



Revision 1

HYDROGEOLOGIC INVESTIGATION REPORT

FLEETWIDE ASSESSMENT
LaSALLE GENERATING STATION
MARSEILLES, ILLINOIS

Prepared For:
Exelon Generation Company, LLC

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EXECUTIVE SUMMARY

This Hydrogeologic Investigation Report (HIR) documents the results of Conestoga-Rovers & Associates' (CRA's) May 2006 Hydrogeologic Investigation Work Plan (Work Plan) pertaining to the LaSalle County Station. CRA prepared this Hydrogeologic Investigation Report for Exelon Generation Company, LLC (Exelon) as part of its Fleetwide Program to determine whether groundwater at and in the vicinity of its nuclear power generating facilities has been adversely impacted by any releases of radionuclides.

CRA collected and analyzed information on historical releases, the structures, components, and areas of the Station that have the potential to release tritium or other radioactive liquids to the environment and past hydrogeologic investigations at the Station. CRA used this information, combined with its understanding of groundwater flow at the Station to identify the Areas for Further Evaluation (AFE) and sample locations for the Station.

CRA installed 13 new monitoring wells and five temporary sample points. CRA collected 20 groundwater samples and six surface water samples at the Station. CRA also collected a full round of water levels from the newly installed and existing wells and measured surface water levels. All groundwater and surface water samples were analyzed for tritium, strontium-89/90, and gamma-emitting radionuclides.

The results of the hydrogeologic investigation are as follows:

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective Lower Limits of Detection (LLDs) in any of the groundwater or surface water samples obtained and analyzed during the course of this investigation;
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 picoCuries per liter (pCi/L) in any of the groundwater or surface water samples obtained and analyzed during the course of this investigation;
- Tritium was not detected at concentrations greater than the United States Environmental Protection Agency drinking water standard of 20,000 pCi/L in any of the groundwater or surface water samples obtained during the course of this investigation;
- Low levels of tritium were detected at concentrations greater than the LLD of 200 pCi/L, which is considered background, but well below the applicable drinking water standard;

- Tritium was detected in a sample from one groundwater monitoring well (MW-LS-105S at $1,280 \pm 184$ pCi/L). The presence of tritium at this location was verified through re-sampling. Tritium was detected in the second groundwater sample from MW-LS-105S at 766 ± 153 pCi/L. The source of tritium in monitoring well MW-LS-105S is most likely from a historical release associated with the Cycled Condensate Storage Tank overflow in 2001. Samples obtained from adjacent monitoring wells and surface water locations revealed no detectable tritium levels. The tritium detected in MW-LS-105S is localized to the area of that well;
- Tritium was also detected in two surface water samples (SW-LS-101 and SW-LS-106 at 232 ± 116 pCi/L and 219 ± 113 pCi/L, respectively). SW-LS-106 was collected from the Intake Canal and SW-LS-101 was collected from the north storm water retention pond. The remaining surface water locations have tritium concentrations of less than the lower limit of detection (200 pCi/L). These detections are likely due to background surface water concentrations, since the Station pumps over 80 million gallons per day of Illinois River water into LaSalle Lake (surface water concentrations from the Illinois River range from non-detect at the lower limit of detection of 200 pCi/L to a high of 1,682 pCi/L);
- Based on the results of this investigation, tritium is not migrating off the Station property at detectable concentrations;
- Based on the results of this investigation, there is no current risk from exposure to radionuclides associated with licensed plant operations through any of the identified potential exposure pathways; and
- Based on the results of this investigation, there are no known active releases into the groundwater at the Station.

Based upon the information collected to date, CRA recommends that Exelon conduct periodic monitoring of selected sample locations.

1.0 INTRODUCTION

Conestoga-Rovers and Associates (CRA) prepared this Hydrogeologic Investigation Report (HIR) for Exelon Generation Company, LLC (Exelon) as part of its Fleetwide Program to determine whether groundwater at and near its nuclear power generating facilities has been adversely impacted by any release of radionuclides. This report documents the results of CRA's May 2006 Hydrogeologic Investigation Work Plan (Work Plan) as well as an additional investigative task recommended by CRA during the course of the investigation. These investigations pertain to Exelon's LaSalle County Generating Station (Station) in Marseilles, Illinois (see Figure 1.1). The Station is defined as all property, structures, systems, and components owned and operated by Exelon, LLC located at 2601 North 21st Road in rural Brookfield Township, LaSalle County, Marseilles, Illinois. The approximate property boundaries are depicted on Figure 1.2.

Pursuant to the Work Plan, CRA assessed groundwater quality at the Station in locations designated as Areas for Further Evaluation (AFE). The process by which CRA identified AFEs is discussed in Section 3.0 of this report.

The objectives of the Work Plan were to:

- characterize the geologic and hydrogeologic conditions at the Station including subsurface soil types, the presence or absence of confining layers, and the direction and rate of groundwater flow;
- characterize the groundwater/surface water interaction at the Station, including a determination of the surface water flow regime;
- evaluate groundwater quality at the Station including the vertical and horizontal extent, quantity, concentrations, and potential sources of tritium and other radionuclides in the groundwater, if any;
- define the probable sources of any radionuclides released at the Station;
- evaluate potential human, ecological, or environmental receptors of any radionuclides that might have been released to the groundwater; and
- evaluate whether interim response activities are warranted.

2.0 STATION DESCRIPTION

The following section presents a general summary of the Station location and definition, overview of Station operations, surrounding land use, and an overview of both regional and Station-specific topography, surface water features, geology, hydrogeology, and groundwater flow conditions. This section also presents an overview of groundwater use in the area.

2.1 STATION LOCATION

The Station consists of approximately 3,055 acres, of which approximately 7 acres are used for generating electricity. The remaining 2,981 acres of property encompass an approximate 2,058-acre cooling lake (LaSalle Lake) and the land associated with the blowdown and make-up water pipelines.

This report uses the following definitions:

- PA - the PA is the area contained within the perimeter fencing where the generating facilities, warehouses, training center, switchyard and other critical Station features are located; and
- Site - the Site includes the PA and the area immediately surrounding the PA within the perimeter vehicle barrier. The Site is approximately 7 acres.

2.2 OVERVIEW OF COOLING WATER OPERATIONS

The Station operates two boiling water reactors, design Type 5 (BWR-5) units manufactured by General Electric. The BWR-5 units are each capable of generating a net electrical output of 1,140 megawatts. Construction of the Station structures commenced in 1974 and both reactor units began commercial operation in 1984. The Station operates the two BWR-5 reactor units to generate power under Nuclear Regulatory Commission (NRC) Operating License Nos. NPF-11 and NPF-18, respectively. In addition to operating the two BWR-5 reactor units under the NRC licenses, the Station discharges wastewater and non-contact cooling water via eleven outfalls under its Illinois National Pollutant Discharge Elimination System (NPDES) Permit (IL 0048151).

The Station's BWR-5 Reactor Cooling Water System consists of two separate loops. Each loop is designed to avoid mixing the fluids of one loop with the fluids of another. The loops are called the primary loop and the secondary loop.

The primary loop transfers the energy generated from fission in the fuel to the turbine to produce electricity. It is a closed-loop system. A byproduct of the nuclear fission is heat. After passing through the steam turbines and transferring the kinetic energy of the steam to the turbine to produce electricity, the steam then passes into the Main Condenser. In the Main Condenser, the remaining heat energy of the steam is transferred to the Circulating Water System changing the steam back into water. The condensate water is then circulated back to the reactor core to start the cycle over again through the Feed Water Pumps.

The main purpose of the secondary loop cooling water is to cool the other side of the Main Condenser, cooling the primary loop steam and transferring the heat to the environment. Cooling water is pumped from the unlined Intake Canal from LaSalle Lake to the Main Condenser. After passing through the Main Condenser, the heated cooling water is then discharged back to LaSalle Lake through the Circulating Water (CW) Discharge Pipe. The CW discharges into the unlined Discharge Canal. The Discharge Canal is located on the west side of the Site and flows in a clockwise direction around the Site back to LaSalle Lake. There are two "baffle" berms located within LaSalle Lake to increase the flow pathway through the lake and increase the heat removal process. In addition, make-up water is pumped into LaSalle Lake from the Illinois River while blowdown water is gravity-discharged from LaSalle Lake back to the Illinois River.

The blowdown and make-up water lines aid in reducing the dissolved mineral concentration in the lake water, which increase due to evaporation and aids in the dissipating of heat energy. Make-up water to the lake is pumped from the Illinois River at a rate of approximately 55,800 gallons per minute (gpm) while blowdown water from LaSalle Lake is discharged back to the Illinois River at a rate of approximately 32,980 gpm. The Illinois River is approximately 5 miles to the north of the Station. The combination of the make-up and blowdown lines from the Illinois River along with the movement of water from LaSalle Lake through the Main Condenser and back into LaSalle Lake constitute the secondary loop.

In addition to the primary and secondary loops, there are a number of support systems, such as the Residual Heat Removal (RHR) heat exchangers, the High Pressure Core Spray (HPCS), the Low Pressure Core Spray (LPCS), and the Suppression Pool which are independent of the primary and secondary loops. The RHR Heat Exchangers remove decay heat and excess heat from the Suppression Pool. LaSalle Lake water is pumped through the RHR Heat Exchangers and discharged back to LaSalle Lake also through the Core Standby Cooling System (CSCS). The HPCS, LPCS and the

Suppression Pool use purified water that is generated through the Station's Demineralizer Systems.

Liquid radiological waste is processed through the Station's Demineralizer Systems prior to being discharged to the blowdown line. Discharge was previously completed on a batch process at a maximum flow rate of 45 gpm, dependant upon dilution calculations, under the authority of the Station's NPDES Permit and NRC Operating Licenses. The Station policy since December 2000 is not to discharge radioactively contaminated fluid into the Radwaste discharge pipe that feeds into the blowdown line.

2.3 SURROUNDING LAND USE

The land surrounding the Station to the north, east, west, and south is rural with farmland and wooded areas encompassing the greatest portion of the area immediately surrounding the Station. The blowdown and make-up pipelines are on an irregularly shaped narrow portion of land that extends northward from the Site to the Illinois River (Figure 1.2). To the east of this portion of land there are rural farms and residences. To the west of this portion of land there are also farms and residences along with the Marseilles State Fish and Wildlife Area and the Illinois National Guard Training Area. The closest town, Seneca, has a population of approximately 2,000 people and is located approximately 4 miles to the north-northeast of the Site (Figure 1.2).

2.4 STATION SETTING

The following sections present a summary of the topography, surface water features, geology, hydrogeology, and groundwater flow conditions in the region surrounding the Station. The information was primarily gathered from Sections 2.4 and 2.5 of the LaSalle Station Updated Final Safety Analysis Report (UFSAR) Revision 15 dated April 2004. The main references UFSAR relies on are listed in Section 10.0 of this HIR. CRA checked and verified all UFSAR references that apply to this HIR.

2.4.1 TOPOGRAPHY AND SURFACE WATER FEATURES

The Station's location is presented on the LaSalle Mosaic, Illinois 7.5-minute United States Geological Service (USGS) topographic quadrangle map (see Figure 1.1). The LaSalle Mosaic is comprised of the USGS topographic quadrangle maps Marseilles-1994,

Ransom-1983, Kinsman-1983, and Seneca-1970; Photorevised 1980. The topography of the region is predominately flat farmland with little relief.

The topography at the Station is generally flat with a gentle slope to the west-southwest, while within the PA the land is generally flat and covered by paved areas, roadways, and parking lots. Further northward from the Site, along the Illinois River, topographic relief is much more pronounced, with a mixture of gently rolling areas, gradual and deep ravines and flatland. Moving northward from the Station to the Illinois River, the elevation changes abruptly at about 4,000 feet from the River, where it descends rapidly to the River valley. The plains of the River valley, in the area of the blowdown/make-up pipelines lie at an elevation of approximately 500 feet above mean sea level (AMSL) (Figure 1.1).

The predominant surface water features in the area of the Station are LaSalle Lake, the Station's storm water retention ponds and the Illinois River. LaSalle Lake is an unlined man-made lake lying immediately east of the Station covering an area of approximately 2,058 acres. The Lake was constructed to function as the cooling lake for the Station. The Lake varies in depth ranging from only a few feet in some areas to over 80 feet deep in other areas with an average depth of approximately 15 feet (UFSAR, Rev. 15, 2004).

The storm water retention ponds are located on the west side of the Station and receive storm water runoff from the PA. Storm water runoff from the PA is drained by a storm water system of surface ditches and underground piping, which discharge to an oil/water separator at the west side of the PA prior to entering the retention ponds. The cooling water discharge canal separates the two storm water retention ponds. The retention ponds discharge through a weir located at the northwest corner of the ponds into the cooling water discharge canal that is connected to LaSalle Lake located to the east of the Site.

The Illinois River is located approximately 5 miles north of the Station. The confluence of the Kankakee and Des Plaines Rivers, approximately 40 miles northwest of the Station near Joliet, Illinois forms the Illinois River. It flows west across northern Illinois at a rate of 12,600 cubic feet per second, eventually turning southwest and joining the Mississippi River near Grafton, Illinois. It is approximately 273 miles long and receives water from a 40,000 square mile drainage basin in central Illinois. The primary uses for the Illinois River are for transportation of bulk goods, recreation, sport fishing, and as a source of potable water (The Nature Conservancy, 2006).

2.4.2 GEOLOGY

LaSalle Station is located at the northern border of the Illinois Basin on the eastern flank of the LaSalle Anticlinal Belt, approximately 5 miles south of the Illinois River. Regional soil deposits in the Uplands portion of LaSalle Station consist predominantly of 120 to 200 feet or more of Pleistocene till resting on Pennsylvanian bedrock. Near the Illinois River valley, soil deposits consist of valley fill of the Ticona and Kempton Buried Bedrock Valleys (UFSAR, Rev. 15, 2004; Visocky et al., 1985).

The Station is between two minor folds at the northwest end of the LaSalle Anticlinal Belt, the Ransom Syncline and the Odell Anticline. Soil at the Site is generally Holocene to Wisconsinan in age, with minor amounts of Illinoian, Kansan, and pre-Kansan sediments reported in the area. Holocene sediments at the Site are primarily alluvium and colluvium along the Illinois River Valley ranging from less than 5 feet to approximately 25 feet in thickness. The Wisconsinan sediments are primarily glacial till (Wedron) and outwash deposits with minor amounts of loess, lacustrine, and ice-contact deposits, as well as some terrace gravels along the Illinois River (Visocky et al., 1985). Figure 2.1 provides a geologic cross-section for the region.

Excavation activities completed during the construction of LaSalle Station confirmed that the Site is entirely within the Yorkville Till Member of the Wedron Formation (Wedron Clay Till). Borings indicated scattered occurrences of small sand and gravel pockets through the Wedron Clay Till (UFSAR, Rev. 15, 2004).

The bedrock units at the Site include nearly flat-lying Pennsylvanian cyclotherm sequences (limestones, shales, sandstones, coals) unconformably overlying Ordovician limestones, shales, dolomites, and sandstones. These units are part of very gently dipping (less than 1 degree), broad folds related to the LaSalle Anticlinal Belt. The Pennsylvanian Carbondale Formation beneath is exposed in narrow strips along the bluffs of the Illinois River (William and Frye, 1970). Refer to Figures 2.2 and 2.3 for the relationships between the units.

2.4.3 HYDROGEOLOGY

At the Station's River Screen house, located approximately 4 miles north of the Site, the alluvial aquifer extends along the Illinois River and is bounded on the north by the River and on the south by the valley walls. The alluvial aquifer near the river screen house ranges in width from 3,500 to 4,800 feet. It is generally composed of two layers. The upper layer is alluvium and consists of silty clay or clayey silt overlain with organic

material. The lower layer is glacial outwash and consists of silty sand, gravelly sand, and sand and gravel mixtures. The thickness of the alluvial aquifer ranges from 0.9 to 37 feet, becoming thicker to the east with an average thickness of 16.7 feet. This aquifer recharges by direct infiltration of precipitation and by inflow from the Illinois River. Groundwater discharge is directly to the river and to the underlying Pennsylvanian bedrock by slow seepage (Schicht et al., 1976, UFSAR, Rev. 15, 2004).

The glacial drift aquitard at the Station is composed of relatively impermeable Wedron Formation silty clay or clay tills with discontinuous pockets of well-graded sand and gravel. The Wedron Clay Till ranges in thickness from 0 foot at the bedrock outcrops along the Illinois River Valley to over 200 feet in the upland portion of the Station (Figure 2.2). The Wedron Clay Till underlies the Site and continues northward along the blowdown/make-up water pipelines until reaching the Illinois River Valley where it has been removed through erosion. The discontinuous pockets of well-graded sand and gravel within the Wedron Clay Till contain groundwater, and groundwater occurs predominantly under water table conditions, but occasionally as artesian conditions. The permeable zones are recharged by slow infiltration of precipitation through the tills, while discharge is controlled under gravity flow into nearby river or stream valleys, underlying bedrock, to glaciofluvial deposits of the buried bedrock valley aquifers, or to pumping wells. The glacial drift aquitard at the Station is also recharged through seepage from LaSalle Lake, the Station intake and discharge canals, the storm water retention ponds as well as groundwater beneath the Station lying on top of the Wedron Formation (Arnold et al., 1999; UFSAR, Rev. 15, 2004).

The underlying Pennsylvanian aquitard consists of alternating beds of shale, siltstone, underclay, sandstone, limestone, coal, and many gradational units. Beneath the Station, the Pennsylvanian aquitard is approximately 180 feet in thickness and groundwater occurs under artesian conditions. Recharge to the Pennsylvanian aquitard is through seepage through the overlying shales and glacial drift (Figure 2.3) (Visocky et al., 1985).

Underlying the Pennsylvanian aquitard is the Cambrian-Ordovician Aquifer. The Cambrian-Ordovician Aquifer consists of various stratigraphic units of dolomite, limestone, and sandstone. Public groundwater use within 10 miles of the Station is obtained primarily from the lower Cambrian-Ordovician Aquifer (Visocky et al., 1985).

The buried bedrock valley aquifers consist of sand and gravel fill within valleys cut into the Pennsylvanian bedrock, mainly the east-west trending Ticona Bedrock Valley. Recharge is primarily by seepage through the overlying clayey Wedron Clay Tills (Schicht et al., 1976).

2.5 AREA GROUNDWATER USE

Water supplies for the municipalities of Seneca (4 miles northeast of the Station), Kinsman (6 miles southeast of the Station), Marseilles (6 miles northwest of the Station) and Illinois State Park (5 miles northwest of the Station) are taken directly from the Cambrian-Ordovician Aquifer. The municipality of Ransom (6 miles south of the Station) withdraws groundwater from both the Pennsylvanian aquitard and the Cambrian-Ordovician Aquifer. Grand Ridge (9 miles west of the Station) is the only municipality within 10 miles of the Station that withdraws groundwater from the glaciofluvial deposits of the buried Ticona Bedrock Valley. Residents of the surrounding rural areas and smaller communities not served by these public water supplies obtain groundwater from individual wells in the glacial drift, Pennsylvanian aquitard, glaciofluvial deposits of the buried Ticona Bedrock Valley, and the upper portions of the Cambrian-Ordovician Aquifer (UFSAR, Rev. 15, 2004).

The alluvial aquifer is generally less than 25 feet in thickness and is recharged through direct infiltration of precipitation and recharge from the Illinois River. The average pumping rate of the alluvial aquifer is 5,680 gpm (UFSAR, Rev. 15, 2004).

The glacial drift aquitard, which is in the Wedron Clay Till, is present throughout the regional area and ranges in thickness from 0 foot near the bedrock outcrops of the Illinois River valley to over 200 feet thick near the Station. The glacial drift aquitard consists predominantly of silty clay tills. LaSalle Station and the Site are underlain by the glacial drift aquitard. Typical permeabilities are 1.0×10^{-07} centimeters per second (cm/sec). Well yields from the glacial drift aquitard range between 2.5 gpm and 15 gpm (UFSAR, Rev. 15, 2004).

The glacial drift aquitard is underlain by Pennsylvanian bedrock composed of siltstone, shale, sandstone, clay, limestone, and coal. The Pennsylvanian strata may locally yield up to 20 gpm from the interbedded sandstones. Beneath the Pennsylvanian bedrock is the Cambrian-Ordovician aquifer, which is composed of a number of dolomite, limestone and sandstone strata. Water supply wells completed in this aquifer are at depths of over 400 feet below ground surface (bgs) and typically produce over 700 gpm. The Station's deep Well No. 1 and Well No. 2 are completed in the Ironton-Galesville Sandstone at a depth of approximately 1,600 feet bgs (Visocky et al., 1985; UFSAR, Rev. 15, 2004).

CRA requested a search of the Illinois Department of Natural Resources State Water Survey (IDNR SWS, 2006) and the Illinois State Geological Survey (ISGS, 2006) database

to identify wells within a 1-mile radius of the property line of the Station. As a result of the database search, 506 domestic, commercial and industrial wells were identified within a 2-mile distance from the Station property boundary. Figure 2.4 depicts the approximate location of the water wells identified in the database search. Information obtained from the IDNR SWS and ISGS database is in Appendix A along with a summary table of the information.

Residences located within an approximate 1-mile radius of the Station use groundwater for potable water supplies as well as irrigation and consumption by livestock. The wells are constructed in the overburden and bedrock and range in depth from approximately 10 feet bgs to over 1,600 feet bgs. The wells identified in the water well reports have not been field verified and it is expected, based on the dates of installation for some of the wells, that many of the wells listed have been abandoned.

3.0 AREAS FOR FURTHER EVALUATION

CRA considered all Station operations in assessing groundwater quality at the Station. During this process, CRA identified areas at the Station that warranted further evaluation or "AFEs". This section discusses the process by which AFEs were selected.

CRA's identification of AFEs involved the following components:

- Station inspection on March 22 and 23, 2006;
- interviews with Station personnel;
- evaluation of Station systems;
- investigation of confirmed and unconfirmed releases of radionuclides; and
- review of previous Station investigations.

CRA analyzed the information collected from these components combined with information obtained from CRA's study of hydrogeologic conditions at the Station to identify those areas where groundwater potentially could be impacted from operations at the Station.

CRA then designed an investigation to determine whether any confirmed or potential releases or any other release of radionuclides adversely affected groundwater. This entailed evaluating whether existing Station groundwater monitoring systems were sufficient to assess the groundwater quality at the AFEs. If the systems were not sufficient to adequately investigate groundwater quality associated with any AFE, additional monitoring wells were installed by CRA.

The following sections describe the above considerations and the identification of AFEs. The results of CRA's investigation are discussed in Section 5.0.

3.1 SYSTEMS EVALUATIONS

Exelon launched an initiative to systematically assess the structures, systems and components that store, use, or convey potentially radioactively contaminated liquids. Maps depicting each of these systems were developed and provided to CRA for review. The locations of these systems are presented on Figures 3.1 and 3.2. The Station identified a total of 22 systems that contain or could contain potentially radioactively contaminated liquids. The following presents a list of these systems.

<i>System Identification</i>	<i>Description</i>
CSCS	Core Standby Cooling System
CW	Circulating Water
CY	Cycled Condensate Storage
DL	Laundry Drain Collector Sump
DR	Radwaste Building Floor Drains and Sump
DT	Units 1 and 2 Fire Sumps
HD	Feedwater Heater Drain Pumps
HPCS	High Pressure Core Spray
LAS	Surface Water Discharges
LPCS	Low Pressure Core Spray
MISC	Miscellaneous Releases
OG	Off-gas Building
RE	Reactor Building Equipment Drains
RF	Reactor Building Floor Drains
RH	Residual Heat Removal
RI	Reactor Core Isolation Cooling
ST/TW/STORM WATER	Sewage Treatment, Wastewater Treatment, Storm Water System
TE	Turbine Building Equipment Drains
TF	Turbine Building Floor Drain Sumps
TW	Wastewater Clarifiers
WE/WF/WX/WY/WZ	Equipment Drain Reprocessing Radwaste
WL	Blowdown and Make-up Pipelines

After these systems were identified, Exelon developed a list of the various structures, components and areas of the systems (e.g., piping, tanks, process equipment) that handle or could potentially handle any radioactively contaminated liquids. The structures, components, and areas may include:

- aboveground storage tanks;
- condensate vents;
- areas where confirmed or potential historical releases, spills or accidental discharges may have occurred;
- pipes;
- pools;
- sumps;
- surface water bodies (i.e., basins, pits, ponds, or lagoons);

- trenches;
- underground storage tanks; and
- vaults.

The Station then individually evaluated the various system components to determine the potential for any release of radioactively contaminated liquid to enter the environment. Each structure or identified component was evaluated against the following seven primary criteria:

- location of the component (i.e., basement or second floor of building);
- component construction material (i.e., stainless steel or steel tanks);
- construction methodologies (i.e., welded or mechanical pipe joints);
- concentration of radioactively contaminated liquid stored or conveyed;
- amount of radioactively contaminated liquid stored or conveyed;
- existing controls (i.e., containment and detection); and
- maintenance history.

System components, which were located inside a building or that otherwise had some form of secondary containment, such that a release of radioactively contaminated liquid would not be discharged directly to the environment, were eliminated from further evaluation. System components that are not located within buildings or did not have some other form of secondary containment were retained for further qualitative evaluation of the risk of a release of a radioactively contaminated liquid to the environment and the potential magnitude of any release.

Exelon's risk evaluation took into consideration factors such as:

- the potential concentration of radionuclides;
- the volume of liquid stored or managed;
- the probabilities of the systems actually containing radioactively contaminated liquid; and
- the potential for a release of radioactively contaminated liquid from the system component.

These factors were then used to rank the systems and system components according to the risk for a potential release of a radioactively contaminated liquid to the environment.

The evaluation process resulted in the identification of structures, components, and areas to be considered for further evaluation.

3.2 HISTORICAL RELEASES

CRA also reviewed information concerning confirmed or potential historical releases of radionuclides at the Station, including reports and documents previously prepared by Exelon and compiled for CRA's review. CRA evaluated this information in identifying the AFEs. Any historical releases identified during the course of this assessment that may have a current impact on Station conditions are further discussed in Section 3.4.

3.3 STATION INVESTIGATIONS

CRA considered previous Station investigations in the process of selecting the AFEs for the Station. This section presents a summary of the pre-operational radiological environmental monitoring program (pre-operational REMP), past Station investigations, and the radiological environmental monitoring program.

3.3.1 PRE-OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

A pre-operational REMP was conducted to establish background radioactivity levels prior to operation of the Station. The environmental media sampled and analyzed during the pre-operational REMP were surface water, rainwater, drinking water, direct radiation, air particulate, sediment, and vegetation and animal products. The results of the monitoring were detailed in the report entitled "Environmental Radiological Monitoring for LaSalle County Nuclear Power Station, Commonwealth Edison Company, Annual Report, 1981", March 1982.

Atmospheric radiation monitoring consisted of gas and air particulate radioactivity measurements. Gross beta radioactivity in air particulate samples collected from 14 locations ranged from 0.01 picoCuries/cubic meter (pCi/m³) to 0.61 pCi/m³ with an average of 0.11 pCi/m³.

Results of gamma isotopic analyses of quarterly composite of air particulate filters from each sampling location indicated the absence of any gamma-emitters above the detection limit of the program of 0.01 pCi/m³.

Surface water samples were collected from eight locations along the Illinois River, at Marseilles, Ottawa, Seneca, as well as Kickapoo Creek, the Illinois Nitrogen Corporation raw water, the Recreational Area Cooling Lake and the LaSalle County Station (LSCS) intake and discharge pipes. Samples were analyzed for gross beta, gamma-emitters, tritium, and strontium-89/90. None of the composite samples indicated the presence of other than naturally occurring gamma-emitters at a lower limit of detection (LLD) of 10 picoCuries/liter (pCi/L). No samples contained strontium-89/90 at a LLD of 10 pCi/L. Tritium concentrations were variable ranging from <200 pCi/L to 350 pCi/L. The gross beta analytical results in surface water samples were <10 pCi/L.

Drinking water samples were collected from an LSCS on-Site well and the following off-Site wells: Marseilles Well, Seneca Well, Ransom Well, Ottawa Well, and Illinois State Park Well. Gross beta analysis was performed on all samples. Gamma isotopic, radioactive strontium, and tritium analyses were conducted on the quarterly samples from the area wells and on a quarterly composite of monthly samples from the on-Site well. No unusual results were observed in analyses performed. However, several of the area wells had gross beta concentrations higher than that of nearby surface water. Samples taken which contained higher beta concentrations are indicative of the presence of slightly elevated concentrations of naturally occurring radionuclides in groundwater. Tritium concentrations in drinking water were variable, within the range of less than 200 pCi/L to 350 pCi/L. Gross beta analytical results in drinking water ranged from less than the LLD (1.6 pCi/L) to 22 pCi/L. In summary, the pre-operational REMP analytical results from samples collected from surface water and drinking water wells indicate that tritium was detected in both surface water and drinking water samples prior to Station operation.

Samples of precipitation were collected from four local farms on a monthly basis. All samples were analyzed for gross beta concentrations, and quarterly composites of monthly samples are analyzed for gamma-emitters, radioactive strontium, and tritium. No unusual findings were made except for the presence of strontium-89/90 in the composites for the second quarter. Presence of this isotope in the precipitation is attributable to the fallout from the nuclear test conducted on October 16, 1980 by the Peoples Republic of China.

3.3.2 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The REMP at the Station was initiated in 1982. The REMP includes the collection of multi-media samples including air, surface water, groundwater, fish, sediment, and vegetation. The samples are analyzed for beta and gamma-emitting radionuclides, tritium, iodine-131, and/or strontium as established in the procedures developed for the REMP. The samples are collected at established locations, identified as stations, so that trends in the data can be monitored.

An annual report is prepared providing a description of the activities performed and the results of the analysis of the samples collected from the various media. The latest report generated was prepared by Station personnel and is entitled "LaSalle County Station, Units 1 and 2 - Annual Radiological Environmental Operating Report - 1 January Through 31 December 2005", May 2006. This report concluded that the operation of the Station had no adverse radiological impact on the environment. The annual report is submitted to the NRC.

As part of REMP, two surface water samples are collected weekly at two locations described as "Illinois River at Seneca, Upstream (control)" and "Illinois River, Downstream (indicator)" which have a location identification number in the REMP report as L-21 and L-40, respectively. Surface water data from 2005, indicate tritium sample concentration results range from less than the LLD (200 pCi/L) to 943 pCi/L. The 943 pCi/L tritium concentration was detected in the surface water sample from location L-21 while it should also be noted that the sample from location L-40 had a tritium concentration of 821 pCi/L during the same sampling event.

Drinking water samples are collected at two locations described as "LSCS (LaSalle County Station) Onsite Well (indicator)" and "Marseilles Well (indicator)" which have a location identification number in the REMP report as L-27 and L-28, respectively. Drinking water tritium sample concentration results were all less than the LLD (200 pCi/L).

3.3.3 HISTORIC INVESTIGATIONS

This section summarizes investigations undertaken at the Station prior to this hydrogeologic investigation, related to actual or potential releases of radioactively contaminated liquids to the subsurface.

3.3.3.1 POWER PLANT DOCUMENTS-UFSAR REPORT

During the construction of the Station, a series of comprehensive investigations of regional and local geology, surface water, and groundwater conditions were conducted. These studies were performed for a number of purposes including geotechnical evaluations of the underlying geologic deposits, present and future sources of groundwater, present and future groundwater use, and other engineering and environmental purposes. These studies are documented in the UFSAR, Rev. 15, 2004.

3.3.3.2 GROUNDWATER TRITIUM MONITORING PROGRAM

Data exists for groundwater samples from four existing monitoring wells located in the area east and southeast of the Reactor Building. These monitoring wells were installed in response to the Units 1 and 2 HPCS CY line rupture in 1985. The Station collected monthly groundwater samples and analyzed them for tritium between January 1986 and September 1987. The highest detected tritium concentration within a groundwater well was approximately 11,000 pCi/L (HP-7). In addition to collecting water samples from four groundwater monitoring wells, the Station also collected groundwater samples from a drawdown borehole that was located approximately 40 feet west of well location HP-7. The drawdown borehole was installed to manage groundwater while repair activities to the HPCS lines were being completed. The highest detected tritium concentration from this drawdown borehole was 148,100 pCi/L. During the last sample collection event for the groundwater monitoring wells in 1987, one groundwater sample contained tritium at a concentration of 490 pCi/L (HP-7) while the other three wells were non-detect at the LLD. In addition to the installation of the four groundwater monitoring wells, the Station also installed several boreholes (HP-1, HP-3, HP-4, HP-6, HP-8, and HP-9) and collected soil samples for radionuclide analysis. A review of the historical data associated with the sampling of the HP-wells indicates a decreasing tritium trend from a high of 11,000 pCi/L (HP-7) to non-detect at the LLD (200 pCi/L). For the drawdown borehole sample (identified as "caisson discharge composite"), the tritium decreased from an initial high concentration of 148,100 pCi/L to a low concentration of 5,740 pCi/L. No radionuclides were detected above their respective LLD in these samples. No stratigraphic or well construction information for the HP boreholes and wells was available for review. The wells HP-2, HP-5, HP-7, and HP-10 were sampled as part of the HIR investigation to evaluate the current condition of groundwater quality in this area of the historical Units 1 and 2 HPCS line ruptures. The results of the sampling are discussed further throughout Section 5.0.

3.3.3.3 BLOWDOWN LINE INVESTIGATION

In the spring of 2006, Station personnel collected discrete water samples from the vacuum breaker locations along the blowdown line where standing water was present. A total of 16 out of 17 vacuum breakers (valve pit locations) had standing water present. A water sample was collected and analyzed for tritium. All samples were non-detect with the exception of one sample collected from vacuum breaker valve pit #7, which had a tritium concentration of 274 ± 129 pCi/L. The sample was re-analyzed using the distillation process resulting in a tritium concentration of less than the LLD of 200 pCi/L. This information was used in developing the AFEs associated with blowdown line.

3.4 IDENTIFIED AREAS FOR FURTHER EVALUATION

CRA used the information presented in the above sections along with its understanding of the hydrogeology at the Station to identify AFEs, which were a primary consideration in the development of the scope of work in the Work Plan. The establishment of AFEs is a standard planning practice in hydrogeologic investigations to focus the investigation activities at areas where there is the greatest potential for impact to groundwater.

Specifically, AFEs were identified based on these six considerations:

- systems evaluations;
- risk evaluations;
- review of confirmed and/or potential releases;
- review of documents;
- review of the hydrogeologic conditions; and
- Station inspection completed on March 22 and 23, 2006.

Prior to CRA completing its analysis and determination of AFEs, Station personnel completed an exhaustive review of all historic and current management of systems that may contain potentially radioactively contaminated liquids.

CRA reviewed the systems identified by the Station, which have the potential for the release of radioactively contaminated liquids to the environment, and groundwater flow at the Station. This evaluation allowed CRA to become familiar with Station operations and potential systems that may impact groundwater. CRA then evaluated information

concerning historic releases as provided by the Station. This information, along with a review of the results from historic investigations, was used to refine CRA's understanding of areas likely to have the highest possibility of impacting groundwater. Where at risk systems or identified historical releases were located in close proximity or were located in areas which could not be evaluated separately, the systems and historical releases were combined into a single AFE. At times, during the Station investigation, separate AFEs were combined into one or were otherwise altered based on additional information and consideration.

Finally, CRA used its understanding of known hydrogeologic conditions (prior to this investigation) to identify AFEs. Groundwater flow was an important factor in deciding whether to combine systems or historical releases into a single AFE or create separate AFEs. For example, groundwater beneath several systems that contain radioactively contaminated liquids that flows toward a common discharge point were likely combined into a single AFE.

Based upon its review of information concerning confirmed or potential historical releases, historic investigations, and the systems at the Station that have the potential for release of radioactively contaminated liquids to the environment combined with its understanding of groundwater flow at the Station, CRA has identified the following as the AFEs (see Figures 3.1 and 3.2).

AFE-LaSalle-1: High Pressure Core Spray (HPCS)/Reactor Core Isolation (RI) Systems

This area was identified as an AFE in order to investigate any residual contamination related to previous releases of tritiated water.

AFE-LaSalle-2: Reactor/Turbine/Radwaste Sumps

This area was identified to evaluate the quality of groundwater in the area around the Reactor, Turbine and Radwaste Buildings. This AFE was established based on information regarding the storage, handling, and potential for releases from sumps within these buildings.

AFE-LaSalle-3: Cycled Condensate (CY) System

In September 2001, the Unit 2 Cycled Condensate (CY) System storage tank overflowed. No active remediation activities were completed relative to this AFE.

Blowdown Line AFEs (4 through 6)

AFEs LaSalle 4, 5, and 6, were established based on information regarding historical releases in this area.

AFE-LaSalle-4: Blowdown Line Vacuum Breaker 3A&B

This area was identified as an AFE in order to investigate any residual contamination related to previous releases of tritiated water.

AFE-LaSalle-5: Blowdown Line Vacuum Breaker 15A&B

This area was identified as an AFE in order to investigate any residual contamination related to previous releases of tritiated water.

AFE-LaSalle-6: Blowdown Line Vacuum Breaker 16B

This area was identified as an AFE in order to investigate any residual contamination related to previous releases of tritiated water.

AFE-LaSalle-7: Radwaste Discharge Line

This area was established as an AFE in order to evaluate and determine whether a tritium release to the environment had occurred during the operation of the Radwaste line. The Station has not discharged Radwaste through this line since December 2000. Based on discussions with Station personnel and the level of tritium concentrations contained within water that was discharged through this line, further evaluation for the potential release of radioactively contaminated liquids was warranted.

4.0 FIELD METHODS

The field investigations completed for this HIR were completed in May and July 2006. CRA supervised the installation of monitoring wells and staff gauges, collected samples from the newly-installed and existing monitoring wells, and collected samples from surface water locations. The field investigations were completed in accordance with the methodologies presented in the Work Plan (CRA, 2006).

4.1 STAFF GAUGES INSTALLATION

Figure 4.1 presents the location of the four new staff gauges installed on July 6, 2006 as part of this investigation. CRA installed staff gauges at four locations (SG-LS-101 to 104) within the intake canal, the discharge canal, the north storm water retention pond, and the south storm water retention pond perimeter ditch in a manner appropriate with the depth and flow velocity of these surface water bodies to maintain the staff gauges in a stable position.

4.2 GROUNDWATER MONITORING WELL INSTALLATION

Prior to completing any ground penetration activities, CRA completed subsurface utility clearance procedures to minimize the potential of injury to workers and/or damage to subsurface utility structures. The subsurface clearance procedures consisted of completing an electronic survey within a minimum of 10-foot radius of the proposed location utilizing electromagnetic and ground penetrating radar technology. Additionally, an air knife was utilized to verify utilities were not present at the proposed location to a depth to 10 feet bgs.

Thirteen new monitoring wells were installed at the Station as part of the fleetwide hydrogeologic investigations. Monitoring well construction logs are provided in Appendix B. Figure 4.1 presents the location of 13 new monitoring wells (MW-LS-101S through MW-LS-113S). These locations were selected based on a review of all data provided, the hydrogeology at the Station, and current understanding of identified AFEs. Table 4.1 summarizes the well completion details. With the exception of MW-LS-110S, the remaining new wells were installed within and adjacent to the PA (four new wells within the PA and eight new wells outside the perimeter of the PA). Well MW-LS-110S was installed adjacent to vacuum breaker 16B (AFE-LaSalle-6), which is located approximately 4 miles north of the Station in the Illinois River Valley. Due to

its distance from the Site, this location was not used for determination of Site groundwater flow direction.

Specific installation protocols for the shallow monitoring wells are described below:

- the borehole was advanced to the target depth using 4.25-inch inside diameter hollow-stem augers (HSA);
- a nominal 2-inch diameter (No. 10 slot) PVC screen, 10 feet in length, attached to a sufficient length of 2-inch diameter schedule 40 PVC riser pipe to extend to the surface, was placed into the borehole through the augers;
- a filter sand pack consisting of silica sand was installed to a minimum height of 2 feet above the top of the screen as the augers were removed;
- a minimum 2-foot thick seal consisting of 3/8-inch diameter bentonite pellets or chips was placed on top of the sand pack and hydrated using potable water;
- the remaining borehole annulus was sealed to within 3 feet of the surface using pure bentonite chips;
- the remaining portion of the annulus was filled with concrete and a 6-inch diameter protective above-grade casing. The well head will be fitted with a water-tight, lockable cap; and
- cement-filled bollard posts were installed around selected monitoring well locations.

The shallow soil borings completed in unconsolidated materials that were to be used for monitoring well installation were installed using either Hydraulic Direct Push or 4.25-inch inside diameter (HSA) drilling techniques. The borehole depths ranged from 6.5 to 30 feet bgs. During the subsurface utility clearance activities described above, the borehole was periodically examined and the soil types documented. A description was added to each monitoring well construction log. The overburden soils were classified using the Unified Soil Classification System (USCS).

The following deviations from the Work Plan were noted during the installation of the monitoring wells due to depth or other area-specific constraints:

- At well location MW-LS-110S, bedrock refusal was encountered at 6.5 feet bgs. Therefore, this monitoring well was installed using a 5-foot 2-inch #10 slot PVC screen, and no filter pack footing was installed, and this monitoring well was installed with the screen on top of the bedrock.
- At monitoring well locations MS-LS-104S/-105S/-106S/-108S/-109S/-110S/-111S/-112S/-113S, bentonite seal was placed to a minimum 1-foot above the filter

- pack instead of the minimum of 2 feet above the filter pack. The above-specified wells were installed to such a shallow depth based on observed depths to groundwater, a 2-foot space above the filter pack could not be completed.
- For monitoring well locations MW-LS-101S/-102S/-103S/-107S/-108S/-109S/-111S flush mount well casings were installed instead of a standard stickup riser due to high traffic concerns in these areas.

4.3 GROUNDWATER MONITORING WELL DEVELOPMENT

To establish good hydraulic communication with the aquifer and to reduce the volume of sediment in the monitoring well, CRA developed the monitoring wells. With the exception of monitoring wells MW-LS-101S/-102S/-103S/-106S/-108S/-110S/-111S/-113S, all of the monitoring wells that were installed were developed in accordance with this procedure:

- Prior to the collection of hydraulic or groundwater quality data, the monitoring wells were developed using a 5-foot bailer. The bailer was allowed to fall freely through the monitoring well until it struck the surface of the water. The contact of the bailer produced a strong outward surge of water. As the bailer filled and was rapidly withdrawn, the drawdown created in the borehole caused the particulate matter outside the well intake to flow through the well intake and into the well.
- Subsequent bailing removed the sand and other particulate from the well.
- Development continued until the turbidity and silt content of the monitoring wells was significantly reduced or a minimum of five well volumes and not more than eight well volumes was removed.

Monitoring wells MW-LS-101S/-102S/-103S/-111S/ and -113S were dry upon installation, and therefore could not be developed. Monitoring wells MW-LS-106S/-108S/ and -110S purged to dry after 7.5 volumes, 4.5 volumes, and 0.9 volumes were removed, respectively. The remaining wells were fully developed without incident.

CRA containerized the water purged during well development, and the containers were labeled as non-hazardous per directions from Station personnel. The containers were left, as directed by Station personnel, for prescreening and management at a later date by Station personnel.

Well development details are presented in Table 4.2.

4.4 SURVEY

The 13 new and four existing monitoring wells and the four staff gauge locations were surveyed to establish reference elevations relative to mean sea level. The top of each well casing was surveyed to the nearest 0.01 foot relative to the National Geodetic Vertical Datum (NGVD), and the survey point was marked on the well casing. The survey included the ground elevation at each well to the nearest 0.10 foot relative to the NGVD, and the well location to the nearest 1.0 foot.

4.5 GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS

On May 22, 2006, CRA collected a round of water level measurements from the monitoring wells and staff gauges at the Station in accordance with the Work Plan. On July 6, 2006, CRA collected a second round of water level measurements from the monitoring wells and staff gauges at the Station. Based on the measured depth to water from the reference point and the surveyed elevation of the reference point, the groundwater or surface water elevation was calculated. A summary of groundwater elevations is provided in Table 4.3. A summary of the surface water elevations is provided in Table 4.4.

Prior to the water level measurements, the wells and staff gauges were identified and located. Once the wells were identified, CRA completed a thorough inspection of each well and noted any deficiencies. Water level measurements were collected using an electronic depth-to-water probe accurate to ± 0.01 foot. The measurements were made from the designated location on the inner riser or steel casing of each monitoring well and reference point on each staff gauge. The water level measurements were obtained using the following procedures:

- the proper elevation of the meter was checked by inserting the tip into water and noting if the contact was registering correctly;
- the tip was dried, and then slowly lowered into the well or surface water body until contact with the water was indicated;
- the tip was slowly raised until the light and/or buzzer just began to activate. This indicated the static water level;
- the reading at the reference point was noted to the nearest hundredth of a foot;
- the reading was then re-checked; and

- the water level was then recorded, and the water level meter decontaminated prior to use at the next location.

4.6 **GROUNDWATER AND SURFACE WATER SAMPLE COLLECTION**

CRA conducted one round of groundwater sampling during the completion of the Work Plan for this hydrogeologic investigation. A total of 17 monitoring wells and five temporary sample locations were sampled between May 22 and 30, 2006. Additional verification sampling at one well location was completed July 5, 2006. Of the 17 monitoring wells sampled, 13 were newly installed. The sampling was scheduled to allow for two weeks to elapse between well development and groundwater sample collection. The existing wells were selected for inclusion in this monitoring program based on their proximity to the AFEs.

At the monitoring well locations, with the exception of wells MW-LS-102S and MW-LS-113S which were dry, CRA conducted the sampling using dedicated tubing and peristaltic pumps to employ low flow purging techniques as described in Puls and Barcelona (1996).

The groundwater in the monitoring wells was sampled by the following low-flow procedures:

- the wells were located and the well identification numbers were verified;
- a water level measurement was taken;
- the well was sounded by carefully lowering the water level tape to the bottom of the well (so as to minimize penetration and disturbance of the well bottom sediment), and comparing the sounded depth to the installed depth to assess the presence of any excess sediment or drill cuttings;
- the pump or tubing was lowered slowly into the well and fixed into place such that the intake was located at the mid-point of the well screen, or a minimum of two feet above the well bottom/sediment level;
- the purging was conducted using a pumping rate between 100 to 500 milliliters per minute (mL/min). Initial purging began using the lower end of this range. The groundwater level was monitored to ensure that a drawdown of less than 0.3 foot occurred. If this criterion was met, the pumping rate was increased dependent on the behavior of the well. During purging, the pumping rate and groundwater level were measured and recorded approximately every 10 minutes;

- the field parameters [pH, temperature, conductivity, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity] were monitored during the purging to evaluate the stabilization of the purged groundwater. Stabilization was considered to be achieved when three consecutive readings for each parameter, taken at 5-minute intervals, were within the following limits:

pH	± 0.1 pH units of the average value of the three readings,
Temperature	± 3 percent of the average value of the three readings,
Conductivity	± 0.005 milliSiemen per centimeter (mS/cm) of the average value of the three readings for conductivity <1 mS/cm and ± 0.01 mS/cm of the average value of the three readings for conductivity >1 mS/cm,
ORP	± 10 millivolts (mV) of the average value of the three readings,
DO	± 10 percent of the average value of the three readings, and
Turbidity	± 10 percent of the average value of the three readings, or a final value of less than 5 nephelometric turbidity units (NTUs);

- once purging was complete, the groundwater samples were collected directly from the pump/tubing directly into the sample containers; and
- in the event that the groundwater recharge to the monitoring well was insufficient to conduct the low-flow procedure, the well was pumped dry and allowed to sufficiently recharge prior to sampling.

All groundwater samples were labeled with a unique sample number, the date and time, the parameters to be analyzed, the job number, and the sampler's initials. The samples were then screened by the Station for shipment to Teledyne Brown Engineering Inc., (Teledyne Brown).

A sample key is presented in Table 4.5; field measurements for the hydrogeologic investigation are presented in Table 4.6.

CRA containerized the water purged from the monitoring wells during the sampling, as well as the water purged from all of the wells during the hydrogeologic investigation. The water was placed into 55-gallon drums, which will be processed by the Station in accordance with its NPDES permit.

Surface water samples SW-LS-101 through SW-LS-103 were collected on May 23, 2006, SW-LS-106 was collected on May 24, 2006 and SW-LS-104 and SW-LS-105 were collected on May 25, 2006. The surface water sampling locations are presented on Figure 4.1.

The surface water samples were collected by directly filling the sample container from the composite samplers at the determined locations until completely filled. A sample key is presented in Table 4.6.

4.7 DATA QUALITY OBJECTIVES

CRA has validated the analytical data to establish the accuracy and completeness of the data reported. Teledyne Brown provided the analytical services. The Quality Assurance Program for the laboratory is described in Appendix C. Analytical data for groundwater and surface water samples collected in accordance with the Work Plan are presented in Appendix D. Data validation memo is presented in Appendix E. The data validation included the following information and evaluations:

- sample preservation;
- sample holding times;
- laboratory method blanks;
- laboratory control samples;
- laboratory duplicates;
- verification of laboratory qualifiers; and
- field quality control (field blanks and duplicates).

Following the completion of field activities, CRA compiled and reviewed the geologic, hydrogeologic, and analytical data.

The data were reviewed using the following techniques:

- data tables and databox figures;
- hydrogeologic cross-sections; and
- hydraulic analyses.

4.8 SAMPLE IDENTIFICATION

Systematic sample identification codes were used to uniquely identify all samples. The identification code format used in the field was: WG - LS - MW-LS-101S - 052406 - NK - 006. A summary of sample identification numbers is presented in Table 4.6.

WG	- Sample matrix -groundwater
WS	- Sample matrix - surface water
RB	- Sample matrix - rinse blank
LS	- Station code
MW-LS-101S	- Well Location
052406	- Date
NK	- Sampler initial
006	- Sample number

4.9 CHAIN-OF-CUSTODY RECORD

The samples were delivered to Station personnel under chain-of-custody protocol. Subsequently, the Station shipped the samples under chain-of-custody protocol to Teledyne Brown for analyses.

4.10 QUALITY CONTROL SAMPLES

Quality control samples were collected to evaluate the sampling and analysis process.

Field Duplicates

Field duplicates were collected to verify the accuracy of the analytical laboratory by providing two samples collected at the same location and then comparing the analytical results for consistency. Field duplicate samples were collected at a frequency of one duplicate for every ten samples collected. A total of three duplicate samples were collected. The locations of duplicate samples were selected in the field during the performance of sample collection activities. The duplicate samples were collected simultaneously with the actual sample and were analyzed for the same parameters as the actual samples.

Rinsate Blank Samples

Rinsate blanks were collected to verify that decontamination procedures conducted in the field were adequate. Rinsate blanks were collected by routing Station-supplied demineralized water through decontaminated sampling equipment. Rinsate blanks were collected at a frequency of one rinsate blank for every day samples were collected

using non-disposable or non-dedicated equipment. A total of two rinsate blanks were collected.

Split Samples

Split samples were collected for the NRC for tritium simultaneously with the actual sample at every sample location. Split samples were delivered to the Station personnel and made available to the NRC.

4.11 ANALYSES

Groundwater and surface water samples were analyzed for tritium and gamma-emitting radionuclides as listed in NUREG-1302 and strontium-89/90 as listed in 40 CFR 141.25.

4.12 ADDITIONAL FIELD ACTIVITIES

4.12.1 WELL INVENTORY

CRA performed a comprehensive water well search of the IDNR SWS and ISGS databases. The results of the database search are in Appendix A.

In addition, CRA personnel conducted an evaluation of the viability of the four existing groundwater monitoring wells at the Station (HP-2, -5, -7, -10). Each well was sounded to determine a top of water elevation and a bottom of well depth and purged of 3- to 5-well volumes to evaluate groundwater recovery capabilities. Each well was determined to be functional and useable for this investigation. Stratigraphic and well construction information for these four wells were not available.

4.12.2 TEMPORARY SAMPLING POINT INSTALLATION

CRA installed five temporary sampling points (TS-LS-101S through TS-LS-105S) using direct push techniques at points between the Station and the Illinois River (see Figure 4.1). These points were installed at locations along the Radwaste Discharge Line and the Blowdown Line to evaluate whether there has been any impact to the groundwater in these areas. TS-LS-101S and TS-LS-102S were located adjacent to vacuum breaker valves 15AB and 3AB, respectively (AFE-LaSalle-5 and AFE-LaSalle-4, respectively). The overburden soils were classified using the USCS. Immediately after

installation and sampling, the sampling point was backfilled with borehole cuttings (with the exception of TS-LS-101S, where an existing open borehole was used).

4.12.3 TEMPORARY SAMPLING POINT SAMPLE COLLECTION

At each temporary sampling point, a single grab sample of water was obtained from the water table immediately after borehole installation. The grab samples were obtained using a 3.0-foot bailer or peristaltic pump with tubing. The bailer or tubing was lowered to the water table, and without purging, the groundwater was immediately collected and placed into the sample containers. The only exception to this procedure was the groundwater sampling at TS-LS-105S. This location did not have sufficient groundwater present to fill all of the sample containers at once. Therefore, the groundwater sample was obtained over a three-day period using a peristaltic pump, allowing for recharge.

A sample key for the temporary sampling points is also presented in Table 4.6.

5.0 RESULTS SUMMARY

This section provides a summary of Station-specific geology and hydrogeology, along with a discussion of hydraulic gradients, groundwater elevations, and flow directions in the vicinity of the Station. This section also presents and evaluates the analytical results obtained from activities performed in accordance with the Work Plan.

5.1 STATION GEOLOGY

The soil information collected from the installation of the permanent monitoring wells and temporary sampling point locations is consistent with the regional geology described in Section 2.4. The geology beneath the Site consists Wedron Clay Till resting on Pennsylvanian bedrock. Historic stratigraphic logs from the Station (UFSAR, Rev. 15, 2004) show that the Wedron Clay Till beneath the Station is more than 200 feet thick.

CRA prepared geologic cross-sections in both north-south and west-east profiles for the Station. Figure 5.1 displays the profile locations across the Site. The cross-sections are presented on Figures 5.2, 5.3, and 5.4. These cross-sections were chosen because of their close proximity to the AFEs and structures potentially influencing groundwater flow patterns.

The main building excavation for the Turbine/Reactor Building extends into the Wedron Clay Till to a maximum depth of 60 feet below the final surface grade while excavation activities for auxiliary buildings, ranged in depth from 5 to 30 feet below the final surface grade. In addition, the excavation for the intake structure and the CSCS piping extends into the Wedron Clay Till from 5 to 40 feet below grade surface. As a result of these construction activities, a trough or "bowl-like" depression at the top of the Wedron Clay Till has been created, containing the groundwater and influencing groundwater flow.

The 13 monitoring wells and five temporary sampling points installed were completed in the overburden fill and clay. The overburden consists of approximately 0.4 to 10 feet of compacted sand, gravel and clay fill material underlain by the Wedron Clay Till which is comprised of silty clay to clay with intermittent pockets of gravel and sand. The stratigraphic and instrumentation logs showing well construction details for the newly installed monitoring wells are in Appendix B.

Profile A-A' is a north-south profile through the middle of the Site. It begins east of the old Exelon parking lot north of the northern fence line bordering the PA and terminates

south of MW-LS-103S. This profile transects with AFE-LaSalle-2 (Reactor/Turbine/Rad Waste Sumps) in the northwest quarter of the PA. This profile shows the relationship between the geology, excavated areas, the Reactor Building foundation, and storm drains in the overburden materials. The Turbine/Reactor Building foundation was constructed in the Wedron Clay Till to an elevation of approximately 635 feet AMSL or approximately 60 feet bgs. The foundation of the Turbine/Reactor Building sits on a 1-foot thick lean concrete mud mat, which extends 10 feet out from the foundation in all directions to prevent sinking or shifting and a base foundation slab that consists of 7-foot thick reinforced concrete overlies the mud mat. The Turbine/Reactor Building foundation is not seated in bedrock. Engineered compacted fill was placed around the foundation of the Turbine/Reactor Building to the ground surface. The storm drainpipes along this sectional line are located in the fill above the clay till unit, to the north and south of the Turbine/Reactor Building.

Profile B-B' is a west-east profile through the middle of the Site. It begins outside the western perimeter fence line in the south storm water retention pond and terminates outside the eastern perimeter fence line at the switchyard. This profile cuts through AFE-LaSalle-3 [Cycled Condensate (CY) System] in the western portion of the PA and AFE-LaSalle-1 [High Pressure Core Spray (HPCS)/Reactor Core Isolation (RI) Systems] in the middle of the PA. This profile shows the relationship between geology, excavated areas, the Turbine/Reactor Building foundation, and storm drains in the overburden materials. The Turbine/Reactor Building foundation in this area was constructed within the Wedron Clay Till to a depth of approximately 655 feet AMSL. The Turbine/Reactor Building foundation is not seated in bedrock. Engineered compacted fill was placed around the foundation of the Turbine/Reactor Building to the ground surface. The storm drainpipes along this sectional line are located in the compacted engineered fill above the clay till unit, to the south and west of the Turbine/Reactor Building. The historical pipe rupture area at AFE-LaSalle-1 is shown to be adjacent to the excavation of the Turbine/Reactor Building to the east, in the vicinity of HP-10. AFE-LaSalle-3 is located in the excavation area just southwest of the Turbine/Reactor Building.

Profile C-C' is a north-south profile through the western side of the Site, outside of the PA. It begins in the "Old Exelon Parking Lot" to the north of the PA, and terminates south of the "In-Processing Facility" to the south of the PA. This profile transects with the Circulating Water pipes that terminate at the discharge canal. This profile shows the relationship between geology, excavated areas, and the two Circulating Water pipes in the overburden material. The excavation for the Circulating Water pipes extends to approximately 680 feet AMSL, and was filled with engineered fill material. The pipes are approximately 12.5 feet in diameter. They discharge into the Discharge Canal.

5.2 STATION HYDROGEOLOGY

The hydrogeologic profiles are presented on Figures 5.2, 5.3, and 5.4. This profile uses the same A-A', B-B', and C-C' profile lines as shown on Figure 5.1 for the geologic cross-sections.

The monitoring wells at the Site were installed to monitor the shallow overburden, therefore, only the overburden hydrogeology is discussed in this section.

Field observations and stratigraphic information developed during the investigation indicates that the Station is underlain by granular fill, which is in turn underlain by the Wedron Clay Till. Groundwater is located in the fill material lying on top of the Wedron Clay Till. These observations are consistent with information provided by the Station in the UFSAR which indicates that the Station is underlain by Wedron Clay Till which is over 200 feet thick in the area of the Station. No borings for the investigation were advanced pass 50 feet bgs (MW-LS-103S and TS-LS-105S) and therefore the thickness of the Wedron Clay Till could not be confirmed. Soil samples from the borings indicated that once the Wedron Clay Till was encountered, it continued to the limit of the borehole (UFSAR, Rev. 15, 2004).

Along the blowdown line, field observations noted during the investigation indicated that the blowdown line, from the Station to the Illinois River Valley, is buried within the Wedron Clay Till. At the onset of the Illinois River Valley, the blowdown line is buried within the alluvium sediments and within bedrock. This was also consistent with the information outlined in the UFSAR (UFSAR, Rev. 15, 2004).

The groundwater contours (Figure 5.5) and top of clay contours (Figure 5.6) at the Site indicate that groundwater flow is divided from north to south in the area of monitoring well HP-2. East of the well, groundwater flows to the intake canal while west of the divide groundwater flows westward around the Reactor/Turbine Building into the storm water retention ponds and the discharge canal.

There are no groundwater pumping activities or slurry walls constructed at the Site that would affect overburden groundwater flow patterns to the nearby surface water bodies.

5.2.1 GROUNDWATER FLOW DIRECTIONS

The foundations or basements associated with the Turbine/Reactor Building extend to depths below the water table (approximately 60 feet bgs) into the Wedron Clay Till (refer to the geologic cross-sections on Figures 5.2, 5.3, and 5.4). These foundations/basements are barriers to groundwater flow in the overburden materials.

The wells installed by CRA at the Site were screened to monitor the interface between the fill and the top of the Wedron Clay Till (clay unit) unit and to delineate the groundwater flow along the top of the relatively impermeable clay unit. The Wedron Clay Till acts as barrier to vertical migration of groundwater and therefore limits groundwater movement to a predominantly horizontal component through the granular fill. Figure 5.5 shows the water table groundwater contours based on data collected May 22, 2006 for the Site. CRA utilized a commercially available contouring program (Surfer, Version 8.02, 2002) to provide an initial contouring of the measured groundwater elevations. The initial contours were then modified using professional judgment to prepare the final contour maps.

As shown on Figure 5.5, the general groundwater flow direction in the shallow overburden is to the southwest with an apparent low point southwest of the Turbine/Reactor Building near MW-LS-105S. The only subsurface feature that appears to be able to affect groundwater flow is the foundation of the Turbine/Reactor Building. Schematic diagrams in the UFSAR show that the foundations of the Turbine/Reactor Building is approximately 60 feet bgs into the Wedron Clay Till (UFSAR, Ref. 15, 2004). Therefore, shallow groundwater flow from the northeast portion of the Site is diverted north and south around the building foundation as it flows toward the west.

Figure 5.6 presents the top of clay unit contours based upon the well logs and building excavation details (UFSAR, 2004). As shown, the elevation of the top of clay ranges from 698.61 feet AMSL (MW-LS-104S) to 703.27 feet AMSL (MS-LS-107S). The elevation of the top of clay unit for the perimeter monitoring wells (outside of the PA) ranges from 704.54 feet AMSL (MW-LS-111S) to 710.85 feet AMSL (MW-LS-112S).

The elevation of the top of clay unit beneath the PA is approximately 1 to 12 feet lower than the elevation of the top of clay at the perimeter of the PA, indicating a depressed area in the natural clay exists beneath the PA near MW-LS-105S, MW-LS-104S, HP-7, and MW-LS-109S. These conditions create a "bowl" beneath the Site where groundwater accumulates until it fills the bowl. Based on the Reactor/Turbine Building excavation details the bowl is a result of the construction activities at the Site. In preparation for constructing the Reactor/Turbine Building complex and the underground circulating

water pipelines, the overburden, which consisted of loess and Wedron Clay Till was excavated to a depth of approximately 60 feet below the final design grade elevation of approximately 710 feet AMSL. In order to safely complete the excavation activities, the side slopes were cut to a 1:1 slope that resulted in the excavation extending 20 to 30 feet beyond the foundations of the building. These areas of the excavation extending beyond the foundation walls were backfilled with granular fill. These construction excavation activities resulted in the present day bowl-like top of clay outline.

During wet conditions, groundwater flows into the bowl area from the northeast, filling the depression. As groundwater continues to flow into the depressed area of the Wedron Clay Till beneath the Site, eventually the depression fills up and overflows. Once the depression is full, groundwater continues to flow to the west and southwest. During dry conditions, with less groundwater flow into the depressed area, the groundwater that is able to flow into the depression would be trapped in the depression, unable to continue to flow west and southwest out of the depressed area, effectively isolating the groundwater beneath the Station from the local flow regime outside of the influence of the depressed area. Although groundwater may become trapped beneath the Station, any residual tritium impacts, as indicated by the presence of tritium in the groundwater sample from MW-LS-105S would be contained due to the Wedron Clay Till beneath the Station that extends to over 200 feet beneath the Station. Figure 5.7 shows the saturated thickness of the groundwater beneath the Station. As expected from the "bowl-like" conditions of the Wedron Clay Till, the saturated thickness is greatest in the vicinity of the Turbine/Reactor Building.

The groundwater flow is likely influenced by the excavation trenches used to install the intake and discharge pipelines. The removal of the clay and emplacement of engineered fill around the building foundations and pipelines would provide a preferential path for the movement of groundwater from the top of the clay till downward along the building foundations. These circumstances may be responsible for the low point in the groundwater elevation at MW-LS-105S.

5.2.2 MAN-MADE INFLUENCES ON GROUNDWATER FLOW

The main building excavation for the Turbine/Reactor Building extends into the Wedron Clay Till to a maximum depth of 60 feet below the final surface grade. The sidewalls of the excavation were constructed at a 1:1 slope. Additional excavation activities within the main building excavation, for Auxiliary Buildings, ranged in depth from 5 to 30 feet below the final surface grade. Prior to erecting the Turbine/Reactor Building structure, the final Wedron Clay Till bearing surfaces were protected with a

mud mat that consisted of a 1-foot thick layer of lean concrete. The mud mat extended 10 feet beyond the outsides of the building walls. A base foundation slab that consists of 7-foot thick reinforced concrete overlies the mud mat. The base foundation slab extends beneath the Turbine and the Reactor Building. In addition, the excavation for the intake structure and the CSCS piping extends into the Wedron Clay Till from 5 to 40 feet below grade surface.

The primary backfill installed around the main buildings (Turbine/Reactor/Auxiliary) and the CSCS piping consisted of C-6 structural fill, which is composed of sand and gravel materials (UFSAR, Rev. 15, 2004).

These construction activities and the use of a granular backfill resulted as a preferential pathway for the flow of groundwater beneath the Station since the granular fill would have higher hydraulic conductivity relative to the highly impermeable Wedron Clay Till.

In addition, LaSalle Lake is a man-made feature, which also influences groundwater flow at the Station. LaSalle Lake functions as a cooling lake and is immediately east of the Site, comprising over 2,058 acres of impounded water. To the west of the Station is the Discharge Canal and the storm water ponds. The Discharge Canal wraps around the northern portion of the Site and discharges back to LaSalle Lake. In addition to these surface water bodies, man-made Site features such as storm water underground piping and underground utilities will also provide preferential pathways for the migration of groundwater across the Site.

5.3 GROUNDWATER QUALITY

CRA personnel collected groundwater samples from 15 wells and five temporary sampling locations. The samples were analyzed for tritium and additional radionuclides. Teledyne Brown provided the analytical services. The Quality Assurance Program for the laboratory is described in Appendix C. The analytical data reports are provided in Appendix D.

The analytical data presented herein has been subjected to CRA's data validation process. CRA has used the data with appropriate qualifiers where necessary.

The data reported in the figures and tables does not include the results of recounts that the laboratory completed, except if those results ultimately replaced an initial report. The tables and figures, therefore, include only the first analysis reported by the

laboratory. Where multiple samples were collected over time, then the most recent result has been used in the discussion, below.

5.3.1 SUMMARY OF BETA-EMITTING RADIONUCLIDES ANALYTICAL RESULTS

A summary of the tritium results for the groundwater samples collected during this investigation is provided in Table 5.1 and shown on Figure 5.8.

All tritium concentrations were below the United States Environmental Protection Agency (USEPA) drinking water standard of 20,000 pCi/L. Tritium was not detected at concentrations greater than the LLD of 200 pCi/L in 19 of the 20 groundwater samples collected.

Further, tritium was only detected in one sample above the laboratory LLD of 200 pCi/L. The concentration of tritium in the May 26, 2006 groundwater sample from MW-LS-105S was $1,280 \pm 184$ pCi/L. Monitoring well location MW-LS-105S was re-sampled on July 5, 2006 and the concentration of tritium in the groundwater sample was 766 ± 153 pCi/L.

Strontium-89/90 was not detected at concentrations greater than the LLD of 2.0 pCi/L. A summary of the strontium-89/90 results for the groundwater samples collected as part of the investigation that is the subject of this HIR is provided in Table 5.2 and shown on Figure 5.9.

5.3.2 SUMMARY OF GAMMA-EMITTING RADIONUCLIDES ANALYTICAL RESULTS

Gamma-emitting target radionuclides were not detected at concentrations greater than their respective LLD. A summary of the gamma-emitting radionuclides results for the groundwater samples collected as part of the investigation that is the subject of this HIR is provided in Table 5.2 and shown on Figure 5.9.

Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides which would otherwise indicate the potential of production from the Station.

5.3.3 SUMMARY OF FIELD MEASUREMENTS

A summary of the field measurement results for the groundwater samples collected as part of the investigation is provided in Table 4.6. These field measurements included pH, dissolved oxygen, conductivity, turbidity and temperature. The field parameters were typical of a shallow granular fill aquifer. pH values ranged from 6.46 standard units to 8.28 standard units. Temperature readings were slightly elevated within the PA area relative to readings from wells outside of the PA. However, the elevated temperature readings are likely due to transfer of residual heat from the Circulating Water piping buried beneath the Station PA. The conductivity was indicative of a shallow water table system subject to surface water recharge. Overall, the readings were within the expected ranges for naturally occurring groundwater.

5.4 SURFACE WATER QUALITY

Six surface water samples were collected from the locations shown on Figure 4.1. The samples were analyzed for tritium, gamma-emitting radionuclides, and strontium-89/90. Teledyne Brown provided the analytical services. The Quality Assurance Programs for the laboratory is described in Appendix C. The analytical data reports are provided in Appendix D.

5.4.1 SUMMARY OF BETA-EMITTING RADIONUCLIDES ANALYTICAL RESULTS

A summary of the tritium results for the surface water samples collected in this investigation is provided in Table 5.3 and shown on Figure 5.9. As shown in the table, the surface water samples from SW-LS-101 and SW-LS-106 contained tritium at concentrations of 232 ± 116 pCi/L and 219 ± 113 pCi/L, respectively.

Annual REMP reporting for surface water samples collected from the Illinois River indicates tritium concentrations in the Illinois River water samples ranging from non-detectable at the LLD of 200 pCi/L to as high as 1,682 pCi/L (2003 REMP Report). In 2004 the average concentration of tritium in Illinois River water samples reported by the Station in their Annual REMP report was 521 pCi/L with a maximum of 1,058 pCi/L while in the 2005 report, the tritium concentrations ranged from non-detectable at the LLD of 200 pCi/L to 943 pCi/L.

Strontium-89/90 was not detected at concentrations greater than the LLD of 2.0 pCi/L. A summary of the strontium-89/90 results for the surface water samples collected in this investigation is provided in Table 5.4 and shown on Figure 5.9.

5.4.2 SUMMARY OF GAMMA-EMITTING RADIONUCLIDES ANALYTICAL RESULTS

Gamma-emitting target radionuclides were not detected at concentrations greater than their respective LLD. A summary of the gamma-emitting radionuclide results for the surface water samples collected in this investigation is provided in Table 5.4 and shown on Figure 5.9.

Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides which would otherwise indicate the potential of production from the Station.

6.0 RADIONUCLIDES OF CONCERN AND SOURCE AREAS

This section discusses radionuclides evaluated in this investigation, potential sources of the radionuclides detected, and their distribution.

6.1 GAMMA-EMITTING RADIONUCLIDES

Gamma-emitting target radionuclides were not detected at concentrations greater than their respective LLD. Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides which would otherwise indicate the potential of production from the Station.

6.2 BETA-EMITTING RADIONUCLIDES

Strontium-89/90 was not detected in any of the 26 samples collected at concentrations that were greater than the LLD of 2.0 pCi/L. Tritium was detected in three of the 26 total sample locations. Concentrations of tritium ranged between less than the LLD of 200 pCi/L to $1,280 \pm 184$ pCi/L.

Since only tritium was detected at concentrations greater than its LLD, the following sections focus on tritium; specifically, providing general characteristics of tritium, potential sources, distribution in groundwater, and a conceptual model for migration.

6.3 TRITIUM

This section discusses the general characteristics of tritium, the distribution of tritium in groundwater and surface water, and the conceptual model of tritium release and migration.

6.3.1 GENERAL CHARACTERISTICS

Tritium (chemical symbol H-3) is a radioactive isotope of hydrogen. The most common forms of tritium are tritium gas and tritium oxide, which is also called "tritiated water." The chemical properties of tritium are essentially those of ordinary hydrogen. Tritiated

water behaves the same as ordinary water in both the environment and the body. Tritium can be taken into the body by drinking water, breathing air, eating food, or absorption through skin. Once tritium enters the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted primarily through urine within a month or so after ingestion. Organically bound tritium (tritium that is incorporated in organic compounds) can remain in the body for a longer period.

Tritium is produced naturally in the upper atmosphere when cosmic rays strike air molecules. Tritium is also produced during nuclear weapons explosions, as a by-product in reactors producing electricity, and in special production reactors, where the isotopes lithium-7 and/or boron-10 are bombarded to produce tritium.

Although tritium can be a gas, its most common form is in water because, like non-radioactive hydrogen, radioactive tritium reacts with oxygen to form water. Tritium replaces one of the stable hydrogen atoms in the water molecule and is called tritiated water. Like normal water, tritiated water is colorless and odorless. Tritiated water behaves chemically and physically like non-tritiated water in the subsurface, and therefore tritiated water will travel at the same velocity as the average groundwater velocity.

Tritium has a half-life of approximately 12.3 years. It decays spontaneously to helium-3 (^3He). This radioactive decay releases a beta particle (low-energy electron). The radioactivity of tritium is the source of the risk of exposure.

Tritium is one of the least dangerous radionuclides because it emits very weak radiation and leaves the body relatively quickly. Since tritium is almost always found as water, it goes directly into soft tissues and organs. The associated dose to these tissues is generally uniform and is dependent on the water content of the specific tissue.

6.3.2 DISTRIBUTION IN STATION GROUNDWATER

This section provides an overview of the lateral and vertical distribution of tritium detected in groundwater at the Station. Tritium was detected in groundwater at concentrations exceeding the LLD of 200 pCi/L.

Tritium concentrations exceeding 200 pCi/L were detected in one groundwater sample collected from well MW-LS-105S at a concentration of $1,280 \pm 184$ pCi/L. MW-LS-105S was re-sampled on July 5, 2006 and tritium was detected in the groundwater sample at 766 ± 153 pCi/L. MW-LS-105S is adjacent to the Interim RadWaste Storage Facility, on

the southwest side of the Turbine/Reactor Building in the PA. A review of the historical release information indicates that MW-LS-105S appears to be located upgradient of the historical release from the AFE-LaSalle-3 - Unit 2 Cycled Condensate Storage Tank. It is possible that this detection is the residual impact related to this previous release. However, Site features that could have acted as interceptors and prevented the migration of tritium from the AFE-LaSalle-2 location northward to MW-LS-105S are a storm drain and the Off-Gas Underground pipelines (Figure 3.2).

6.3.3 DISTRIBUTION IN STATION SURFACE WATER

Tritium concentrations exceeding 200 pCi/L were detected in two surface water samples, SW-LS-101 and SW-LS-106. Surface water samples from SW-LS-101 and SW-LS-106 had concentrations of tritium of 232 ± 116 pCi/L and 219 ± 113 pCi/L, respectively. SW-LS-101 was collected from the north storm water retention pond, which is connected to the Discharge Canal which feeds LaSalle Lake, and SW-LS-106 was collected from the Intake Canal emanating from the LaSalle Lake. Based upon the groundwater flow for the Station (see Figure 5.6), groundwater from the north side of the Reactor/Turbine Building appears to discharge to the north storm water retention pond while groundwater from the northeast corner of the Site discharges back to the intake canal. Although above the anticipated background concentration for tritium for the Site, the detections are not uncharacteristic of the data set over time. As part of the REMP, routine sampling of the Illinois River, which provides makeup water to LaSalle Lake, has consistently demonstrated tritium concentrations in both upstream and downstream surface water samples ranging from 1,680 pCi/L in 2003 to non-detectable at the LLD of 200 pCi/L during this hydrogeological investigation. As such, the detected concentrations of tritium in the two surface water samples collected as part of the hydrogeologic investigation are likely the result of elevated tritium concentrations in the Illinois River.

6.3.4 CONCEPTUAL MODEL OF TRITIUM RELEASE AND MIGRATION

This section presents CRA's conceptual model of groundwater and tritium migration at the Station.

Hydrogeological Framework

Groundwater flows through the overburden fill materials at the Site in response to the surface water bodies located to the east and west of the Site (Figure 5.1). Groundwater elevations indicate a groundwater divide extending from north to south near HP-2. Groundwater to the east of HP-2 appears to flow eastward to the Intake Canal while groundwater to the west of HP-2 appears to flow west-southwest towards and around the Reactor/Turbine Building until it discharges to the storm water ponds and Discharge Canal to the west.

The underlying Wedron Clay Till, which is over 200 feet thick in the area of the Station, separates this overburden groundwater zone from regional overburden and bedrock aquifers. Construction activities have produced a depression in the top of the Wedron Clay Till also, which creates a minor groundwater depression surrounding the Reactor/Turbine Building. This groundwater depression also influences the horizontal movement of groundwater from east to west across the Site. Groundwater flowing through the overburden fill materials overlying the Wedron Clay Till, is also influenced by the presence of building foundations which extend into the top of the Wedron Clay Till. There are no slurry walls or groundwater pumping locations within the overburden fill material that would influence groundwater movement.

Vertical migration of radioactively contaminated liquids through the Wedron Clay Till is limited due to the very low permeability of the till (less than 1.0×10^{-07} cm/sec).

Sources and Migration of Tritium

Tritium concentrations exceeding 200 pCi/L were detected in one groundwater sample at the Site from monitoring well MW-LS-105S.

The detection of tritium above 200 pCi/L in the groundwater sample from monitoring well MW-LS-105S appears to be localized to the area around the well. Tritium was not detected at the lower limit of detection of 200 pCi/L in the groundwater samples collected from monitoring wells in the vicinity and downgradient of this location.

The most likely source of the tritium in the groundwater at this well is from the historical release associated with the overflow of the Unit 2 Cycled Condensate Tank in 2001 (AFE-LaSalle-3) Discussion with Station personnel have been unable to define another possible source of the tritium detection.

Due to the low permeability of the Wedron Clay Till combined with the generally shallow east to west gradient of the water table and the apparent groundwater depression around MW-LS-105S, the tritiated water is not expected to migrate very far laterally from this monitoring well location.

There are two potential migration pathways for the tritiated groundwater found near MW-LS-105S:

- There is a potential for tritiated groundwater to discharge to the storm drain system (see Figure 3.2). The storm water drain invert nearest to MW-LS-105S is at approximately 705 feet AMSL. On May 22, 2006, the groundwater elevation at MW-LS-105S was 704.36 feet AMSL. This shows that the water table is below the invert of the nearest storm drain; however, as discussed in Section 5.2.2, there is a groundwater depression present at MW-LS-105S. It is possible that during high groundwater conditions, the water table may rise to the invert of the storm drain, allowing the tritiated groundwater to discharge into the storm drain. The groundwater that infiltrates the storm water system will flow to the oil/water separator to the west. This separator discharges water to the south storm water retention pond; and
- During periods of high groundwater elevations, it is possible that the groundwater near MW-LS-105S could flow northwest along the foundation of the Turbine/Reactor Building to the fill material for the discharge pipeline. The fill material surrounding the pipeline could create a preferential pathway for the migration of tritiated groundwater into the Discharge Canal.

There is no indication from the HIR investigation that tritium impacted groundwater is migrating off Site.

Surface Water

As part of the Station's REMP, the Station collects water samples from the Illinois River quarterly, both upstream of the river intake and downstream of the blowdown line, which discharges to the Illinois River. The Station collects its upstream river sample from a boat pier/dock in the municipality of Seneca, Illinois which is located approximately 4 miles northeast of the Station and approximately 3.5 miles upstream of the Station's intake (make-up water line). The Station collects the downstream sample at a boat launch in Illinois State Park, which is located approximately 4.5 miles northwest of the Station and approximately 2 miles downstream of the blowdown line discharge. Annual reporting of the average tritium concentrations for the last 3 years indicates

tritium concentrations in the Illinois River, from water samples collected upstream and downstream of the Station, ranged from ND (2005 REMP Report) at the LLD of 200 pCi/L to as high as 1,682 pCi/L (2003 REMP Report).

In addition, a review of the groundwater contours presented on Figure 5.5 indicates that it would be highly unlikely that the tritium detected in the groundwater sample from MW-LS-105S could migrate eastward (against the groundwater gradient) and be the cause of the tritium detection in the intake canal. As previously stated in the section above, it is possible that tritium impacted groundwater from MW-LS-105S could migrate along the building foundation northward to the discharge canal piping and discharge into the discharge canal.

Based the historical tritium levels of the Illinois River and the volume of water that is pumped daily into LaSalle Lake from the Illinois River (80.4 million gallons per day), it is likely that the source of the detections of tritium in the two surface water samples are associated with the levels of tritium present in the Illinois River and not with impacted groundwater near MW-LS-105S.

7.0 EXPOSURE PATHWAY ASSESSMENT

This section addresses the groundwater impacts from tritium and other radionuclides at the Station and potential risks to human health and the environment.

Based upon historical knowledge and data related to the Station operations, and based upon radionuclide analyses of groundwater samples, the primary constituent of concern (COC) is tritium. The discussions that follow are restricted to the exposure pathways related to tritium.

Teledyne Brown reports all samples to their statistically derived minimum detectable concentration (MDC) of approximately 150 to 170 pCi/L, which is associated with 95 percent confidence interval on their hard copy reports. However, the laboratory uses a 99 percent confidence range (± 3 sigma) for determining whether to report the sample activity concentration as detected or not. This 3-sigma confidence range typically equates to 150 (± 135.75) pCi/L.

Exelon has specified a LLD of 200 pCi/L for the Fleetwide Assessment. Exelon has also required the laboratory to report related peaks identified at the 95 percent confidence level (2-sigma).

This HIR, therefore, screens and assesses data using Exelon's LLD of 200 pCi/L. As is outlined below, this concentration is also a reasonable approximation of the background concentration of tritium in groundwater at the Station.

7.1 HEALTH EFFECTS OF TRITIUM

Tritium is a radionuclide that decays by emitting a low-energy beta particle that cannot penetrate deeply into tissue or travel far in air. A person's exposure to tritium is primarily through the ingestion of water (drinking water) or through ingestion of water bearing food products. Inhalation of tritium requires the water to be in a vapor form (i.e., through evaporation or vaporization due to heating). Inhalation is a minor exposure route when compared to direct ingestion or drinking of tritiated water. Absorption of tritium through skin is possible, but tritium exposure is more limited here versus direct ingestion or drinking of tritiated water.

7.2 BACKGROUND CONCENTRATIONS OF TRITIUM

The purpose of the following paragraphs is to establish a background concentration through review of various media.

7.2.1 GROUNDWATER

Tritium is created in the environment from naturally occurring processes both cosmic and subterranean, as well as from anthropogenic (i.e., man-made) sources. In the upper atmosphere, "cosmogenic" tritium is produced from the bombardment of stable nuclides and combines with oxygen to form tritiated water, which will then enter the hydrologic cycle. Below ground, "lithogenic" tritium is produced by the bombardment of natural lithium isotopes ${}^6\text{Li}$ (92.5 percent abundance) and ${}^7\text{Li}$ (7.5 percent abundance) present in crystalline rocks by neutrons produced by the radioactive decay of uranium and thorium. Lithogenic production of tritium is usually negligible compared to other sources due to the limited abundance of lithium in rock. The lithogenic tritium is introduced directly to groundwater.

A major anthropogenic source of tritium comes from the former atmospheric testing of thermonuclear weapons. Levels of tritium in precipitation increased during the 1950s and early 1960s, coinciding with the release of significant amounts of tritium to the atmosphere during nuclear weapons testing prior to the signing of the Limited Test Ban Treaty in 1963, which prohibited atmospheric nuclear tests.

7.2.2 PRECIPITATION DATA

Precipitation samples are routinely collected at stations around the world for the analysis of tritium and other radionuclides. Two publicly available databases that provided tritium concentrations in precipitation are Global Network of Isotopes in Precipitation (GNIP) and USEPA's RadNet database. GNIP provides tritium precipitation concentration data for samples collected world wide from 1960 to 2006. RadNet provides tritium precipitation concentration data for samples collected at Stations through the U.S. from 1960 up to and including 2006.

Based on GNIP data for sample stations located in the U.S. Midwest including Chicago, St. Louis and Madison, Wisconsin, as well as Ottawa Ontario, and data from the University of Chicago, tritium concentrations peaked around 1963. This peak, which approached 10,000 pCi/L for some stations, coincided with the atmospheric testing of

thermonuclear weapons. Tritium concentrations showed a sharp decline up until 1975 followed by a gradual decline since that time. Tritium concentrations in Midwest precipitation have typically been below 100 pCi/L since around 1980.

The RadNet database for several stations in the U.S. Midwest (Chicago, Columbus, Indianapolis, Lansing, Madison, Minneapolis, Painesville, Toledo, and Welsch, MN) did not show the same trend, which can be attributed to pre-1995 data handling procedures. The pre-1995 data were rounded to the nearest 100 pCi/L, which dampened out variances in the data. The post-1995 RadNet data, where rounding was not applied, exhibit much more scatter, and similar to the GNIP data, the vast majority of the data were less than 100 pCi/L.

CRA constructed a non-parametric upper tolerance limit with a confidence of 95 percent and coverage of 95 percent based on RadNet data for USEPA Region 5 from 2004 to 2005. The resulting upper tolerance limit is 133 pCi/L, which indicates that CRA is 95 percent confident that 95 percent of the ambient precipitation concentration results are below 133 pCi/L. The statistical confidence, however, must be compared with the limitations of the underlying RadNet data, which does not include the minimum detectable concentration for a majority of the measurements. Some of the RadNet values below 200 pCi/L may be approximated. Nevertheless, these results show a background contribution for precipitation of up to 133 pCi/L.

7.2.3 SURFACE WATER DATA

Tritium concentrations are routinely measured in large surface water bodies, including Lake Michigan and the Mississippi River. Surface water data from the RadNet database for Illinois sampling stations include East Moline (Mississippi River), Moline (Mississippi River), Marseilles (Illinois River), Morris (Illinois River), Oregon (Rock River), and Zion (Lake Michigan). As is the case for the RadNet precipitation data, the pre-September 1995 Illinois surface water data was rounded to the nearest 100 pCi/L, creating a dampening of variances in the data. The post-1995 Illinois surface water data, similar to the post-1995 Midwest precipitation data, were less than 100 pCi/L with the exception of the Moline (Mississippi River) station. Tritium surface water concentrations at this location varied between 100 and 800 pCi/L, which may reflect local natural or anthropogenic inputs.

For the Lake Michigan station, the surface water concentrations were less than 100 pCi/L, with the exception of a couple of occasions occurring around 1996 to 1997. Tritium concentrations in Lake Michigan would be expected to be lower than

precipitation concentrations given the 99-year surface water residence time within Lake Michigan, which corresponds to 8 half-lives of tritium and the dilution provided the large volume of the Lake (1,180 cubic miles) as well as seasonal mixing effects (WDNR, 1999).

Recent surface water measurements for tritium sampling locations upstream and downstream of the LaSalle Generating Station show that concentrations in the Illinois River consistently range between below 200 pCi/L to as high as 1,682 pCi/L (REMP, 2003, 2004, & 2005).

Surface water samples were taken from eight locations, along the Illinois River at Marseilles, Ottawa, Seneca, as well as Kickapoo Creek, the Illinois Nitrogen Corporation Raw, the Recreational Area Cooling Lake and the LSCS intake and discharge pipes. Samples were analyzed for gross beta content, gamma-emitters, tritium, and strontium-89/90. None of the composite samples indicated the presence of other than naturally occurring gamma-emitters at a sensitivity of 10 pCi/L. No samples contained strontium-89/90 at a detection level of 10 pCi/L. Tritium concentrations were ranged from less than the LLD of 200 pCi/L to 350 pCi/L. The Gross beta analytical results in surface water samples were less than the LLD of 10 pCi/L.

The USEPA RadNet surface water data typically has a reported 'Combined Standard Uncertainty' of 35 to 50 pCi/L. According to USEPA, this corresponds to a ± 70 to 100 pCi/L 95 percent confidence bound on each given measurement. Therefore, the typical background data provided may be subject to measurement uncertainty of approximately ± 70 to 100 pCi/L.

7.2.4 DRINKING WATER DATA

Tritium concentrations in drinking water from the RadNet database for three Illinois sampling stations (Chicago, Morris, and East Chicago) exhibit similar trends as the precipitation and surface water data. As with the precipitation and surface water data, the pre-1995 data has dampened out variances due to rounding the data to the nearest 100 pCi/L. The post-1995 results show tritium concentrations in samples of drinking water were less than 100 pCi/L and less than the tritium concentrations found in precipitation and surface water.

Drinking water samples were taken from an LSCS on-Site well and the following off-Site wells: Marseilles Well, Seneca Well, Ransom Well, Ottawa Well, and Illinois State Park Well. Gross beta analysis was performed on all samples. Gamma isotopic, radioactive

strontium, and tritium analyses were conducted on the quarterly samples from the area wells and on a quarterly composite of monthly samples from the on-Site well. No unusual results were observed in analyses performed. However, several of the area wells had gross beta concentrations higher than that of nearby surface water. Sample results, which show samples contained higher beta concentrations, are indicative of the presence of slightly elevated concentrations of naturally occurring radionuclides in subsurface water. Tritium concentrations were variable, within the range of less than 200 pCi/L to 350 pCi/L. Gross beta analytical results in drinking water ranged from less than the LLD of 1.6 pCi/L to 22 pCi/L.

7.2.5 EXPECTED TRITIUM BACKGROUND FOR THE STATION

As reported in the GNIP and RadNet databases, tritium concentrations in U.S. Midwest precipitation has typically been less than 100 pCi/L since 1980. Tritium concentrations reported in the RadNet database for Illinois surface water and groundwater, at least since 1995, has typically been less than 100 pCi/L. Based on the USEPA Region 5's 2004 to 2005 RadNet precipitation data, 95 percent of the ambient concentrations of tritiated water in Illinois are expected to be less than 133 pCi/L, based on a 95 percent confidence limit. Tritium concentrations in surface water and drinking water are expected to be comparable or less based on historical data and trends.

Concentrations in groundwater similar to surface and drinking water are expected to be less than precipitation values. The lower groundwater concentrations are related to the age of the groundwater as compared to the half-life of tritium. Deep aquifers in proximity to crystalline basement rock, however, can potentially show elevated concentrations of tritium due to lithogenic sources.

According to the 1981 pre-operational REMP, groundwater well sample results from off-Site wells indicated tritium levels ranged from a maximum of 360 ± 100 pCi/L to a less than the LLD of 200 pCi/L. On-Site well sample results indicated tritium levels ranged from a maximum of 300 pCi/L to less than the LLD of 200 pCi/L.

As noted in Section 7.0, the analytical laboratory is reporting tritium results to a LLD of 200 pCi/L. This concentration also represents a reasonable representation of background groundwater quality, given the data for precipitation, surface water, and drinking water.

Based on the evaluation presented above, the background concentration for tritium at the Station is reasonably represented by the LLD of 200 pCi/L.

7.3 **IDENTIFICATION OF POTENTIAL EXPOSURE PATHWAYS AND POTENTIAL RECEPTORS**

Three potential exposure pathways were considered during the evaluation of tritium in groundwater.

- potential groundwater migration to the Station's potable water supply well;
- potential groundwater migration off the Station property to private and public groundwater users; and
- potential groundwater migration off the Station property to a surface water body.

The following section provides an overview of each of these three potential exposure pathways for tritium in groundwater.

7.3.1 **POTENTIAL GROUNDWATER MIGRATION TO DRINKING WATER USERS AT THE STATION**

Based on the groundwater elevation data, there appears to be a groundwater divide at monitoring well location HP-2. Groundwater east of the divide flows northeast back to the intake canal while groundwater to the west of the divide flows to the west towards the Reactor/Turbine Building, around the building and eventually discharges into the discharge canal and storm water ponds on the west side of the Station. Although tritiated groundwater could migrate horizontally to the east and west from the divide, there is no exposure route for the ingestion of tritiated groundwater on the Station. The Station receives its potable water from a cased 1,600-foot bedrock well on the Site, which is installed in the Ironton-Galesville Sandstone. The vertical movement of tritiated water from the shallow overburden into deeper formations is restricted by the Wedron Clay Till, which is highly impermeable. Since vertical migration of tritiated water through the impermeable Wedron Clay Till to the Ironton-Galesville Aquifer is restricted but theoretically not eliminated, this is a potentially complete exposure pathway but there is no current risk for groundwater ingestion at the Station.

7.3.2 POTENTIAL GROUNDWATER MIGRATION TO DRINKING WATER USERS OFF THE STATION PROPERTY

Off-Site migration of tritium impacted groundwater is highly unlikely since groundwater elevation data indicates that the Site groundwater discharges to the Intake and Discharge Canals and the storm water ponds at the Site. Since there is no off-Site migration, tritium concentrations detected are less than the USEPA drinking water standard of 20,000 pCi/L, and there are no potable water supply wells in the overburden groundwater zone, there is no potentially complete exposure pathway, therefore, there is no current risk for groundwater ingestion off the Station property.

Groundwater samples were also collected adjacent to vacuum breakers associated with historical releases along the blowdown line. The results of the tritium analysis were non detect at the LLD of 200 pCi/L. Potential private wells could theoretically extract groundwater that is sourced from this area, but the groundwater immediately adjacent to the blowdown line is not impacted by tritium. As such, this is a potentially complete exposure pathway, but there is no current risk for groundwater ingestion off the Station property.

7.3.3 POTENTIAL GROUNDWATER MIGRATION TO SURFACE WATER USERS

Under this potential exposure route groundwater must migrate from the Station property to nearby LaSalle Lake at concentrations greater than the 20,000 pCi/L drinking water and surface water standards. Potential exposures could occur if the groundwater discharge to the surface water body was sufficient to increase tritium levels in LaSalle Lake to levels above 20,000 pCi/L. Current surface water data for LaSalle Lake and one of the Station's storm water retention ponds indicates tritium concentrations slightly above 200 pCi/L. The highest tritium concentration in the groundwater at the Station is $1,280 \pm 184$ pCi/L (MW-LS-105S), which is significantly less than the Illinois surface water standard of 20,000 pCi/L. There is no indication from the HIR investigation that tritium impacted groundwater from the area of MW-LS-105S is migrating off the Station into the adjacent LaSalle Lake. This is a potentially complete exposure pathway, but there is no current risk for ingestion off the Station property.

7.4 SUMMARY OF TRITIUM EXPOSURE PATHWAYS

In summary, there are three potential exposure pathways for tritium originating at the Station:

- potential groundwater migration to the Station potable water supply well;
- potential groundwater migration off the Station property to private and public groundwater users; and
- potential groundwater migration off the Station property to a surface water user.

Based upon the groundwater and surface water data provided and referenced in this report, none of the potential receptors are at risk of exposure to concentrations of tritium in excess of the USEPA drinking water standard (20,000 pCi/L).

7.5 OTHER RADIONUCLIDES

Target radionuclides were not detected in the groundwater and surface water samples collected at concentrations greater than their respective LLD. Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides which would otherwise indicate the potential of production from the Station.

8.0 CONCLUSIONS

Based on this hydrogeologic investigation, CRA concludes:

Groundwater Flow

- The groundwater table beneath LaSalle Station is in the overburden, which consists of granular fill and silty clay. Depth to water ranges from 2 to 7.5 feet bgs.
- There is an isolated groundwater trough beneath the PA to the southwest of the Turbine/Reactor Building due to a depression in the Wedron Clay Till which acts like a bowl; trapping groundwater beneath the PA.
- There appears to be a groundwater divide extending from north to south in the area of the existing monitoring well HP-2. Groundwater to the east of HP-2 flows towards and discharges into the intake canal while groundwater to the west of the divide flows to the west around the Reactor/Turbine Building into the storm water retention ponds and discharge canal located west of the PA.
- Groundwater flow within the PA is affected by the foundations of the Reactor/Turbine Building structure, which is constructed in the Wedron Clay Till. This building is a barrier to horizontal groundwater flow to the west.
- The deeper bedrock and overburden water supply aquifers are separated from the Station groundwater by the Wedron Clay Till. There are two potable bedrock wells installed in the Ironton-Galesville Sandstone at a depth of approximately 1,600 feet bgs. These wells are cased from the surface into bedrock.
- The Station building structures were not constructed through the Wedron Clay Till and as such the Wedron Clay Till has not been penetrated by the Station construction activities. Also the Wedron Clay Till has a very low permeability. Therefore, it continues to restrict downward vertical movement of groundwater.
- Groundwater appears to discharge to the north and south storm water retention ponds.

Groundwater Quality

- Tritium concentrations in groundwater were not detected at concentrations greater than the USEPA drinking water standard of 20,000 pCi/L.
- Tritium was not detected at concentrations greater than the LLD (200 pCi/L) in 19 of the 20 groundwater samples collected as part of this investigation.

- Tritium was detected in a groundwater sample from monitoring well MW-LS-105S at a concentration of $1,280 \pm 184$ pCi/L. A second groundwater sample collected from MW-LS-105S had tritium detected at a concentration of 766 ± 153 pCi/L.
- The source of tritium in the groundwater sample from monitoring well MW-LS-105S is most likely attributable to historical spills. Samples obtained from adjacent monitoring wells and surface water locations revealed no detectable tritium levels. The tritium detected in the groundwater sample from MW-LS-105S is localized to the area of that well.
- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in 20 of the 20 groundwater samples collected as part of this investigation.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in 20 of the 20 samples collected as part of this investigation.

Surface Water Quality

- Tritium concentrations in surface water were not detected at concentrations greater than the USEPA drinking water standard of 20,000 pCi/L.
- Tritium was not detected at concentrations greater than the LLD (200 pCi/L) in four of the six surface water samples collected as part of this investigation.
- Tritium was detected at a concentration of 219 ± 113 pCi/L in sample SW-LS-106 collected from the intake canal (Circulating Water Inlet).
- Tritium was detected at a concentration of 232 ± 116 pCi/L in sample SW-LS-101 collected from the north Storm Water Retention Pond.
- The likely source of the tritium detections are from the Illinois River since the Station pumps over 80 million gallons per day of Illinois River Water into LaSalle Lake.
- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in six of the six surface water samples collected as part of this investigation.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in six of the six surface water samples collected as part of this investigation.

AFE-LaSalle-1 - High Pressure Core Spray (HPCS)/Reactor Core Isolation (RI) Systems

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the

groundwater samples collected from the monitoring wells in the vicinity of AFE-LaSalle-1.

- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-LaSalle-1.
- Tritium was not detected at concentrations greater than the LLD of 200 pCi/L in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-LaSalle-1.
- There is no current impact from this AFE to groundwater at the Station.
- The groundwater samples collected from monitoring wells HP-2, HP-5, HP-7, and HP-10 installed to evaluate AFE-LaSalle-1 did not contain tritium, targeted gamma-emitting radionuclides, or strontium-89/90 at concentrations greater than their respective LLDs. This AFE is not a source of radionuclides to groundwater.

AFE-LaSalle-2 – Reactor/Turbine/Radwaste Sumps and AFE-LaSalle-3 –
Cycled Condensate (CY) System

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-LaSalle-2 and -3.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the monitoring wells in the vicinity of AFEs-LaSalle-2 and -3.
- The groundwater samples collected from monitoring wells HP-2, HP-5, HP-7, HP-10, MW-LS-104S, and MW-LS-107S installed to evaluate AFEs-LaSalle-2 and -3 did not contain tritium, targeted gamma-emitting radionuclides, or strontium-89/90 at concentrations greater than their respective LLDs.
- Tritium was detected at a concentration of $1,280 \pm 184$ pCi/L at monitoring well MW-LS-105S. Re-sampling of this well on July 5, 2006 verified the presence of tritium. Tritium was detected in the second groundwater sample at a concentration of 766 ± 153 pCi/L.
- The source of tritium in monitoring well MW-LS-105S is most likely from a historical release associated with the CY Storage Tank overflow in 2001. Samples obtained from adjacent monitoring wells and surface water locations revealed no detectable tritium levels. The tritium detected in MW-LS-105S is localized to the area of that well.

AFE-LaSalle-4 – Blowdown Line Valve/Vacuum Breaker 3A&B:

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-4.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-4.
- Tritium was not detected at concentrations greater than the LLD of 200 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-4.
- The groundwater samples collected from temporary sampling point TS-LS-102S installed adjacent to VB-3A&B installed to evaluate AFE-LaSalle-4 did not contain tritium, targeted gamma-emitting radionuclides, or strontium-89/90 at concentrations greater than their respective LLDs. This AFE is not a source of radionuclides to groundwater.
- There is no current impact from this AFE to groundwater at the Station.

AFE-LaSalle-5 – Blowdown Line Valve/Vacuum Breaker 15A&B:

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-5.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-5.
- Tritium was not detected at concentrations greater than the LLD of 200 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-5.
- The groundwater samples collected from temporary sampling point TS-LS-101S installed adjacent to VB-15A&B to evaluate AFE-LaSalle-5 did not contain tritium, targeted gamma-emitting radionuclides, or strontium-89/90 at concentrations greater than their respective LLDs. This AFE is not a source of radionuclides to groundwater.
- There is no current impact from this AFE to groundwater at the Station.

AFE-LaSalle-6 – Blowdown Line Valve/Vacuum Breaker 16B:

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-6.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-6.
- Tritium was not detected at concentrations greater than the LLD of 200 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-6.
- The groundwater samples collected from temporary sampling point TS-LS-110 installed adjacent to VB-16B installed to evaluate AFE-LaSalle-6 did not contain tritium, targeted gamma-emitting radionuclides, or strontium-89/90 at concentrations greater than their respective LLDs. This AFE is not a source of radionuclides to groundwater.
- There is no current impact from this AFE to groundwater at the Station.

AFE-LaSalle-7 –Radwaste Discharge Line:

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-7.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-7.
- Tritium was not detected at concentrations greater than the LLD of 200 pCi/L in any of the groundwater samples collected from the temporary sampling locations in the vicinity of AFE-LaSalle-7.
- The groundwater samples collected from temporary sampling point TS-LS-103S, TS-LS-104S and TS-LS-105S installed adjacent to the Radwaste Discharge Line to evaluate AFE-LaSalle-7 did not contain tritium, targeted gamma-emitting radionuclides, or strontium-89/90 at concentrations greater than their respective LLDs. The Station discontinued the discharge of Radwaste through this line in December 2000. This AFE is not a source of radionuclides to groundwater.
- There is no current impact from this AFE to groundwater at the Station.

Potential Receptors

- Based on the results of this investigation¹, there is no current risk from exposure to radionuclides associated with licensed plant operations through any of the identified potential exposure pathways.

General Conclusions

- Based on the results of this investigation, tritium is not migrating off the Station property at detectable concentrations.
- Based on the results of this investigation, there are no known active releases into the groundwater at the Station.

¹ Using the LLD specified in this HIR.

9.0 RECOMMENDATIONS

The following presents CRA's recommendations for proposed activities to be completed at the Station.

9.1 DATA GAPS

Based on the results of this hydrogeologic investigation, there are no data gaps remaining to support CRA's conclusions regarding the characterization of the groundwater regime and potential impacts from radionuclides at the Station.

9.2 GROUNDWATER MONITORING

Based upon the information collected to date, CRA recommends that Exelon conduct periodic monitoring of selected sample locations.

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