SECTION 7.0 - CONCLUSIONS

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7.0 CONCLUSIONS

This RFI Report presents the field investigation within the 150 acre Bailey Point area of the Maine Yankee site, the portion of the site most impacted by construction and operation of the facility. The goals of this RFI were to complete the sampling program according to the PQOs identified in the QAPP. The PQOs include the generation of data to characterize contaminant sources, determine nature and extent of contamination, support fate and transport analysis, conduct risk assessments for human health and the environment, and support future remedial activities, if necessary, to minimize potential risk. A Backlands RFI Report, based on an investigation of the remaining unaffected 670 acres, was prepared separately to allow Maine Yankee the ability to expedite ownership transfer of the backlands portion of the site. In addition to investigating two study areas (Study Area 1 and 2), the Backlands RFI Report outlines the sampling program to establish soil and groundwater reference data.

As outlined in the QAPP, RFI activities included collection of soil, concrete, sediment, biota, surface water, and groundwater samples from specific areas of Bailey Point that had the greatest impact potential. The investigation was performed in four study areas (Study Areas 3 through 6), and included deep-water sediments collected in and around the submerged diffuser pipes, and reference sediment and tissue samples from locations sited away from impacted areas of the site. Remediation was performed in some areas (i.e., ISFSI) to support ongoing decommissioning activities and several activities were deferred as a result of demolition, sub-grade radiological remediation, and/or inability to access active areas (i.e., transformers and sumps). These sampling activities will be performed prior to final site closure as areas become available.

A number of contaminant migration pathways and receptors are present in the Bailey Point area of Maine Yankee. The Bailey Point area includes a near-shore environment that consists of populations of benthic organisms that are commercially and recreationally harvested and are a source of food for fish and wildlife. Future receptors include office workers, passive recreation seekers and construction workers.

The previous understanding of subsurface geology and hydrology in the Bailey Point area developed in the QAPP was confirmed and/or enhanced by the RFI. The additional information was integrated with existing geologic data and interpreted in a consistent manner to facilitate the prediction of contaminant fate and transport.

Three quality assurance assessments were performed for this RFI in the form of technical system audits, which were based on criteria outlined in the QAPP. The audits reviewed field sampling collection activities, laboratory analysis and data validation. The audits did not identify any deficiencies that impacted data quality.
7.1 Nature and Extent of Contamination

The Bailey Point RFI consisted of four study areas -- Study Areas 3 through 6 -- and an investigation of sediments in and around the submerged portion of the plant’s diffuser pipes in the Back River. Potential contaminants of concern and migration pathways were identified, which focused primarily on releases to surface water discharge areas, soils from within the industrial area, and migration of contaminants from soils to site groundwater. Based on field and laboratory results for the Bailey Point RFI program, the following is a summary of the nature and extent of contamination.

7.1.1 Soil

A total of 263 soil samples were collected from 183 locations on Bailey Point from Study Areas 3 through 5. Sampling consisted of soil borings, surface/subslab samples, hand augering, test pitting, and Geoprobes. As a result of decommissioning activities, nine soil samples proposed in the QAPP remain to be collected from the plant area as confirmatory samples.

The following is a summary of the nature and extent of soil contamination within each of the study areas.

Study Area 3 – Foxbird Island

Surface soil samples collected from this 12-acre area to characterize the soil associated with historic construction of the diffuser pipeline detected no chemical constituents of concern. Based on these results, no further action is planned for this area.

Study Area 4 - ISFSI

Soil samples were collected from within this 9.5-acre area based on activity during construction and operation of the plant. Several areas of contamination were identified and remediated both prior to and during construction of the ISFSI. The following is a summary of the RFI and remedial actions performed in this area:

- The area was visually inspected prior to construction of the ISFSI and one small area of oil-contaminated soil was identified, which was characterized and removed. The characterization results, submitted to MDEP prior to ISFSI construction (MY, 2000d), noted EPH remaining in the soil.

- A release of kerosene to soil beneath a former spare generator storage building on the west side of this area was investigated and remediated to MDEP Baseline-2 standards (MDEP, 2000a) prior to the RFI. Approximately 1,700 tons of petroleum-contaminated soil was removed, and the remediation was completed in
accordance with an MDEP-approved remediation plan and clean-up criteria (Stratex, 2000c).

- Two areas of subsurface historical petroleum contamination were discovered during construction of the ISFSI, which were subsequently remediated to MDEP Baseline-2 standards (MDEP, 2000a). The initial contamination discovery was during utility trenching along the west side of the ISFSI Operations Building. Approximately 300 cubic yards of petroleum-contaminated soil was removed, which was completed in accordance with an MDEP-approved remediation plan and clean-up criteria (S&W, 2000f). The second area was in the central portion of the ISFSI area and resulted in the removal of about 30 cubic yards of petroleum-impacted soil. A report summarizing that remediation of this second area was performed in accordance with the MDEP-approved plan and clean-up criteria was submitted to MDEP (JWC, 2000).

- One small area of “form oil” over-spray was reported during construction of the ISFSI that was remediated to MDEP Baseline-2 standards (MDEP, 2000a). About seven cubic yards of impacted surface soil was removed in a timely manner in accordance with MDEP clean-up criteria (JWC, 2001).

Based on data collected during the RFI, the additional samples that supported the ISFSI Site Location of Development permit and completion of aforementioned remedial activities, no further action is anticipated within Study Area 4.

**Study Area 5 - Southern Plant Area**

The southern portion of Study Area 5 is the area south of the ISFSI where the majority of plant operations occurred, and includes the diffuser forebay. Soil samples collected from this area were biased towards areas where plant operations had the greatest impact potential.

Three releases occurred in this area during operation of the plant and prior to the RFI: chromated water to a storm drain; water containing sodium chromate to subsurface soils; and release of low viscosity non-PCB-containing transformer oil to surface soils and the Back River. Several USTs were removed from this area: a gasoline tank northeast of the former Information Center; two diesel fuel tanks south of the former Turbine Hall; and a ferrous sulfate tank north of the former Circulating Water Pump House. These documented releases and closures were addressed in a timely manner, were remediated as necessary to the satisfaction of MDEP, and were sampled as part of the RFI.

The former Interim Hazardous Waste Storage Facility, the Lube Oil Storage Room, was closed during the RFI in accordance with an MDEP-approved closure plan (Stratex, 2001a). Because of DRO and PAH detections in subslab soils, these results were assessed as part of the RFI (MDEP, 2002c).
As a result of radiological impacts, several areas were or will be remediated, thus eliminating areas of potential concern identified in the RFI. These activities include removal of soil from the Radiological Restricted Area (MY, 2002k).

Samples collected from the forebay area prior to remedial activities indicated that operation of the forebay did not significantly impact either soils and sediments within the forebay, or seep water and sediment exterior to the forebay (MY, 2002p). As required by the MDEP-approved forebay remediation plan (MDEP, 2003a), confirmatory soil samples will be collected following completion of remedial activities.

During the RFI, several small surface spills and a historic subsurface petroleum-contaminated area were addressed, including:

- Two hydraulic oil leaks to surface soils in the Radiological Restricted Area that were cleaned-up to MDEP Baseline-2 standards (MDEP, 2000a). The two spills were timely addressed and a small volume of impacted surface soils was removed to MDEP clean-up standards (JWC, 2002).

- An area of subsurface historical petroleum soil contamination, discovered in the PAB Alleyway during decommissioning activities, was remediated to MDEP Baseline-2 standards (MDEP, 2000a). About eight cubic yards of soil was removed from this area. The soil was removed from about 10 feet below ground surface down to bedrock achieving MDEP clean-up standards (JWC, 2003).

Based on comparison to project action limits and reference soil, the RFI identified potential contaminants in soil in the southern portion of Study Area 5, including the following:

- Surface and subsurface soils in the Industrial and Radiological Restricted Areas contain elevated concentrations of PAHs and detected concentrations of PCBs and EPH. The distribution of these constituents is focused in surface soils beneath the Turbine Hall in the Industrial Area. These compounds are believed to be derived from the use of PCB-containing, petroleum-based compounds, and were typically detected in association with specific sources (i.e., oil reservoirs, sumps, and drains) and industrial activities.

- Surface soils behind the northwest side of Warehouse 2/3 contain elevated levels of PAHs, lead and PCBs. The PAHs, PCBs and elevated lead were only observed in surface soils and, following the collection of additional samples, the distribution of PAHs was bounded to a relatively small area.

- Subsurface soils behind the southwest side of Warehouse 2/3 contain elevated levels of VOCs (xylenes, ethylbenzene, and toluene) and PCBs associated with the disposal of paint and paint thinners. A focused test pit study has bounded the distribution of VOCs and PCBs in the subsurface soils.
Surface soils associated with the Construction Transformer contain elevated concentrations of EPH and PCBs. The distribution of EPH and PCBs is focused in oil-stained surface soils adjacent to the transformer pad.

Shallow soils in Parking Lot C contain elevated levels of EPH and PAHs.

Shallow soils beneath the former Information Center contained an elevated concentration of lead.

Several areas identified in the QAPP remain to be investigated as a result of ongoing decommissioning activities. These areas, identified below, will be collected as confirmatory samples when the decommissioning schedule allows:

- Main and North Transformer pits – following de-energizing and removal of stone from these pits, confirmatory soil/concrete samples will be collected; and

- RA Buildings and an active sump in the Staff Building - subslab soil samples will be collected following removal of remaining building slabs and de-activating sumps.

Study Area 5 – Northern Plant Area

The northern portion of Study Area 5 is the area north of the ISFSI and 345 kV Switchyard and south of Old Ferry Road. The soils investigation within this area was in areas that had the greatest potential to be impacted by construction and operation of the plant.

Three notable features relating to construction of the plant were investigated as part of the RFI: a chemical cleaning basin; a garage used for the maintenance of concrete trucks; and a marine sediment/construction debris disposal area.

Based on comparison to project action limits and reference soils, the RFI identified potential contaminants in soil in the northern portion of Study Area 5, including the following:

- Subsurface soils in the 345 kV Transmission Line area contain elevated concentrations of EPH and PAHs, and some PCBs. These chemicals were likely associated with miscellaneous construction debris buried in this portion of the site.

- Subsurface soils in the Former Truck Maintenance Garage area contain elevated concentrations of petroleum hydrocarbons. Additional characterization will be required to improve understanding of the extent of petroleum hydrocarbon contamination.
• Subsurface soils in the Bailey Farm House area contain elevated levels of EPH and detected concentrations of PCBs. The EPH was detected in oil-stained soils from a residential fuel oil tank in the basement of the farmhouse and in shallow soils adjacent to and within a septic leachfield associated with the farmhouse. The petroleum-contaminated soils and the fuel oil tank in the Bailey Farm House were removed in July/August 2003. Low concentrations of PCBs were reported in shallow soils adjacent to and within the western leachfield soils.

7.1.2 Groundwater

An extensive sampling campaign was conducted within the Bailey Point area (Study Area 4 and 5) to characterize the nature and extent of contamination in groundwater. A total of 118 groundwater samples were collected for analysis from 65 locations, which consisted of 53 newly installed wells, 10 existing wells and two grab locations.

Study Area 4 – ISFSI

Groundwater samples were collected from existing and installed monitoring wells around the perimeter of Study Area 4. The groundwater sample results exhibited similar characteristics to that of the other wells installed and sampled across the northern portion of the site, namely, elevated petroleum hydrocarbons and metals. The groundwater results from this area are discussed within the context of the groundwater flow regime across the northern portion of Study Area 5.

Study Area 5 - Southern Plant Area

Sampling of groundwater monitoring wells in the southern portion of Bailey Point has revealed contaminants that were related to some aspect of plant construction and/or operation. Some contaminants may have been introduced to surface and/or subsurface soil through accidental spills or leaks, while other contaminants may not have been directly associated with plant activities, but were released from natural, geologic materials. The following is a summary of potential groundwater contaminants identified in the RFI for this portion of the site:

• Groundwater in the Industrial and Radiological Restricted Areas contains sodium concentrations that exceed MEGs, most likely as a result of saltwater intrusion, operational dosing of seawater, sodium chromate leaks, and winter salt application on site roadways;

• Groundwater in the Industrial and Radiological Restricted Areas contains DRO concentrations that exceed MEGs, most likely as a result of historical petroleum releases, former USTs and other non-point sources;

• Dieldrin was found in several bedrock wells in and near the RA in concentrations exceeding the MEGs, most likely from placement of fill during construction;
• Groundwater east and south of Warehouse 2/3 contains TCA and related chlorinated daughter products that exceed MEGs and MCLs, most likely as a result of solvent leakage from drum storage and management activities; and

• Groundwater west of Warehouse 2/3 contains BTEX compounds and metals that exceed MEGs, most likely from spilling paints and solvents to surface soils during operation.

Study Area 5 – Northern Plant Area

The following is a summary of potential groundwater contaminants identified in the RFI for this portion of the site:

• Groundwater beneath the dredge spoil disposal area north of the ISFSI and 345 kV Switchyard contains elevated metals, including boron, sodium, iron and manganese concentrations that exceed MEGs. These levels were most likely a result of the historic filling of the marsh area with marine sediments.

• Groundwater in most of the wells north of the Knoll contains DRO and EPH concentrations in excess of MEGs, most likely as a result of the kerosene and historical petroleum spills discovered within Study Area 4 (ISFSI), pre-operational features such as the Former Truck Maintenance Garage, and miscellaneous sources within the marine sediment/construction debris disposal area north of the 345 kV Switchyard.

• Across much of the northern and southern Bailey Point areas, the molybdenum concentration in groundwater exceeds the MEG. The source of molybdenum is unclear; possible sources are petroleum lubricant spills and natural rock minerals.

7.1.3 Sediment

Sediment was investigated within Study Area 5 (Bailey Point), Study Area 6 (Shoreline Areas) and the submerged diffuser system in Back River. A total of 103 samples were collected from 83 locations. For comparison purposes, seven reference marine sediment samples were collected away from the impact of the site in Brookings Bay, and two reference samples were collected from the Back River away from the impact of the diffuser system.

Study Area 5

Fifteen sediment samples collected from Study Area 5 consist of marine sediment from the forebay area and northern reaches of Bailey Cove and freshwater sediment from northern portions of Bailey Point. Elevated metal concentrations were detected in the marine sediment samples. Sediment within the forebay had, in addition to metals, elevated levels of PCBs, pesticides and PAHs. Most of the sediment will be removed as part of radiological remediation activities (MY, 2002g, 2002k and 2002p). Confirmatory
soil samples will be collected following completion of remedial activities. Marine sediments from the reference location (Brookings Bay) had comparable metal concentrations.

Six freshwater sediment samples collected from Bailey Point were evaluated against reference soil data and/or ecological screening values. A bottom sediment sample from the Fire Pond, collected prior to draining, contained elevated metals compared to reference soil. This sediment, originally from Montsweag Brook water, was removed along with the Pond liner as part of decommissioning activities. Four sediment samples were collected from stormwater drainage areas north of the 345 kV Switchyard. Although several metals from each of the samples slightly exceeded ecological screening values, a significant ecological risk does not exist within these areas because of either lack of standing water and/or critical habitat. A freshwater sediment sample was collected from the small pond located in the northern portion of Bailey Point where a cleaning basin existed prior to operation. Two metals (arsenic and nickel) exceeded ecological screening values, but the concentrations are consistent with background levels.

Study Area 6 – Shoreline (Outfalls)

Study Area 6 consists of the intertidal and subtidal zones around the Bailey Point area where the majority of industrial area stormwater discharges occurred, and a small intertidal mudflat in the northern reach of Bailey Cove that received runoff from the silt spreading area. Seventy sediment, 47 biota (clams and blue mussel) samples from the outfall areas, three sediment samples from the mudflat north of the 345 kV Switchyard, and two sets of mummichog samples from intertidal water near Bailey Point were collected.

The sediment was evaluated in phases against ecological risk/toxicity benchmarks and reference concentrations. The results of the initial sediment screening, presented to MDEP in November 2001, concluded that only three of the outfall sampling locations required further investigation to assess ecological risk (CH2M Hill, 2001b). Therefore, additional testing for sediment toxicity and benthic community structure was performed at an intertidal location at Outfall 005/006 and Outfall 010, and a subtidal location at Outfall 009.

Following an investigation of sediment toxicity and the benthic community at these locations, the ecological risk to the benthic community near each outfall and potential risk posed by bioaccumulative chemicals in the sediments was assessed (CH2M Hill, 2002a, 2002b and 2002c). It was agreed with MDEP and federal regulators that PAH contamination identified at Outfall 009 should be remediated. The finding of PAHs at Outfall 009 is consistent with the petroleum releases documented during operation of the plant. The extent of PAH contamination was bounded as part of the RFI to an area of about 5,500 square feet and nearly 4 inches in depth. A remediation plan for this area has been developed and approved by MDEP for implementation summer 2003 (MDEP, 2003c).
The potential human-health risk associated with commercial and recreational fisherman and other recreational users who may be exposed to residual sediment contamination while wading in the intertidal and subtidal zones was also evaluated and is summarized below in Section 7.3.

**Diffuser**

Although separate from the RFI, eight deep water sediment samples were collected from the Back River in and around the plant submerged diffuser system, including two reference samples upstream and downstream from the diffusers, to support an evaluation of decommissioning options and potential impact from operational releases (MDEP, 2002a). The chemical constituents detected in the six sediment samples collected from the interior and immediate exterior of the diffuser system were consistent with the results from the two reference sediment samples collected for the program. The diffuser pipes will remain in Back River and beneath Foxbird Island.

### 7.1.4 Tissue

Representative ecological receptors within Study Area 6 were selected and evaluated to assess potential risk from bioaccumulative chemicals. To this end, 38 samples of soft-shelled clams, blue mussel and mummichog were collected for chemical analysis. Seven reference tissue samples of clam, mussel and mummichog were collected from Brookings Bay for comparison purposes.

Analysis of clam and mussel tissue suggests that there are slightly elevated PAH concentrations at Outfalls 005/006 and 010, and substantially elevated PAH concentrations in blue mussels at Outfall 009, compared with the reference site. Mummichog tissue exhibited several elevated metals, PAHs, and four pesticides relative to reference conditions. However, all tissue residues were at or below critical tissue residue (screening) levels.

The results of this assessment phase were presented in a technical memorandum to the MDEP in July 2002 and was discussed with MDEP and federal regulators October 2002 (CH2M Hill, 2002b and 2002c). It was concluded that there is little to no elevated risk relative to reference conditions from the chemicals in the sediments and biota near the outfalls. Since potential risk from PAHs can be underestimated from tissue residues alone, the potential risk to fish from the PAHs in the sediments at Outfall 009 could not be ruled out. The weight of evidence and overall potential ecological risks associated with the identified chemical concentrations in both sediment and tissue were evaluated in the Ecological Risk Assessment and are summarized below in Section 7.4.

The human-health risk associated with ingestion of shellfish tissue, including mussels, clams and lobster, was also evaluated and is summarized below in Section 7.3.
7.1.5 Concrete

Subgrade concrete that will remain onsite was investigated in the industrial portion of Bailey Point (Study Area 5). Twenty samples of concrete were collected from 20 locations. The majority of the concrete surfaces were located within the RA area and were remediated (scabbled) prior to collection of RFI samples. Five areas identified in the QAPP remain to be sampled as confirmatory samples following completion of decommissioning activities.

Two small surface petroleum stains sampled in subgrade areas of the PAB and CWPH are not a significant source and are not expected to migrate from the concrete. A petroleum stain on the uncoated concrete slab of the Fire Pond Pump House was removed and confirmatory samples were collected as part of the RFI to confirm removal of contaminants.

Based on data collected during the RFI to characterize concrete that will remain onsite, no further action is warranted.

7.1.6 Surface Water

Five surface water locations were sampled from areas downgradient or within areas of suspected contamination within Study Area 5; seep locations on the Bailey Cove side of the forebay and 345 kV Transmission Line area, excess flow from Outfall 011 to Back River, and the small pond in the northern portion of Bailey Point where a cleaning basin existed prior to operation.

With the exception of three metals (aluminum, lead and zinc) and low EPH concentrations identified in seeps, all other compounds are below surface water PALs. Based on this understanding, no significant impacts to surface water were identified. Since these seep areas are small in size relative to receiving water bodies (Back River and Bailey Cove) and consist of low, intermittent flows, no further action is anticipated.

7.2 Contaminant Fate and Transport

The fate and transport of both organic and inorganic compounds in the environment is typically controlled by physical and chemical properties of the source and the media through which it travels. The RFI evaluated the fate and transport of identified contaminants, including the possible leaching from soil to groundwater, flow of groundwater and surface runoff to near shore areas and possible natural attenuation over time.
7.2.1 Fate and Transport in Soil

The concentration of detected metals in soil was typically below project action limits and reference concentrations, with the exception of iron, manganese and lead. These metals will typically remain stable in soil unless the stability of the metals changes. With the exception of an isolated detection of lead in shallow soil beneath the former Information Center, the areas of Bailey Point exhibiting the greatest concentrations of these metals are areas that were filled during construction, namely the RA, industrial, Warehouse 2/3, and 345 kV Transmission Line areas.

Surface and/or subsurface soils in several areas of the site (i.e., Industrial and Radiological Restricted Areas, Warehouse 2/3 area, Construction Transformer, Former Truck Maintenance Garage, 345 kV Transmission Line area, and the Bailey Farm House) contain elevated concentrations of PAHs, PCBs and/or EPH. These compounds have limited mobility in the environment, have biodegradation potential, and are expected to remain adsorbed to the shallow soils. The major portion of the detected EPH in the area of the Former Truck Maintenance Garage was comprised of C9-C18 aliphatic petroleum hydrocarbons, consistent with a diesel-like source material. This range of petroleum hydrocarbons has limited solubility, but will continue to degrade groundwater quality via infiltration and leaching processes. Biodegradation will also occur under aerobic conditions provided there is a source of oxygen or other electron acceptors. EPHs detected in most other portions of the site are heavier petroleum hydrocarbons including C19-C36 aliphatics and C11-C22 aromatics. These petroleum hydrocarbons are less soluble in water and will remain partitioned to soils.

Subsurface soils located behind Warehouse 2/3 contain elevated levels of VOCs (xylenes, ethylbenzene, and toluene) and PCBs associated with the disposal of paint thinners and paint. The VOCs have leached through the soil horizon via infiltration process and have degraded the adjacent groundwater. The PCBs associated with the paint wastes have gained enhanced mobility due to their inclusion in the waste material, and are present at decreasing concentrations with depth in the subsurface soils. The low water solubility of Aroclor 1254 has minimized the migration of PCBs into groundwater.

Low concentrations of pesticides were detected in surface and subsurface soils at several locations. Dieldrin was detected in several subsurface samples at depths up to 13 feet below ground surface. When detected in the subsurface soils, dieldrin was not observed in shallower soil samples at those locations. These dieldrin–containing soils were typically comprised of fill material. The limited mobility of dieldrin, the lack of dieldrin in shallow samples and the occurrence in fill material indicates that the source of the dieldrin is the original fill material.

7.2.2 Fate and Transport in Groundwater

There are several groundwater regimes on Bailey Point including the upper regime that encompasses the phreatic surface, and a deep bedrock regime. Flow generally moves...
perpendicular to ground surface topography in the soils and shallow bedrock. In the
deeper bedrock, flow is generally down the axis of the peninsula from north to south. As
bedrock flow approaches the edge of the shore, it turns toward it and flows upward to
discharge in the near-shore area.

There are several remaining potential sources of contaminants on the site. Some sources,
such as petroleum spills, are held in the unsaturated zone of soil or soil fill. Most of the
identified spills have been remediated. Another contaminant source on the site is residual
sodium that is moving from the solid phase to the liquid phase and diluting in the
groundwater. This sodium has a number of sources on the site and occurs broadly over
the site in concentrations exceeding the State of Maine MEG.

Iron, manganese, and, to a much lesser extent, arsenic are naturally occurring geologic
materials that have dissolved into the groundwater. The metal solubility is a function of
Eh-pH conditions related to burying former organic marsh deposits with marine dredge
spoils, to petroleum spills and to other oxygen consuming contaminants. These metals
are not likely to become lower in concentration with time. Molybdenum is more
complicated and exceeds the State of Maine MEG over a large area of Bailey Point. The
source of molybdenum in groundwater is not clear, but may be related to molybdenum-
bearing petroleum lubricants and a natural occurrence from minerals in the granite and
pegmatite bedrock.

TCA and its breakdown products 1,1-DCA, 1,1-DCE and VC, occur in a small
groundwater plume originating east of Warehouse 2/3 and flowing south to discharge in
the near-shore area of Outfalls 005 and 006. The presence of the TCA daughter
compounds in groundwater downgradient of the source area indicates that TCA is
naturally degrading and will attenuate over time. The low concentrations of TCA
detected in soils within the historic release area do not represent an ongoing source to
groundwater.

On the west side of Warehouse 2/3, there are BTEX compounds and metals in
groundwater that are associated with a nearby source of contamination in soil.
Ethylbenzene concentrations currently exceed the State of Maine MEG. The removal of
the source should reduce the groundwater contamination in a fairly short period of time.
Meanwhile, the groundwater from this area is flowing westward to discharge in the near-
shore areas of Bailey Cove.

7.2.3 Fate and Transport in Sediment

Several metals detected in sediment - arsenic, chromium, lead, mercury, and selenium -
will bioaccumulate to some degree; mercury (and in some cases selenium) is also known
to biomagnify in aquatic food webs.

Most of the SVOCs detected in the sediment are PAHs. As the level of organic carbon in
sediment increases, PAHs tend to become strongly adsorbed to the sediment and thus
have limited bioavailability. Biodegradation and biotransformation by benthic organisms
are the most important biological fate processes for PAHs in sediments. Most animals and microorganisms can metabolize and transform PAHs to breakdown products that may ultimately experience complete degradation. PAHs with high molecular weights are degraded slowly by microbes and readily by multicellular organisms.

### 7.3 Human Health Risk Assessment

The purpose of this baseline HHEA was to evaluate potential human health risks due to exposure to residual contamination in soils, sediment, shellfish tissue and groundwater at or surrounding the industrial portion of the Maine Yankee Facility. Based on the site history and results of the RFI, the site was divided into 10 discrete areas for purposes of site and risk characterization. The risks associated with exposure to soils in three of these areas (i.e., Foxbird Island, the Forebay, and the Former Truck Maintenance Area) were not evaluated as part of this risk assessment. RCRA constituents were found to be below PALs in soil samples from Foxbird Island and the Forebay has undergone significant radiological-driven soil remediation. Confirmatory samples following the Forebay remediation will be included in the RCRA Closure documentation. Only petroleum hydrocarbons were detected in soils at the Former Truck Maintenance Garage. Remediation of the petroleum hydrocarbons will be driven by the MDEP Decision Tree Guidance (MDEP, 2000a) and documented in the CMS.

The risks associated with exposure to soils at the 115 kV Switchyard, Personnel Buildings and Parking Lot Areas, and ISFSI (Study Area 4) were evaluated by comparing detected concentrations to the MDEP Remedial Action Guidelines concentrations. This approach was considered appropriate for these three areas as sampling and analytical results support the conclusion that these areas have not been adversely impacted by historical site activities. The risks associated with exposure at the Plant Areas, Warehouse 2/3, the 345 kV Transmission Line Area and the Bailey Farmhouse were evaluated in accordance with MDEP and USEPA methodology as presented in the Draft HHEA Work Plan.

A comparison of Remedial Action Guidelines to soil concentrations detected at the 115 kV Switchyard, ISFSI and Personnel Buildings and Parking Lot Areas indicates that these areas have not been adversely impacted by historical land use.

Exposure to soils within the Plant Area, Warehouse 2/3, 345 kV Transmission Line Area and Bailey Farmhouse was evaluated for a construction worker, on-site worker and resident. Exposure to sediment, fish tissue, groundwater and homegrown produce was evaluated for a hypothetical area resident. COPCs were selected for each study area based on USEPA screening criteria. EPCs were calculated for each COPC and used to estimate an exposure dose concentration for each exposure pathway. The exposure dose concentrations were combined with toxicity information to quantitatively estimate non-carcinogenic and carcinogenic risks. Estimated cancer risks were compared to the USEPA risk range of $10^{-4}$ to $10^{-6}$ and MDEP target risk level of $10^{-5}$. Non-carcinogenic risks were compared to an HI of 1. The quantitative risk estimates were based on assumptions that render the final risk estimates as overly conservative.
7.3.1 Soils

Noncarcinogenic and carcinogenic risks associated with exposure to soil were evaluated for the on-site worker, construction worker and resident. A residential scenario was included at the request of MBOH. The application of institutional controls will restrict future land use to industrial/commercial activities. A summary of the Non Cancer and Cancer Risks is provided below.

Non-Cancer Risks

The noncarcinogenic risks for all exposure scenarios except the child residential exposure scenario were below an HI of 1.0. The HI, based on a 6-year childhood exposure to soils in the Warehouse 2/3 slightly exceeded 1.0. However, exposure to arsenic and iron accounts for the majority of the non-carcinogenic risks in this area. Arsenic and iron are naturally occurring elements and are not related to plant activities. Eliminating the risks associated with exposure to arsenic and iron results in a lowering of all noncarcinogenic risk estimates to below an HI of 1.0.

The noncarcinogenic risks from exposure to soils throughout Bailey Point are below levels considered to present a human health risk.

Cancer Risks

Carcinogenic risks associated with exposure to soil were evaluated for the construction worker, on-site worker and resident and are discussed below.

The carcinogenic risks associated with exposure to soil for the construction worker scenarios were all at or below the lower end of the USEPA target risk range and below MDEP target risk level of $10^{-5}$. These risk estimates indicate that short-term intensive exposure to both surface and subsurface soils throughout Bailey Point does not present a significant health risk.

The carcinogenic risks associated with exposure to soil for the on-site worker were within or below the USEPA target risk range and at or below the MDEP target risk level. Only two constituents, arsenic and benzo(a)pyrene, are present in soil at concentrations associated with individual risk level greater than $10^{-6}$.

For all exposure scenarios evaluated, exposure to arsenic presents the greatest risk. Arsenic is a naturally occurring element that is present at background levels and was not utilized or produced by any plant-related activities. Removing arsenic from the risk calculations results in carcinogenic risk estimates at or below the MDEP target risk level. Benzo(a)pyrene becomes the only constituent present in soils at concentrations associated with individual cancer risks greater than $10^{-6}$, and no constituents are present at concentrations associated with individual cancer risks greater than $10^{-5}$. These risk
estimates indicate that long term exposure of an on-site worker to soil does not present a significant health risk.

The carcinogenic risks based on the residential CT exposure scenarios were all below the MDEP risk level and within the USEPA target risk range. The risks from exposure to soil under the residential Reasonable Maximum Exposure (RME) exposure scenario were greater than the MDEP target risk level of $10^{-5}$ for three of the four study areas. Exposure to arsenic presents the greatest risk to a hypothetical future resident. Removing arsenic from the carcinogenic risk calculations results in a lowering of the residential risk estimates to below the MDEP target level for all but two study areas. Only four constituents are present in soil at concentrations associated with a cancer risk of greater than $10^{-6}$ and include: benzo(a)pyrene; benzo(a)anthracene; benzo(b)fluoranthene; and dibenzo(a,h)anthracene. Benzo(a)pyrene is the only constituent present in soil at a concentration associated with an individual cancer risk greater than $10^{-5}$.

Based on these risk estimates, no additional actions are considered necessary to reduce human health risks from exposure to surface soils at this site.

### 7.3.2 Subsurface Soils

A hypothetical construction worker scenario was developed consistent with USEPA guidance to evaluate potential risks from exposure to subsurface soil. The carcinogenic risks for this scenario were all less than the MDEP target risk level of $1 \times 10^{-5}$, and at or below the lower end of the USEPA target risk range. No individual cancer risks were above $1 \times 10^{-6}$. These risk estimates indicate that future exposure to subsurface soils at Bailey Point by construction workers does not present a significant health risk. No additional actions are considered necessary to reduce human health risks from exposure to subsurface soils at this site.

### 7.3.3 Sediments

Residual contamination was detected in sediments collected from the intertidal and subtidal portion of the Back River and Bailey Cove. Hypothetical Commercial Shell-fishing and residential exposure scenarios were evaluated to estimate potential risks from sediment exposure under future unrestricted access to the shoreline sediments. The carcinogenic risk estimates were within and below the USEPA target risk range and at or below the MDEP target risk level. The noncarcinogenic risks were all below a target HI of 1.0. These risk estimates indicate that future exposure to sediments within the Back River and Bailey Cove does not present a significant health risk. No additional actions are considered necessary to reduce human health risks from exposure to sediments at this site.
7.3.4 Shellfish Tissue

This risk assessment evaluated the ingestion of shellfish, including mussels, clams, lobsters, and lobster tomalley. The carcinogenic risk estimates for this route of exposure exceed both the MDEP target risk level and the USEPA target risk range for all species. Ingestion of shellfish containing arsenic presented the greatest risk based on the assumption that arsenic in shellfish is in the organic form. This assumption is overly conservative as 80 to 99 percent of arsenic in shellfish is typically in the nontoxic, organic form (ASTDR, 2000). The noncarcinogenic risks were greater than an HI of 1 for all species.

Carcinogenic and noncarcinogenic risks from ingestion of clams and mussels obtained from the reference locations were also greater than the MDEP target risk level and the USEPA target risk range and exceeded an HI of 1.0. Similar contaminants were detected in site and reference clam and mussel samples with the majority of contaminants at greater concentrations in the reference samples. The concentrations of individual PAH compounds, the primary contaminant in the outfall sediments, were actually greater in the reference samples. There does not appear to be a significant difference between the chemical composition of the site and reference samples. As such, the risks from ingestion of biota appear to be the result of background conditions.

7.3.5 Groundwater

Residual contamination was detected in the groundwater collected from Bailey Point. A residential groundwater scenario was evaluated to estimate potential risks from groundwater exposure under future unrestricted land use. The noncarcinogenic and carcinogenic risk estimates exceeded the USEPA target risk range and the MDEP target risk level and HI of 1.0. In addition, eighteen groundwater constituents were detected at concentrations greater than their respective MCL or MEG concentration.

These risk estimates indicate that exposure to groundwater from the Bailey Point may present health risks. As such, the Corrective Measures Study (CMS) should evaluate potential strategies to reduce human exposure to contaminant concentrations in groundwater.

7.3.6 Produce

This risk assessment evaluated the potential risks from contaminant uptake and ingestion of homegrown produce. Contaminant concentrations in produce were estimated using chemical specific bioconcentration factors and site-specific surface soil concentrations (USEPA, 1998f). The noncarcinogenic risks ranged from 0.2 to 1.3. The carcinogenic risks were all above the MDEP target risk level.

These risk estimates indicate that future exposure to homegrown produce may present a health risk.
7.4 Ecological Risk Assessment

The ERA was prepared to evaluate the potential risk to ecological receptors associated with the marine habitat surrounding the Maine Yankee site in order to make informed risk management decisions. This risk assessment was conducted consistent with the ERA Work Plan outlined in the QAPP, and in accordance with USEPA and MDEP guidance.

Based on the weight of evidence from the various studies and evaluations conducted for the ecological risk assessment, there are potentially moderate risks to fish and benthic invertebrates from site-related chemicals in the sediments at Outfall 009. Although some site-related chemicals were detected in the sediments at some of the other outfall locations, the weight of evidence suggests that the potential ecological risk at the other outfalls is minimal. The following is a summary of the ecological risk assessment.

7.4.1 Benthic Community

The results of the ERA indicated that there is no elevated benthic community risk, relative to the reference site, at Outfalls 008, 011, and 012. The risk characterization did indicate that there exists some potential risk to the benthic community at Outfalls 005/006 and 010; however, the risk does not appear great and a healthy benthic community is currently present at Outfall 005/006. Although pollution-tolerant species were found at Outfall 010, the species diversity and density were generally comparable to the reference station. The results of the ERA suggest that there is risk to the benthic community at Outfall 009, which will be addressed through the sediment removal action planned at this outfall.

7.4.2 Small Benthic Fish

The results of the ERA indicated that no elevated risk, relative to reference conditions, exists to small benthic fish from chemicals in the sediments at the outfall areas at Maine Yankee.

7.4.3 Carnivorous Fish

With one exception, the results of the ERA indicated that no elevated risk, relative to reference conditions, exists to carnivorous fishes from chemicals in the sediments at the outfall areas at Maine Yankee. The one exception was for arsenic on the west side of the facility (Bailey Cove), where it was identified as a COPC for carnivorous fish. However, there is uncertainty in this conclusion because of the conservative assumptions used in the food web calculations (e.g., the multiplier of ten used to estimate long-term exposure does not account for depuration of arsenic over time).

7.4.4 Carnivorous Wading Birds
The results of the ERA indicated that there is little to no potential risk to carnivorous wading birds that may forage near the outfall areas around Maine Yankee. In addition, relative to the reference area in Brookings Bay, there is no elevated risk from any of the chemicals detected, since the chemicals were present at higher concentrations in prey items from the reference area, and thus represent a pervasive presence throughout Montsweag Bay.

### 7.4.5 Piscivorous Birds

The potential risk to two groups of piscivorous birds was evaluated; birds that feed primarily on small estuarine fishes, such as the belted kingfisher, and birds that feed on larger predaceous fishes, such as the osprey. This evaluation revealed that for the kingfisher and similar birds, the dosages of only two chemicals, mercury and zinc, pose a potential risk. However, the concentrations of these metals in mummichog tissue were similar between the site and the reference area, indicating no elevated potential risk relative to reference conditions.

The evaluation for piscivorous birds that feed on larger predaceous fishes revealed that only one chemical (mercury) might pose a potential risk. However, the potential risk near Maine Yankee was similar to the potential risk at the reference site. Therefore, although a potential risk from mercury cannot be dismissed for piscivorous birds that feed on larger fishes, the potential risk appears to be pervasive throughout Montsweag Bay and unrelated to activities at the Maine Yankee facility.

### 7.4.6 Evaluation of Potential Effects from PAH Exposure to Fish

Since fish rapidly metabolize PAHs, additional evaluation was undertaken to assess potential risk to fish from these chemicals that might not be identified by tissue chemical residues. Sediment PAH concentrations linked to mutagenic and carcinogenic effects in fishes were compared with sediment PAH concentrations at the outfall areas. The results of this comparison indicated that there is no cancer risk to fish from PAH exposure at Outfall 005/006, a possibility of a risk to fish from PAHs at Outfall 010, but likely not significant, and a potential risk to fish from PAHs at Outfall 009.

### 7.5 Summary and Recommendations

RFI activities included the collection of soil, concrete, sediment, biota, surface water, and groundwater samples from areas of Bailey Point with known or suspected contamination. An evaluation of the affected site media was conducted to assess its nature and extent and fate and transport against project action limits, reference data and cited literature. Based on this evaluation, several areas of interest within Bailey Point were identified, which corresponded to the known or suspected areas of potential contamination. Several areas were remediated (i.e., soil removed) prior to or during the RFI to eliminate the potential sources of contamination.
The potential risk to human health and the environment was assessed within Bailey Point based on the relationship of identified source areas to potential pathways and receptors. The assessment of risk to human health concluded that exposure to groundwater from Bailey Point may present a health risk and no additional corrective actions are necessary to reduce risks from exposure to soil, sediment or shellfish. Based on the ecological risk assessment, there are potentially moderate risks to fish and benthic invertebrates in sediment at Outfall 009.

Several remaining areas will be addressed in the CMS, which will identify areas to be remediated, methods of remediation, and areas that will require ongoing monitoring. Remedial activities performed to date will be documented in the CMS.

Based on the fate and transport qualities and assessment of risk to human health and the environment, the following areas are recommended for consideration in the CMS:

- Subsurface soils containing VOCs on the southwest side of Warehouse 2/3 that affect groundwater quality;
- Surface and shallow soils containing petroleum hydrocarbons and PCBs near the Construction Transformer;
- Subsurface soils containing petroleum hydrocarbons in the area of the Former Truck Maintenance Garage;
- Subsurface soils adjacent to MW-401B in the RA as a result of petroleum hydrocarbons in groundwater;
- Groundwater associated with solvents and various metals downgradient of Warehouse 2/3; and
- Groundwater for DRO and various metals throughout Bailey Point.