWPS)

With respect to historical parameters associated with the ORR, a few constituents were present at low levels. Nitrate was present at some wells, but at low levels. As previously stated, no metals were found above MCLs. No amount of arsenic, cadmium, or mercury was detected in any wells. Some wells show the presence of barium and chromium (wells CRS-OW401L and OW402U), but at low levels. Tc99 was detected in wells CRS-OW429U, OW421L and OW401D. Of the various VOCs of concern, tetrachloroethene, TCE, and 1,1-dichloroethane (1,1-DCA) were not detected in any wells. Low levels of chloroform were detected in some wells, but no other VOC's were found, besides what was found in the 422 well cluster. Small amounts of Sr90 were detected in wells CRS-OW401U, OW415L, OW416L, OW418L, and OW419U. Tritium radionuclides were detected at wells CRS-OW422D and OW428D. No detectable amounts of uranium were detected in any wells.

## REFERENCES

DOE 2014. *Oak Ridge Reservation Annual Site Environmental Report for 2013*. DOE/ORO-2473. Oak Ridge National Laboratory, US Department of Energy, Oak Ridge, Tennessee.