Natural Resource Damage Assessment Plan: White Sands Test Facility

Doña Ana County, New Mexico

New Mexico Office of Natural Resources Trustee
Albuquerque, New Mexico

FINAL

March, 2019

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LIST OF EXHIBITS

LIST OF ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
DOD	United States Department of Defense
DOI	United States Department of the Interior
EPA	United States Environmental Protection Agency
FWPCA	Federal Water Pollution Control Act of 1972 or Clean Water Act
FWS	United States Fish and Wildlife Service
HEA	Habitat Equivalency Analysis
HWMUs	Hazardous Waste Management Units
MCL	Maximum Contaminant Level
MPITS	mid-plume interception and treatment system
NASA	National Aeronautics and Space Administration
NDMA	n-nitrosodimethylamine
N.M.	New Mexico
NMAC	New Mexico Administrative Code
NMSA	New Mexico Statutes Annotated
NMED	New Mexico Environment Department
NMSC	New Mexico Supreme Court
NRDA	Natural Resource Damage Assessment
ONRT	New Mexico Office of Natural Resources Trustee
PAS	Preassessment Screen Determination Report
PCE	tetrachloroethene
PFTS	plume front treatment system
PI	Principal Investigator
Plan	Natural Resource Damage Assessment Plan

QA	quality assurance
QAP	Quality Assurance Plan
QC	quality control
RCDP	Restoration and Compensation Determination Plan
RCRA	Resource Conservation Recovery Act
REA	Resource Equivalency Analysis
TCE	trichloroethene
TDS	total dissolved solids
TEV	Total Economic Value
USC	United States Code
VOCs	volatile organic compounds
WQCC	Water Quality Control Commission
WSMR	White Sands Missile Range
WSTF	White Sands Test Facility

EXECUTIVE SUMMARY

The National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF, "the Site") is located near Las Cruces, New Mexico. WSTF was established in 1962 to support the NASA Apollo Space Program. Activities at WSTF include propulsion testing for rocket systems, laboratories for testing the quality of space flight materials, and other technical support activities (NASA 2013a, Corbett 2013). Site operations have resulted in the release of hazardous substances, particularly from tanks and impoundments used to store waste materials. Hazardous substances have come to be located in groundwater and soils and may have adversely impacted other natural resources.

Under Federal law, Federal, state, and Tribal governments are authorized to act as trustees of natural resources on behalf of the public (e.g., Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERLCA], at Title 42 of the United States Code [USC] § 9607 (f); see also 43 Code of Federal Regulations [CFR] Part 11). In this role, trustees plan and implement actions to restore, replace, or acquire the equivalent of injured natural resources and lost natural resource services as a result of the release of hazardous substances to the environment. Specifically, trustees conduct a natural resource damage assessment (NRDA) to assess and recover damages from the parties responsible for the release(s). All damages recovered as a result of a NRDA under CERCLA must be used to undertake actions to restore, replace, or acquire the equivalent of the resources that were injured and the services those resources would have provided in their baseline (i.e., but for hazardous release) condition.

To meet its responsibilities, the New Mexico Office of Natural Resources Trustee (ONRT, the "Trustee") is conducting a NRDA for WSTF. The NRDA process started with the development and release of the Preassessment Screen Determination Report in March 2016 (ONRT 2016). This document serves as the Natural Resource Damage Assessment Plan (the Plan) for the Site. The purpose of this Plan is to describe the approach that the Trustee will take in determining and quantifying injury to natural resources affected by the release of Site-related hazardous substances, as well as determining damages required for compensation of those injuries. This process will ensure that the NRDA is conducted in a systematic manner and at a reasonable cost. This Plan was released to the public for review and comment as a draft Plan in December 2016, and no comments were received. This document represents the release of the final Plan.

The Trustee has completed a preliminary review of available data as part of the assessment planning process, and anticipates beginning the assessment with a more in-depth review and evaluation of available data, followed by the implementation of specific assessment activities. The Trustee's planned assessment activities are summarized in Exhibit ES-1 below and in Chapter 6. This Plan and the proposed assessment activities represent the Trustee's current understanding of the analyses that may be necessary to identify and quantify injuries to natural resources and the services they provide on and around WSTF, and to identify and scale restoration. Inclusion of an activity within this Plan does not guarantee that it will be undertaken, and efforts not included within this Plan may be deemed necessary at a later date. This Plan does not limit in any way the extent and nature of analyses that maybe undertaken in the course of the assessment. Rather, it provides a framework within which the Trustee will begin to implement the assessment. As these efforts progress and additional information is generated, the Trustee may modify this Plan, and may provide amendments to this Plan, or portions of this Plan, for public review and comment.

EXHIBIT ES-1 PROPOSED ASSESSMENT ACTIVITIES

CATEGORY / RESOURCE	ASSESSMENT ACTIVITY	SUMMARY OF ASSESSMENT ACTIVITY
ECOLOGICAL	Compilation and Review of Existing WSTF Ecological Data	Compile available data related to ecological resources (e.g., soils, biota) and contaminant exposure and begin to review data to identify information relevant for the ecological assessment.
	Identification of Ecological Contaminants of Concern and Adverse Effects Thresholds	Based on the review of existing information, identify a suite of contaminants of concern and summarize available information on the ecotoxicological impacts of these contaminants of concern. Identify adverse effects thresholds from the literature and/or promulgated standards for use in identifying and quantifying ecological injuries.
	Identification and Quantification of Ecological Impacts due to Remedy	Compile available information on remedial actions completed and planned at WSTF. Determine the potential ecological adverse impacts, and benefits, resulting from the remedial actions.
	Quantification of Ecological Injuries and Service Losses	Analyze resource-use specific information compiled during previous efforts to quantify lost ecological services.
	Determination and Monetization of Ecological Damages	Identify and scale restoration projects needed to compensate for ecological injuries and associated lost services.
GROUNDWATER	Compilation and Review of Existing WSTF Groundwater Data	Compile and review groundwater data contained within available WSTF databases and reports, and identify information relevant for groundwater assessment purposes.
	Quantification of the Volume of Contaminated Groundwater	Quantify injured groundwater volume and time dimensions using existing information and information obtained as a result of activities listed in this Plan.
	Assessment of Groundwater Service Losses	Describe the services provided by groundwater in and around WSTF under baseline conditions and how these services have been impacted by the release of hazardous contaminants, in order to determine the service losses attributable to hazardous substance contamination.
	Determination and Monetization of Groundwater Damages	Identify and scale restoration projects needed to compensate for groundwater injuries and associated lost services.
ALL RESOURCES	Development of a Restoration and Compensation Determination Plan (RCDP)	Compile information and results from the ecological and groundwater assessment activities to develop an RCDP, summarizing restoration alternatives and the Trustee's preferred alternative.

CHAPTER 1 | INTRODUCTION AND BACKGROUND INFORMATION

The National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF, “the Site”) is located near Las Cruces, New Mexico. WSTF has supported testing of space flight equipment for over 50 years. WSTF was built primarily to support NASA’s Apollo Space Program, and past activities included developing and testing spacecraft propulsion systems. The Site currently includes propulsion testing facilities for rocket systems; materials and components laboratories for testing the quality of space flight materials; and technical services offices that provide expertise for developing ground support equipment (NASA 2013a, Corbett 2013).

Operations conducted at the Site have resulted in the release of hazardous substances to the environment. Under Federal law, Federal, state, and Tribal governments are authorized to act as trustees of natural resources on behalf of the public (e.g., Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERLCA], 42 USC [United States Code] § 9607 (f); see also 43 Code of Federal Regulations [CFR] Part 11). In this role, trustees plan and implement actions to restore, replace, or acquire the equivalent of injured natural resources and lost natural resource services as a result of the release of hazardous substances to the environment. Specifically, trustees conduct a natural resource damage assessment (NRDA) to assess and recover damages from the parties responsible for the release, and use those damages to implement restoration actions. Damages may include the cost of primary restoration actions to restore the injured resources and the services provided by those resources to their baseline condition (i.e., the condition that would have existed but for the release), as well as the cost of compensatory restoration actions to compensate for interim losses pending restoration (73 Fed. Reg. 57,260). All damages recovered as a result of a damage assessment under CERCLA must be used to undertake actions to restore, replace, or acquire the equivalent of the resources that were injured and the services those resources would have provided in their baseline (i.e., but for hazardous release) condition.

To meet its responsibilities, the New Mexico Office of Natural Resources Trustee (ONRT, the “Trustee”) is conducting a NRDA for WSTF. The NRDA process started with the development and release of the Preassessment Screen Determination Report in March 2016 (ONRT 2016). This document serves as the Natural Resource Damage Assessment Plan (the Plan) for the Site. This Plan was prepared in accordance with the United States Department of the Interior (DOI) NRDA regulations in the CFR at Title 43 Part 11. This Chapter presents background information and discusses the NRDA process and current status of the WSTF NRDA.

1.1 PURPOSE

The purpose of this Plan is to describe the approach that the Trustee will take in determining and quantifying injury to natural resources affected by the release of Site-related hazardous substances, as well as determining damages required for compensation of those injuries. This process will ensure that the NRDA is conducted in a systematic manner and at a reasonable cost, as required by the DOI NRDA regulations (43 CFR Part 11), and in accordance with other applicable Federal and state laws.

The Plan allows for coordination between the Trustee and the public. The draft Plan was released for a public comment period in December 2016, with the goal of creating a comprehensive damage assessment plan based on information currently available to the Trustee. No comments were received, and this document represents the final Plan. The Trustee intends for this Plan to serve as a living document, subject to change as the NRDA progresses. If significant changes are made to this Plan or it is amended as additional data are collected or information is uncovered during the assessment, the Trustee may release subsequent versions of this document, in whole or in part, for public comment.

1.2 TRUSTEE AUTHORITY

The CERCLA as amended, at Title 42 of the USC § 9601, *et seq.*, the Oil Pollution Act of 1990, 33 USC § 2701, *et seq.*, and the Federal Water Pollution Control Act of 1972 (FWPCA; also known as the Clean Water Act), as amended, 33 USC § 1251, *et seq.*, authorize the Federal Government, states, and Tribal governments to recover damages for injuries to natural resources and their supporting ecosystems, belonging to, managed by, appertaining to, or otherwise controlled by them:

> *"In the case of an injury to, destruction of, or loss of natural resources under subparagraph (C) of subsection (a) of this section liability shall be to the United States Government and to any State for natural resources within the State or belonging to, managed by, controlled by, or appertaining to such… Provided, however, that no liability to the United States or State or Indian tribe… shall be imposed under subparagraph (C) of subsection (a) of this section, where the party sought to be charged has demonstrated that the damages to natural resources complained of were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement, or other comparable environment analysis, and the decision to grant a permit or license authorizes such commitment of natural resources, and the facility or project was otherwise operating within the terms of its permit or license…"* (42 USC § 9607 (f)(1))

In New Mexico, the Natural Resources Trustee is designated under the Natural Resources Trustee Act (New Mexico Statutes Annotated [NMSA] 1978, §§ 75-7-1 to -5) to act pursuant to these federal authorities. Specifically:

> *"The natural resources trustee shall act on behalf of the public as trustee of natural resources within the state or belonging to, managed by, controlled by or appertaining to the state, including protecting and representing the state's interest under applicable*

> *federal laws regarding injury to, destruction of or loss of natural resources in the state."* (NMSA 1978, § 75-7-2A)

Under CERCLA, a natural resource is defined in relevant part as "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States… any State or local government, any foreign government, [or] any Indian tribe." (42 USC § 9601 (16), 43 CFR § 11.14(z))

Based on a review of available information, the natural resource most clearly affected by releases from the Site is groundwater. In New Mexico, all underground waters are public waters and belong to the public of the State of New Mexico (NMSA 1978, § 72-12-18).

> *"The public waters of [New Mexico] are owned by the state as trustee for the people… and it is authorized to institute suits to protect the public waters against unlawful use, or to bring any other action whether authorized by any particular statute, if required by its pecuniary interests or for the general public welfare." State ex rel. Reynolds v. Mears, 1974-NMSC-070 [New Mexico Supreme Court], 86 N.M. 510 [New Mexico], 515 (internal citations omitted).*

The Trustee is therefore authorized to assert trusteeship over groundwater. There may also be terrestrial resource injuries at the Site, including contamination of soil resources and potential impacts to wildlife.

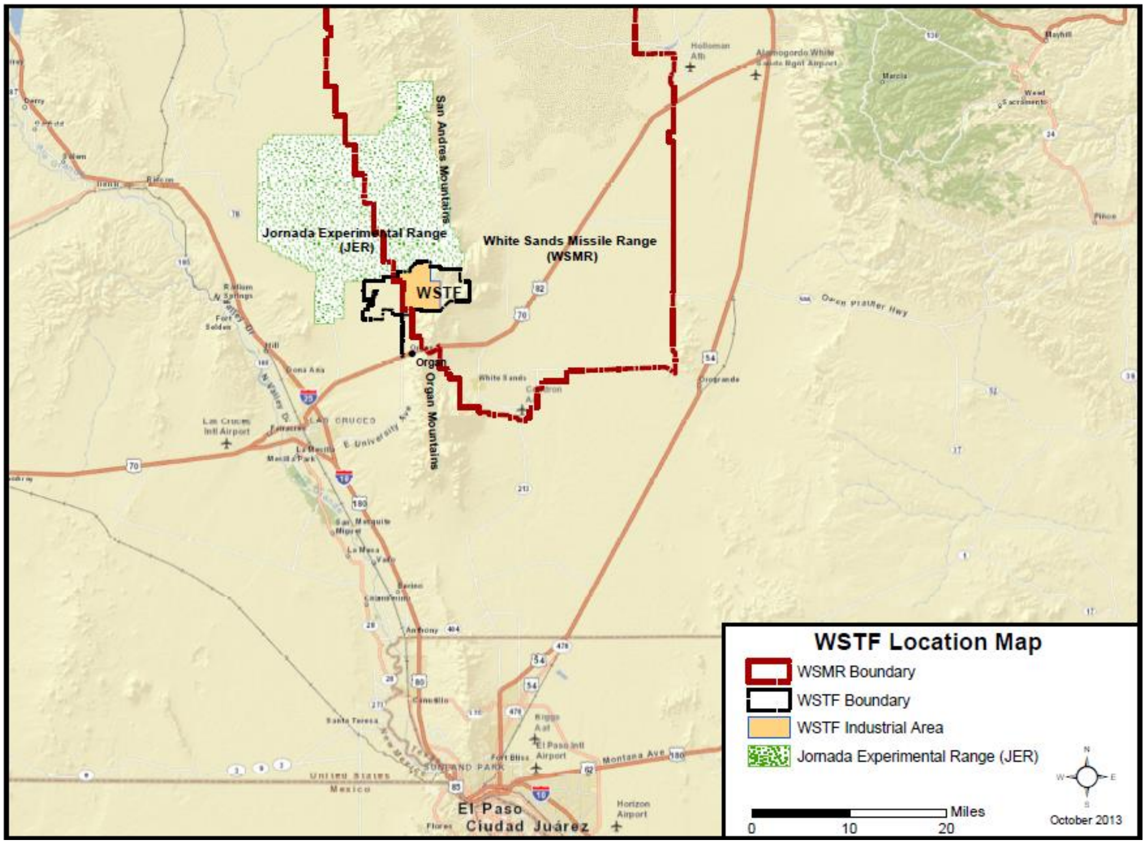
1.3 POTENTIALLY RESPONSIBLE PARTIES

The Trustee has identified NASA and the United States Department of Defense (DOD) as the potentially responsible parties, as defined under CERCLA. DOD owns the WSTF property and from 1963 through the present, WSTF has been operated by NASA. At this time there are no other identified potentially responsible parties for the hazardous substances at the Site.

1.4 SITE DESCRIPTION AND HISTORY

The facility, established to support the NASA Apollo Space Program in the early 1960s, is located in southern New Mexico (Exhibit 1-1). The area, approximately 18 miles northeast of Las Cruces, was chosen for the Johnson Space Center Propulsion Systems Development Facility in 1962 because of its isolated location and topography. Construction of the facilities began in 1963, and in 1965 the name was changed to White Sands Test Facility. As noted above, DOD owns the WSTF property, which is operated by NASA. DOD also operates the White Sands Missile Range (WSMR) property adjacent to WSTF.

EXHIBIT 1-1 WHITE SANDS TEST FACILITY (WSTF) SITE MAP (FROM NASA 2014A)



At the peak of the Apollo era in the mid-1960s, WSTF employed over 1,700 people. Work during that time involved developing, qualifying, refurbishing, and testing spacecraft propulsion systems, subsystems, and ground support equipment; investigating flight hardware anomalies; testing materials and components; and performing hazard and failure analyses (NASA 2013a). The tanks and impoundments storing waste materials in support of these activities have caused releases of hazardous substances to the environment. By 1970, WSTF was facing closure. However, due to its unique test facilities, existing buffer zones, and other advantages, hazard tests for the Space Shuttle Program began at the facility. WSTF currently employs 750 people (NASA 2013a, Corbett 2013).

Ongoing operations at the Site include serving as a field test facility under NASA's Lyndon B. Johnson Space Center, which provides testing services to NASA for the United States space programs and support to the DOD, Department of Energy, private industry, and foreign government agencies (NASA 2013a). Activities at the Site are primarily associated with the development and testing of the limits of spacecraft propulsion systems and subsystems. In addition, there are also several laboratories that conduct simulated use tests for space station materials, and compatibility testing (NASA 2013a).

As a result of Site operations, hazardous substances were disposed of and released to the environment, and have come to be located outside of WSTF property boundaries. Some tanks and impoundments in what are defined as the 200, 300, 400, and 600 industrial areas of the Site (described in more detail in Section 1.6.3) were closed under the requirements of the Resource Conservation and Recovery Act (RCRA). The closure areas were permitted under a post-closure care permit in the early 1990s and continue to be monitored in accordance with the Hazardous Waste Permit issued by the New Mexico Environment Department (NMED), and with related plans (NASA 2013a, NASA 2013b). In 1996, NASA also developed and implemented a strategy intended to remediate contaminated groundwater based on human health risk and the environmental and hydrological characteristics of the Site.[1] NASA currently operates a plume treatment system intended to prevent further migration of the groundwater contaminant plume. As described in more detail below, the routine groundwater monitoring program provides useful information for understanding the nature and extent of groundwater contamination.

1.5 OVERVIEW OF NATURAL RESOURCE DAMAGE ASSESSMENT PROCESS

The Trustee is conducting this NRDA in accordance with the DOI NRDA regulations at 43 CFR Part 11, which provide guidelines for conducting an assessment.

1.5.1 DETERMINATION TO PURSUE A TYPE B ASSESSMENT

Under 43 CFR § 11.34 through § 11.36, the regulations allow for two different assessment methods: Type A and Type B. Type A assessments are "standard procedures for simplified assessments…" (43 CFR § 11.14(ss)) and rely on a computer model where certain site-related input parameters are required (e.g., mass or volume of substances released, duration of releases). Type B assessments are conducted through the review of existing data and the collection of additional data to fill information gaps. Type B assessments are "alternative methodologies for conducting assessments in individual cases…" (43 CFR § 11.14(tt)) and are typically selected when a hazardous substance release occurs over a long timeframe, consists of multiple contaminants, or occurs in a complex system. The Type A procedures generally do not apply to complex sites such as WSTF. It is the intent of the Trustee to perform a Type B Assessment.

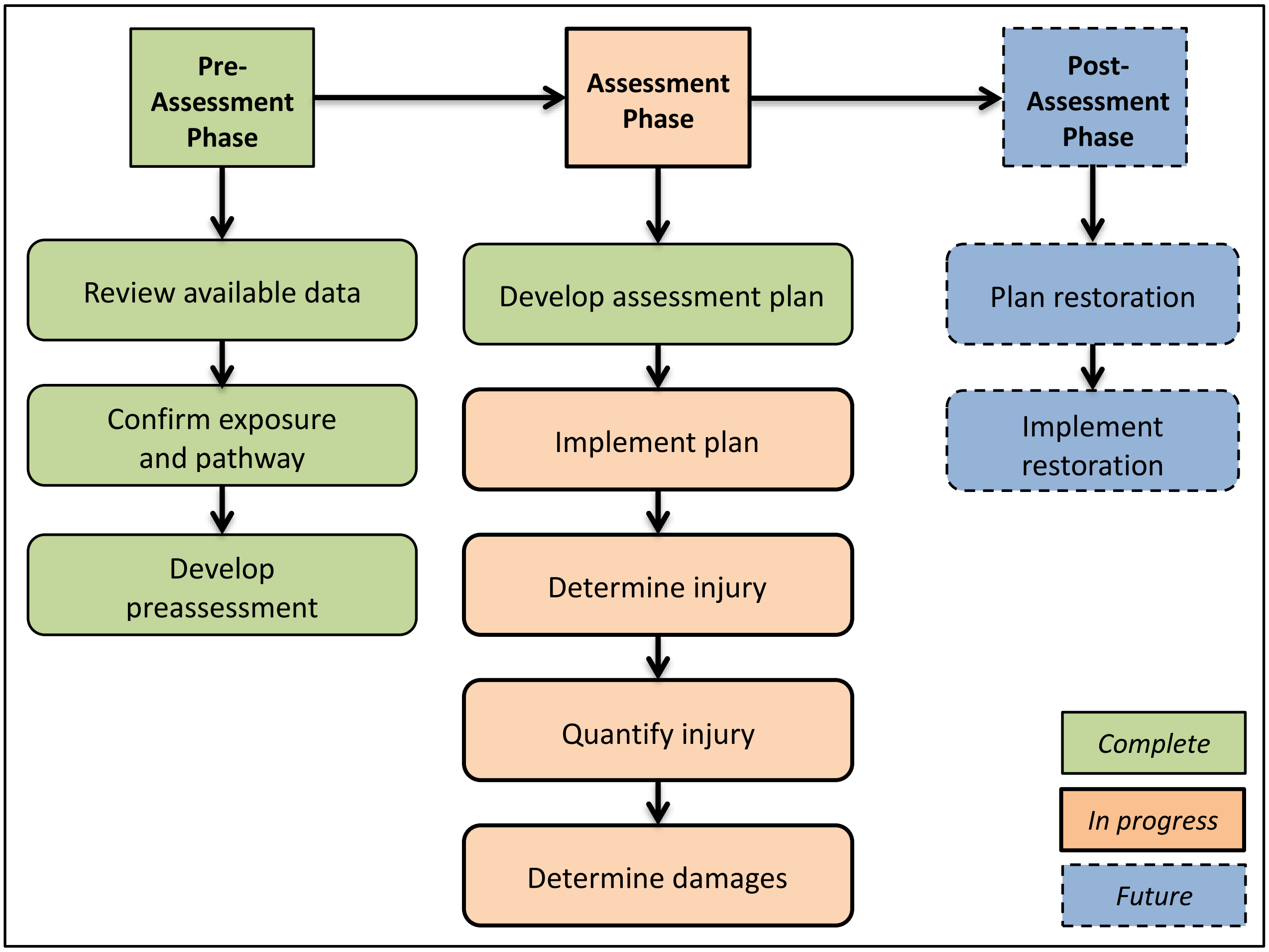
1.5.2 STEPS IN THE NATURAL RESOURCE DAMAGE ASSESSMENT PROCESS

The NRDA process includes three distinct phases (Exhibit 1-2), listed below.

- Preassessment,
- Assessment, and
- Post-assessment.

[1] The remedy decision was reviewed and selected by the NMED Hazardous Waste Bureau per the RCRA permit.

EXHIBIT 1-2 PHASES OF THE NATURAL RESOURCE DAMAGE ASSESSMENT PROCESS



During the **Preassessment Phase**, trustees review readily available information and existing data related to the release of hazardous substances and the potential impacts of those substances on natural resources. This review leads to a determination of whether a successful claim can be made against the responsible parties that released the hazardous substances to the environment. This step also documents the trustee's determination that further investigation and assessments are warranted (i.e., that a NRDA could and should be performed). In March 2016 the Trustee released the Preassessment Screen Determination Report and issued a Notice of Intent to perform an assessment. The Notice of Intent invited NASA to participate in the assessment plan. NASA declined to participate, but offered to provide full access to the Site and any data not already in the State's files.

The **Assessment Phase**, which includes drafting and implementing this Plan, can be grouped into two main steps:

- *Assessment Planning* – The assessment planning step includes developing an assessment plan (this document) which outlines the process for determining and quantifying natural resource injuries and associated damages.

- *Conducting the Assessment* – This step involves implementing the assessment plan developed in the previous step. During the assessment, trustees first determine natural resource injuries by documenting the pathway(s) from the released hazardous substance to exposure of natural resources and determining whether the exposed natural resources have been injured (as defined in 43 CFR § 11.62). Once injury to a natural resource has been documented, the injury may be quantified. *Injury quantification* is measured as the magnitude of injuries and the scope of lost ecological services as compared to the baseline conditions of the natural resources. The final step of the assessment is *determining damages*, which involves estimating the monetary compensation of restoration projects required to make the public whole for natural resource injuries and service losses. This phase can also include development of a Restoration and Compensation Determination Plan (RCDP), which describes restoration alternatives and the trustee's preferred alternative.

During the **Post-assessment Phase,** a Restoration Plan is developed. The Restoration Plan can be based on the RCDP or developed using information from previously completed restoration planning documents. Restoration Plans document the specific restoration actions that will be implemented to restore injured natural resources and associated services that were lost as a result of the releases of hazardous substances. This phase can also include the development of a Report of the Assessment, which contains the results of the assessment, and documents that the assessment has been carried out according to the DOI regulations (43 CFR 11.13(f)).

Although the various phases and steps of a NRDA are set forth as a sequential process within the DOI NRDA regulations, it may be possible for the trustee to simultaneously complete some steps to move the assessment forward in an efficient and timely manner. This will be especially true when there is sufficient existing information on the site and contaminant related injuries to make judgements on injury determination and quantification. The regulations encourage the use of existing information where possible; as a result, the trustee may also choose to utilize reasonable conservative assumptions where primary data collection is not judged to be cost-effective, to determine and quantify injuries and determine damages to establish the scale and scope of required restoration.

1.5.3 RELATIONSHIP TO REMEDIAL ACTIVITIES

Following the release of a hazardous substance that resulted in injury to a natural resource or resources, CERCLA provides an avenue by which the affected sites and resources can be remediated and restored. "Remediation" and "restoration" represent two related, but distinct, processes under CERCLA.

Remedial actions, as defined in 42 USC §9601(24), are:

> *"Those actions consistent with permanent remedy taken instead of or in addition to removal actions in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause*

> *substantial danger to present or future public health or welfare or the environment".*

Remedial and/or cleanup actions are risk-based and aim to remove and/or reduce current and future human health and ecological risks associated with hazardous substances to acceptable levels. At WSTF, remediation activities are overseen by the NMED pursuant to Hazardous Waste Permits issued under RCRA. Cleanup efforts can re-expose site resources to the hazardous substances of concern for a short time period or may permanently alter habitat structure. NRDA, however, as defined in 43 CFR § 11.10:

> *"…provides a procedure by which a natural resource trustee can determine compensation for injuries to natural resources that have not been nor are expected to be addressed by response actions…"*

Restoration, the focus of the NRDA process, is designed to restore injured natural resources to their baseline condition. NRDA accounts for interim losses that the public has incurred due to the release of hazardous substances as well as any injuries resulting from remedial activities. Achieving a risk-based cleanup goal (remediation) does not necessarily return injured natural resources to their baseline condition. However, trustees are directed in the DOI regulations to take cleanup activities and outcomes into account – and whenever possible coordinate with the remedial process – in order to enhance the cost-effectiveness of proposed restoration activities.

1.6 ASSESSMENT ACTIVITIES AT THE SITE

1.6.1 SUMMARY

The Trustee utilized existing information to develop a Preassessment Screen Determination Report (PAS; ONRT 2016). Based on this PAS, the Trustee confirmed that further investigation and assessment efforts are warranted at WSTF and therefore decided to proceed with an assessment.

After posting the PAS on the ONRT website (www.onrt.state.nm.us), the Trustee began the assessment planning process including the development of this Plan. The draft Plan was released for public review in December 2016 and this document represents the final Plan. The current status of the assessment at WSTF is outlined in Exhibit 1-2. With the release of this final Plan, the Trustee intends to proceed with the assessment. When available, updated information about assessment activities at WSTF will be posted on the ONRT website.

1.6.2 USE OF EXISTING INFORMATION

The DOI NRDA regulations state that the assessment be conducted in a planned, systematic manner and at a reasonable cost (43 CFR § 11.13(c)). Cost-effectiveness is a trustee priority. As such, existing data will be reviewed prior to undertaking any new data collection effort. Where existing data do not allow for the determination of the nature or extent of injuries, the Trustee will determine whether reasonable conservative assumptions can be utilized or if primary data collection is necessary to fill data gaps. If necessary, any primary data collection efforts will be designed and implemented in phases to allow for subsequent adjustments in study design based on initial findings.

1.6.3 SUMMARY OF SITE REMEDIAL ACTIVITIES

WSTF operations generated hazardous wastes that were historically managed in surface impoundments and underground storage tanks (i.e., referred to as the 100, 200, 300, 400, 500, 600, 700, and 800 Areas). Leaks from these waste areas and tanks contributed to the contamination of groundwater beneath the Site, starting in the early 1960s (NASA 2013a; 2014a; 2014b). NASA is required by post-closure care requirements specified by the NASA WSTF Hazardous Waste Permit to investigate and assess historical releases of hazardous substances to the subsurface, and to determine whether the soils beneath the closed Hazardous Waste Management Units (HWMUs) are continuing sources of groundwater contamination. NASA issues quarterly groundwater monitoring reports and other Site investigation reports that describe conditions at the Site and the need for any additional remedial actions (NASA 2013a; 2014a; 2014b).

NASA has completed a number of remedial investigations and has removed contaminated source materials from various WSTF industrial areas. The 200, 300, 400, and 600 areas are under post-closure care, with closure caps completed in 1989. Following closure, NASA continued to investigate the vadose zone[2] below each of the caps to determine the potential for continued groundwater contamination (NASA 2013a; 2014a; 2014b). In 1996, NASA developed its plan for remediating groundwater contamination at the Site using a three-phase approach: (1) stabilizing the leading edge of the groundwater plume in the alluvial aquifer, (2) intercepting the high concentration portion of the plume within fractured bedrock in the mid-plume constriction area, and (3) investigating contaminant source areas for remediation. Routine groundwater monitoring and remedial investigations are ongoing (NASA 2013a; 2014a; 2014b).

There are over 220 groundwater monitoring locations across the Site from which NASA collects groundwater samples to analyze for volatile organic compounds (VOCs) (e.g., trichloroethene [TCE], tetrachloroethene [PCE]), n-nitrosodimethylamine (NDMA), and several inorganics (e.g., arsenic, chromium, nickel). As part of their groundwater remediation plan, NASA also operates two groundwater treatment systems: the plume front treatment system (PFTS) and the mid-plume interception and treatment system (MPITS) (NASA 2014a). The PFTS is an interim measure, consisting of a pump-and-treat groundwater remediation system at the leading edge of the contaminant plume designed to stabilize plume migration. The PFTS utilizes air stripping and ultraviolet photolysis to remove VOCs and nitrosamines from the groundwater, and the treated water is re-injected into the aquifer (NASA 2014a). The MPITS is a similar system to the PFTS and was built to intercept groundwater with high contaminant concentrations within the fractured bedrock of the mid-plume constriction area (NASA 2014a).

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[2] The unsaturated zone, below the surface of the land, down to the first saturated zone (aquifer).

A rough estimate of the time that may be required to remediate the contaminated groundwater can be made by dividing the total mass of contamination in the aquifers by the mass removed annually through remediation efforts (i.e., if an aquifer has 1,000 kg of a contaminant and the contaminant is being removed at a rate of 10 kg/year, then a simplified calculation is that it will take 100 years to return the aquifer to an uncontaminated state [1,000 kg ÷ 10 kg/year = 100 years]). This approach does not account for the likelihood that recovery rates may decline over time. Reported data for the mass of contaminants in the aquifer and recent rates of mass removal by the remediation systems are provided in NASA reports (2013a; 2014a). According to NASA reports, most of the mass of contaminants are being removed from the plume front area, and the mass of contaminants in the mid-plume area and bedrock areas are being removed at slower rates which is consistent with the occurrence of fractured bedrock. Using TCE as an example, an estimated 0.925 kg of TCE is being removed from the mid-plume area per year and an estimated 4,663 kg was released; assuming that 65 percent of the mass is in the bedrock (0.65 × 4,663 kg = 3,031 kg), it would take over 3,000 years to remove all of the TCE (3,031 kg ÷ 0.925 kg/year = 3,277 years). If remedial activities continue in the future at rates recently observed and documented in NASA reports, it can be assumed that a contaminant plume will continue to exist at the Site for at least over 100 years. Additional information on the Site and groundwater monitoring and remediation can be found in Site reports (e.g., NASA 2013a; NASA 2014a).

The Trustee recognizes the importance of coordinating efforts to meet assessment and remedial objectives as effectively and efficiently as possible. As the assessment progresses, if new information is learned through the remedial process, the Trustee will account for completed and planned remedial actions, as necessary, when quantifying natural resource injuries and determining the likely recovery period for injured resources.

1.6.4 GEOGRAPHIC SCOPE

The geographic scope for the damage assessment includes all locations where contaminants have come to be located. This includes, but is not necessary limited to, the boundary of WSTF (Exhibit 1-1) and the extent of the contaminated groundwater plume. Note that the geographic scope of individual injury assessment activities may vary to account for the characteristics of particular species and/or natural resources.

1.6.5 TEMPORAL SCOPE

Injury quantification efforts will focus on the period beginning in 1981 (in accordance with the promulgation of the CERCLA in 1980) and continue through a reasonable expected recovery time period for resource services and will account for the divisibility of injury. Specifically:

- For resources not expected to fully recover, injuries will be considered to be permanent.
- Where injuries pre- and post- 1981 are not distinguishable, injury will be quantified for all years that injury occurred in the past and is expected to occur in the future.

- Where injuries pre- and post-1981 are distinguishable, the incremental injury after 1981 will be quantified.

Contaminant releases and associated injuries occurring wholly before 1981 will not be included in the injury assessment.

1.7 PUBLIC PARTICIPATION

The Trustee actively encourages public participation in this assessment and views such participation as an important component of the Plan development process. A draft version of this Plan was released by the Trustee, for review and comment by the potentially responsible parties and affected Federal, state, or tribal entities, in addition to any interested members of the public (43 CFR § 11.32(c)(1)). The draft Plan was available for review for a period of thirty days from December 12, 2016 to January 12, 2017 in accordance with 43 CFR § 11.32(c)(1). No comments were received via mail or e-mail, and therefore no substantive changes were made to the Plan. An electronic copy of the draft Plan and this final Plan are available for download on the ONRT website at: https://onrt.env.nm.gov/white-sands-test-facility/.

As the Trustee moves forward with this NRDA, there will be additional opportunities for public participation. Examples include review of restoration plans and proposed settlements. The Trustee will provide sufficient notification to the public in advance of these opportunities.

1.8 ORGANIZATION OF THE NATURAL RESOURCE DAMAGE ASSESSMENT PLAN

The remainder of this document is organized as follows:

Chapter 2 – Describes the ecological context of the area, the natural resources in and around WSTF, and the services provided by those resources.

Chapter 3 – Outlines the contaminants of concern, pathways for those contaminants to reach natural resources, discusses confirmation of exposure, and likely injuries.

Chapter 4 – Specifies the approaches available for quantification of Site-related natural resource injuries.

Chapter 5 – Discusses available approaches for damages determination and the topics covered by a Restoration, Compensation, and Determination Plan.

Chapter 6 – Presents the Trustee's proposed studies for determining and quantifying natural resource injuries.

Chapter 7 – Provides a framework for data quality assurance and project management.

CHAPTER 2 | NATURAL RESOURCES AND RESOURCE SERVICES

2.1 DESCRIPTION OF THE STUDY AREA

WSTF lies at the western foothills of the San Andres Mountains in southcentral New Mexico. The mountain range is relatively dry and does not support extensive woodland, as compared to the Organ Mountains to the south. Its terrain is characterized by steep, rugged mountainsides and deep canyons while the vegetation changes from creosote, small cacti, yuccas, and agave to piñon pine, juniper, desert willow, and Apache plume depending on the elevation and distance to a water source (FWS 2016).

The habitat surrounding WSTF is classified as Chihuahuan Desert Grassland with a 200 day growing season, consisting of sparse vegetation including grasses and cacti. Human use of the area, such as permitted grazing, has left the habitat with low vegetative diversity (NASA 2002). Despite this fact, a number of wildlife species have been documented using the assessment area for foraging and nesting purposes (NASA 2002). A description of species that utilize the assessment area's habitat is provided in the sections below.

Climate in the assessment area consists of abundant sunlight, low humidity, minimal rainfall, and large diurnal temperature variations (NASA 2002). The mountains abutting WSTF's property influence the climate by exerting control over the movement of air masses in the area. The amount of precipitation this area receives is low, 10 inches annually, and most occurs in July and August (NASA 2002).

Hydrologically, WSTF sits in the Jornada Draw Watershed just outside the boundary of the El Paso-Las Cruces Watershed, which encompasses a portion of the Rio Grande River (NRCS 2012). The Jornada Draw Watershed is part of the Rio Grande aquifer system. Specifically, the groundwater underlying the Site is part of the Lower Rio Grande Groundwater Basin, which is one of three basins in this watershed that has been proclaimed by the New Mexico State Engineer (NRCS 2012). The majority of groundwater withdrawal in the basin is for agricultural use (over 60%) and for public water supply (approximately 25%) (e.g., Terracon 2003).

Information on the terrestrial habitat and wildlife species utilizing WSTF and the surrounding area is limited. However, nearby is the San Andres National Wildlife Refuge. The Refuge represents one of the least disturbed Chihuahuan desert ecosystems in the United States and is less than 10 miles north of the assessment area (FWS 2016). The Refuge is closed to the public[3], but hosts a wide variety of flora and fauna indicative of a highly functional desert habitat. Notably, it had a crucial role in returning the desert bighorn sheep population to sustainable numbers after being reduced to just one ewe in 1997 (FWS 2016). Along with desert bighorn, there are thirty-seven species of mammals, 175 bird species, more than 45 species of reptiles, and at least 82 species of invertebrates that have been documented on the refuge. For example:

> **Mammals** – desert mule deer, mountain lion, bobcat, coyote, gray fox, desert cottontail, jack rabbit, ring-tailed cat, skunk, porcupine, raccoon, rock and ground squirrel, black bear, elk, and a wide variety of rodents typical of western mountains and deserts.
>
> **Birds** – golden eagle, red-tailed hawk, turkey vulture, the Greater roadrunner, and the Gambel's and Scaled quail are common. Blue grosbeaks, summer tanagers, and yellow-breasted chats also frequent the area.
>
> **Reptiles** – several species of rattlesnake and non-poisonous snakes, collared lizard, Texas horned lizard, and several other lizard species.
>
> **Invertebrates** – 40 species of butterflies, 24 species of damselflies, and 18 species of dragonflies.
>
> **Others** – red spotted toad and 13 species of bats, which take shelter in the rock caves.

2.2 DESCRIPTION AND DEFINITION OF NATURAL RESOURCES

Natural resources have been exposed to, and likely injured by, hazardous substances released into the environment surrounding WSTF. This section defines natural resources as per the DOI NRDA regulations and generally describes the groundwater, geologic (soil), surface water (including sediment), and biological resources within the assessment area. Section 2.3 discusses the ecological and human use services that these resources provide.

Natural resources include:

> *"…land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States . . . any State or local government, any foreign government, any Indian tribe, or, if such resources are subject to a trust restriction on alienation, any member of an Indian tribe."* 43 CFR § 11.14(z).

Under the DOI NRDA regulations, these resources have been categorized into the following five groups: surface water (including sediments), groundwater, air, geological (including soils), and biological resources. This Plan focuses on groundwater, geologic, and biological resources. While air and surface water may have been exposed to Site-related contaminants, at this time the Trustee does not anticipate quantifying injury to these resources. Rather, this Plan focuses on air and surface water resources as pathways for hazardous substances to reach groundwater, geologic, and biological resources.

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[3] Research on specific animals, desert ecosystems, hydrology, and prescribed burns takes place at the Refuge.

2.2.1 GROUNDWATER RESOURCES

The surficial site lithology consists of coalescent alluvial fan deposits of the late Tertiary Santa Fe Group. Underlying the Santa Fe Group alluvium in the area of the facilities are Paleozoic limestone and Tertiary andesite bedrock at a depth of 15 to 160 feet below ground surface (bgs). Groundwater is typically located at depths of 100 to 180 feet within fractured bedrock (NASA 2012).

In the mid-plume area, Tertiary rhyolites and tuff are present at a depth of 300 to 350 feet bgs. Groundwater is typically located at depths ranging from 320 to 380 feet bgs within fractured bedrock. A flow-banded rhyolite has been identified as potentially serving as a localized barrier to flow, such that the contaminant plume bifurcates around this unit. A major fault, the Western Boundary Fault, is located to the west of the mid-plume area. West of the fault the bedrock is several hundred to a few thousand feet bgs, and the plume is located within the Santa Fe Group alluvial and basin-fill materials.

The groundwater table slopes west from the San Andres Mountains toward the Rio Grande. In areas where the water table is in bedrock, groundwater typically moves through an irregular fracture system under the influence of a steep hydraulic gradient of 0.05 feet/feet. Faults, fractures, and solution channels locally influence flow directions, which can lead to uncertainty in understanding and controlling contaminant movement. The gradient flattens substantially to 0.0002 feet/feet in the thick Santa Fe Group basin fill, where flow is comparatively even (NASA 2002, 2012).[4]

Based on available information, groundwater in the area was potable prior to releases from facility operations (Wilson et al. 1981).

2.2.2 GEOLOGIC RESOURCES (SOIL)

The Site is located within the Mexican Highland Section of the Basin and Range Province (NASA 2002). The Basin and Range Province is an extensional tectonic feature that is characterized by north-trending mountain ranges separated by basins. The soils in this area are sandy to silty, loamy soils and are associated with alluvial fan deposits. The Site also has abundant, shallow arroyos that flow to the west.[5]

NASA work plans indicate the collection and analytical testing of soil boring samples (e.g., NASA 2013b); however, limited data are publicly available. Injury to this resource will be further investigated during the assessment.

2.2.3 SURFACE WATER RESOURCES (INCLUDING SEDIMENT)

As mentioned above, numerous arroyos exist in this desert landscape, but are active only during temporary or seasonal precipitation events. As a result, the arroyo sediments behave more like soils for most of the year. There are few distinct stream channels extending from

[4] See Figure 11 of the 2018 WSTF Groundwater Monitoring Plan for a geologic cross section of this area: https://www.nasa.gov/sites/default/files/atoms/files/2018_04_24_re-18-060_nmed_gmp_2018update_letter.pdf

[5] An arroyo is an ephemeral or intermittent stream bed that is typically only active during precipitation events, either temporarily or seasonally.

the western side of the San Andres Mountains (the side adjacent to the Site), but heavy thunderstorms do result in swift, shallow flows that begins to infiltrate the coarser alluvium that exists within a mile of the slope break (NASA 2002). Water from these events typically remains within the semi-permanent channels on the western mountain flank and then flow as sheet-flood onto the alluvial plain. Only very heavy precipitation events cause runoff to extend beyond the mountainside.

Though infrequent (i.e., the area receives an average of 10 inches of rain per year), precipitation could serve as a pathway for contaminants in surface soils and sediments to be transported to areas around and away from the Site. As noted above, at this time, the Trustee intends to treat surface water resources as a potential pathway of hazardous substances to groundwater, geologic, and biological resources.

2.2.4 BIOLOGICAL RESOURCES

The biological community in the area of the Site is typical of an arid desert environment, with shrubs and grasses dominating the vegetative community. Some species include burro grass (*Scleropogon brevifolius*), yucca (*Yucca* spp.), snakeweed (*Xanthocephalum sarothrae*), sagebrush (*Artemisia* spp.), and honey mesquite (*Prosopis glanulosa*). The most dominant grasses are fluff grass (*Erioneuron pulchellum*), tobosa grass (*Hilaria mutica*), and alkali sacaton (*Sporobolus airoides*), while patches of grama grasses (*Bouteloua* spp.) occur less frequently. Larger plant species include tarbush (*Flourensia cernua*), creosotebush (*Larrea tridentata*), Russian thistle (*Salsola kali*), lotebush (*Ziziphus obtusifolia*), Morman tea (*Ephedra trifurca*), littleleaf sumac (*Rhus microphylla*), night shade (*Solanum eleagnifolium*), narrow leaf globemallow (*Sphaeralcea angustiforlim*), Western pink verbena (*Verbena ambrosifollia*), soaptree yucca (*Yucca elata*), and the desert Christmas cactus (*Opuntia leptocaulis*). Ball cacti (*Coryphantha vivipara*) are also located in the area, but have not been seen in bloom to differentiate between subspecies (NASA 2002).

These plant species support higher trophic level communities of biota, including insects, birds, small mammals, and larger mammals such as deer and antelope. These grass and scrubland areas provide important hunting opportunities for raptors to capture small to medium-sized prey items. For example, Swainson's (*Buteo swainsoni*) and red-tailed (*Buteo jamaicensis*) hawks have been observed on power poles along the Site's road system, feeding on prey, searching the desert floor for prey, and sunning themselves in the morning (NASA 2002).[6] Golden eagles (*Aquila chrysaetos*) are also found in the area, using upland habitats in the nearby San Andres Mountains for nesting while hunting in the lowland areas.

There is evidence that other species utilize the assessment area as well, ranging from reptiles to large mammals. These species may have been exposed to and potentially injured by Site-related releases of hazardous substances:

> **Reptiles** – specimens of the Texas horned lizard (*Phrynosoma cornutum*) have been found in the assessment area (NASA 2002).

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[6] Large stick nests made of honey mesquite and desert sumac were also found in the mid-plume constriction area, providing an indication that some bird species nest in the area.

Mammals – the most common mammals include the desert cottontail (*Sylvilagus auduboni*), blacktailed jackrabbit (*Lepus californicus*), white-throated woodrat (*Neotoma albigula*), mule deer, and banner-tailed kangaroo rat (*Dipodomys spectablis*). Coyotes (*Canus latrans*) and gray foxes (*Urocyon cinereoargenteus*) have also been observed (NASA 2002).

Though data and information are scarce regarding biological resources and their exposure to hazardous substances at the Site, available information will be compiled and reviewed during the assessment and data gaps will be identified.

2.3 NATURAL RESOURCE SERVICES

Ecosystems provide a wide range of services, including ecological and human use services. Habitats within and adjacent to the Site are utilized by a variety of organisms for a range of uses. According to 43 CFR § 11.14(nn), services are;

> *"…the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource."*

Further, the DOI NRDA regulations indicate;

> *"services" are a metric for measuring resource conditions and resource restoration. They are not abstract functions that are disassociated from natural resources, and they are restored or replaced by actions related to the quality, quantity, or availability of natural resources."* 73 Fed. Reg. 57,259.

In defining services this way, the DOI NRDA regulations specifically identify as compensable the services one component of an ecosystem provides to another (e.g., via a food chain), and the human uses and non-uses of the resource, if those services are reduced as a result of a release of a hazardous substance(s). The DOI NRDA regulations further describe services as the metric by which the benefits of natural resources may be quantified. There is evidence that natural resource services at the Site have likely been reduced due to the release of Site-related hazardous substances (ONRT 2016). Potential changes to ecological (including geologic and biological) and groundwater services are described in the sections below.

2.3.1 ECOLOGICAL SERVICES

Each of the natural resources described in Section 2.2 provides a variety of ecological services. For example, geologic resources, including soils, at WSTF provide a variety of services including nutrient recycling, facilitating energy transfer up the food chain, and allow for the production of plants and invertebrates. Soil resources are necessary for breeding, nesting, foraging, and resting habitat for a variety of migratory bird species, including state and federally listed endangered and threatened animals. Geologic resources are essential to the long-term survival and reproduction of plants and invertebrates (e.g., federally endangered Sneed Pincushion Cactus [*Coryphantha sneedii*]), which function as the base of the food chain.

Wildlife species also provide numerous ecological services. Plants provide protective cover, materials for nesting animals, and represent the base of the food chain. Insects, reptiles, and small mammals serve as prey for other organisms (e.g., birds and large mammals), and help to move nutrients and energy throughout the food chain.

The ecological resources discussed in this chapter are also often interdependent (43 CFR § 11.71(b)(4)). For example, if the insect community is reduced either in abundance or diversity due to the release of hazardous substances, the effect of that reduction is likely to ripple through the food web by negatively impacting the success and fitness of predator species (e.g., reptiles and birds).

2.3.2 GROUNDWATER SERVICES

Groundwater resources provide a range of services including the provision of water for drinking, agricultural, and industrial purposes, drought protection, assimilative capacity, and prevention of land subsidence (e.g., NRC 1997, EPA 1995, Bergstrom et al. 1996). As recognized by the regulations, groundwater services include both use and non-use values (Exhibit 2-1). Groundwater use values may be associated with the consumption of the resource, current extractive uses (e.g., municipal or commercial uses) or *in situ* services. Non-use values may be motivated by a desire to preserve groundwater for future generations (bequest value) or simply to protect and maintain natural resources in an uncontaminated state (existence value). The National Academy of Sciences book Valuing Groundwater: Economic Concepts and Approaches states, “The total economic value (TEV) of ground water is a summation of its values across all of its uses.” (NRC 1997, p. 48). Hence, the total economic value of groundwater includes the summation of its use and non-use values.

A change in the quality or quantity of any of the groundwater services influences the value(s) the public places on groundwater. Because uncertainty exists regarding the quantity and quality of groundwater services that may be available in the future, and the level of demand for those services, the public also holds an option value for groundwater. Several economic studies have estimated households’ willingness to pay for protection programs and other measures that would reduce or eliminate future threats of contamination (e.g., see Bergstrom et al. 2001 for a summary of these studies). This value – a total value for groundwater services under uncertain future conditions of groundwater demand and supply – is referred to as *option value* (Freeman et al. 2014). Option value is particularly relevant in areas where water may become increasingly scarce, where demand for groundwater is highly uncertain, or where there are multiple sources of contaminants threatening the viability of groundwater as a potable water source.

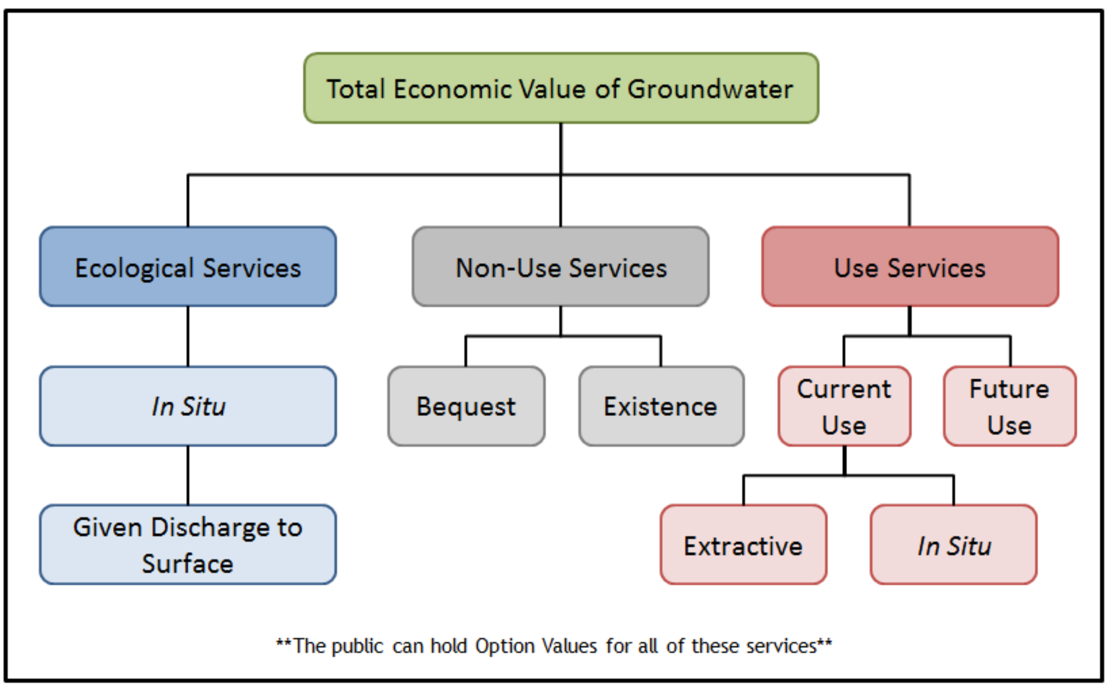
Option value, or option price, is well established in the economics literature generally (see Freeman et al. 2014), and specifically with respect to groundwater protection (see Bergstrom et al. 2001). To this end, a State’s practice of inventorying and protecting groundwater resources is an expression of this concept on behalf of its residents.

The conclusion that the public holds a value for the option to use groundwater in the future, absent current use, is also supported by the United States Environmental Protection Agency’s (EPA’s) policy guidance to its CERCLA groundwater restoration program, which states:

> *"Recognizing that ground waters of the United States are valued natural resources, the Agency [EPA] carries out CERCLA response actions in a manner that ensures Superfund remedies are protective by, among other things, restoring contaminated groundwater to beneficial uses."* (EPA 2009)

The value placed on groundwater by New Mexico is demonstrated by the statutory and regulatory scheme the state has developed for its protection. The New Mexico Water Quality Act, NMSA 1978, §§ 74-6-1 *et seq.*, created the Water Quality Control Commission (WQCC) with the authority to adopt water quality standards and regulations to prevent or abate water pollution, including in aquifers. Pursuant to that authority, the WQCC adopted regulations at New Mexico Administrative Code (NMAC) 20.6.2 for ground and surface water protection. NMAC 20.6.2.3101 declares that the purpose of "controlling discharges onto or below the surface of the ground is to protect all groundwater of the state of New Mexico which has an existing concentration of 10,000 mg/l or less total dissolved solids (TDS) for present and potential future use as domestic and agricultural water supply, and to protect those segments of surface waters which are gaining because of ground water inflow, for uses designated in the New Mexico Water Quality Standards" (emphasis added).

EXHIBIT 2-1 GROUNDWATER SERVICES



CHAPTER 3 | APPROACH FOR INJURY DETERMINATION

3.1 INJURY ASSESSMENT APPROACH

Determination of injury to natural resources under the DOI NRDA regulations consists of documentation: (1) that there is a pathway for the released hazardous substance from the point of release to a point at which natural resources are exposed to the released substance, and (2) that injury of a natural resource has occurred, as defined in 43 CFR § 11.62.

This chapter identifies the hazardous substances of concern, outlines the Trustee's understanding of contaminant pathways, documents exposure of natural resources to Site-related hazardous substances, and discusses natural resource injury due to the presence of these hazardous substances.

3.2 HAZARDOUS SUBSTANCES

Available NASA WSTF reports identify three CERCLA hazardous substances, listed below, which are the focus of this Plan. Each of the three primary contaminants is present in groundwater over a large area. Additional contaminants of concern may be identified as new information is obtained during the assessment.

- **Trichloroethene (TCE)** – TCE was primarily used for component servicing and cleaning. TCE is a clear, colorless, and nonflammable liquid that possesses a sweet and fruity odor, which is characteristic of chloroform. When in the atmosphere, TCE is destroyed by photooxidation with a half-life of three to eight days in the summer and approximately two weeks in the winter (ATSDR 2007). Thus, TCE's transport is limited in air, but can be continually volatilized from contaminated surface waters or emissions sources, ensuring its persistence in air. The biodgredation in anaerobic conditions (e.g., groundwater) is slow, making it relatively persistent in subsurface waters. Studies indicate that TCE has a low tendency to bioaccumulate (ATSDR 1997).

  Studies on the neurological effects of acute TCE inhalation in animals have produced results similar to the human studies (ATSDR 1997). Effects from human occupational studies include central nervous system depression, decreased appetite, gastrointestinal irritation, headaches, mucous membrane irritation, skin irritation, developmental abnormalities, liver damage, renal failure, and cardiac dysrhythmias, among others (ATSDR 2007).

- **Tetrachloroethene (PCE)** – PCE was also primarily used for component servicing and cleaning. It is a synthetic chemical with physical properties (e.g., color, scent) similar to TCE. Also similar to TCE, PCE can cause central nervous system depression, liver damage, kidney damage, and causes skin, throat, and eye irritation in humans (ATSDR 2008).

- **N-Nitrosodimethylamine (NDMA)** – NDMA was primarily used in propulsion system testing programs (e.g., production of rocket fuel). It is a yellow liquid with faint characteristic or no distinct color. It is highly mobile in soil, giving it the potential to leach into groundwater (EPA 2014 and references therein).

  Exposure effects include headache, fever, nausea, jaundice, vomiting, abdominal cramps, enlarged liver, dizziness, and reduced function of liver, kidneys, and lungs (EPA 2014; ATSDR 1989). In animal studies, exposure has caused tumors of the liver, respiratory tract, kidneys, and blood vessels (EPA 2014; WHO 2006; and references therein).

3.3 PATHWAYS

The waste impoundments and storage tanks (described in Section 1.6.3) leaked wastes and hazardous substances, which infiltrated soils and groundwater. The various industrial areas and sources of contamination at the Site are described briefly in Exhibit 3-1 (NASA 2013a, NASA 2014b). Though this Plan is focused on CERCLA hazardous substances, additional compounds, such as Freon, were released along with the hazardous substances described below. Little historical data are available describing the exact nature and amounts of chemical wastes that were contained or released at WSTF, therefore NASA derived release estimates based on numerical models (NASA 2013a; NASA 2014b).

EXHIBIT 3-1 SUMMARY OF CURRENT AND PAST OPERATIONS AND SOURCES OF RELEASES

INDUSTRIAL AREA	FACILITIES AND ACTIVITIES	CONTAMINANTS
100	Administrative offices and support facilities, including firefighting, vehicle maintenance, and warehousing facilities. The 100 Area Burn Pit, in operation from 1969 to 1983, was a potential source of contamination to the subsurface. NASA estimates approximately 1,000 gallons of flammable liquids were burned in the pit each year during operation.	• Specific contaminants unknown, but unlikely to be a significant source of contamination.
200	Laboratories, clean rooms, hardware fabrication and various testing facilities, including materials, oxygen, detonation, and hypervelocity impact testing facilities. Two of the major sources of contamination in the 200 Area are the Chemistry Lab Tank and the Clean Room Tank, which are considered the primary sources of TCE in groundwater. The Chemistry Lab Tank, installed in 1964 with a storage capacity of 1,500 gallons, received wastes from metallurgical and etching laboratory operations including propellants and solvents. The 4,000 gallon Clean Room Tank received wastes generated by precision cleaning of flight hardware from 1964 to 1979 including TCE and other substances. The 200 Area is also the primary source of PCE, with lesser contributions from the 100, 300, 400, and 600 Areas. This HWMU was closed in 1989 and has been under post-closure care.	• Primary source of TCE. • Also, likely source of Freon 113, Freon 11, chromic acid, isopropyl alcohol, and other solvents.
300	Altitude chambers, engine test stands, and a former wastewater treatment impoundment (a closed HWMU). The 300 Area surface impoundments, which began operations in 1965, have leaked, resulting in one of the primary sources of NDMA at WSTF. TCE was also used in this area to clean pipelines and is likely a source of TCE contamination in groundwater.	• Primary source of NDMA. • Also, likely source of TCE, hydrazine, monomethyl hydrazine, unsymmetrical dimethylhydrazine, Aerozine 50, nitrogen tetroxide, Freon 113, and isopropyl alcohol.
400	Altitude chambers, engine test stands, and a former wastewater treatment impoundment (a closed HWMU). Surface impoundments in this area, which became operational in 1964, are another source of NDMA. Similar to the 300 Area, TCE was used here to clean pipelines.	• Primary source of NDMA. • Also, likely source of hydrazine, monomethyl hydrazine, unsymmetrical dimethylhydrazine, Aerozine 50, nitrogen tetroxide, Freon 113, isopropyl alcohol, Freon 11, Freon 21, and TCE.
500	Two separate areas with cryogenic gas storage; breathing air generation; and fuel, oxidizer, and waste fuel storage. Another potential source of NDMA is the 500 Area fuel storage area, which consists of a 20,000 gallon storage tank with secondary containment that is used to store hydrazine fuel. No further investigation was recommended in this area as NASA concluded that NDMA levels in soil were below NMED soil screening levels during their investigation in 2000 and 2001.	• Potential minor source of NDMA.

INDUSTRIAL AREA	FACILITIES AND ACTIVITIES	CONTAMINANTS
600	Groundwater supply wells, groundwater monitoring and remediation systems, wastewater treatment lagoons, and a closed HWMU. The 600 Area surface impoundments, in operation from 1968 to 1986, contained saltwater and an undetermined amount of hazardous waste from the 200 Area. NASA recently performed a soil vapor extraction pilot test in 2012 to determine if the vadose zone is a continuing source of contamination to groundwater. Although NASA concluded that the vadose zone is not a source of continuing contamination, NMED has not yet approved a final decision for this area.	• Unlikely a source of continuing contamination to groundwater.
700	Closed landfill and high energy blast facilities. The 24 acre landfill was used for the disposal of solid waste between 1964 and 1997 and is a source of groundwater contamination. Routine groundwater monitoring is performed in this area.	• Potential source of groundwater contamination. • Hazardous wastes (e.g., spent solvents, waste paints, and soft goods [e.g., textiles] contaminated with hydrazine and oxidizer) may have been disposed to this landfill prior to 1987.
800	Hazardous fluids and materials test cells.	• Unknown.
Notes: Information from NASA 2014b.		

3.4 CONFIRMATION OF EXPOSURE

Consistent with 43 CFR § 11.31(c)(1) and § 11.37, this Plan documents that natural resources have been exposed to hazardous contaminants, thereby supporting the Trustee's decision to implement a formal assessment. There are a number of sources that report measured concentrations of contaminants in assessment area natural resources, confirming exposure of those resources to Site-related contaminants. For example, the White Sands Test Facility PAS summarizes contaminant levels in groundwater within the assessment area (ONRT 2016). To the extent that individual efforts conducted under this Plan address data gaps related to the exposure of certain resources or geographic areas to hazardous contaminants, the Trustee will confirm exposure prior to conducting injury determination, injury quantification, or damage determination efforts. This NRDA focuses on geologic resources (soil), groundwater and biological resources. Surface water (including sediment) and air will be considered as pathways to the geologic, groundwater, and biological resources.

3.5 INJURY DETERMINATION

Following confirmation of exposure to hazardous substances, the Trustee will evaluate whether injury to trust resources has occurred. Injury is defined in the DOI NRDA regulations as:

> *"A measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource resulting either directly or indirectly from exposure to a…release of a hazardous substance."* 43 CFR § 11.14 (v).

For certain natural resource categories, the DOI NRDA regulations provide more specific definitions for what constitutes injury to that particular resource. For example, several resource categories have Federally- or state-promulgated criteria (e.g., a water quality criterion for groundwater). If the concentration of a site-related contaminant in a natural resource exceeds one of these criteria, that resource is considered injured under the regulations.

Injury to resources for which promulgated criteria do not exist (e.g., biological resources) may be determined by establishing a "measurable adverse change" in the resource, focusing on metrics that are relevant for a particular ecosystem, habitat, or resource. For example, site-specific toxicity tests could indicate a significant reduction in survival or reproduction of a resource, which would constitute an injury to that resource under the DOI NRDA regulations.

As described in this Plan, the Trustee anticipates applying a variety of approaches to determine if an injury to a natural resource has occurred, ranging from comparisons of contaminant concentrations to promulgated thresholds to identifying measurable adverse changes in resources. As part of the assessment, the Trustee will decide upon appropriate adverse effects endpoints or criteria based on a variety of factors (e.g., nature of the contaminants, nature of the resource, potentially exposed receptors, review of available toxicity information or other relevant data).

It is a priority of the Trustee to rely on existing data and information to the fullest extent possible, including using existing information to establish metrics of injury and service loss. Additionally, the Trustee may consider reasonable conservative assumptions and/or a phased approach for developing additional assessment activities or analyses, as necessary, to address insufficient data in the assessment. These are cost-effective strategies that are expected to satisfy the standard of reasonable cost, as laid out in the DOI NRDA regulations (43 CFR § 11.13(c)).

Below are more specific examples of the injury definitions for geologic, groundwater and biological resources.

3.5.1 GEOLOGIC RESOURCES

As defined in Section 2.2.2, geologic resources include those "elements of the Earth's crust such as soils, sediments, rocks, and minerals…that are not included in the definitions of ground and surface water resources" (11.14(s)). Injury to geologic resources or soils occurs when the release of a hazardous substance is sufficient to cause one or more of the following changes in the physical or chemical quality of the resource:

(i) *"Concentrations of substances sufficient for the materials in the geologic resource to exhibit characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act, 42 U.S.C. 6921;*

(ii) *Concentrations of substances sufficient to raise the negative logarithm of the hydrogen ion concentration of the soil (pH) to above 8.5 (above 7.5 in humid areas) or to reduce it below 4.0;*

(iii) *Concentrations of substances sufficient to yield a salt saturation value greater than 2 millimhos per centimeter in the soil or a sodium adsorption ratio of more than 0.176;*

(iv) *Concentrations of substances sufficient to decrease the water holding capacity such that plant, microbial, or invertebrate populations are affected;*

(v) *Concentrations of substances sufficient to impede soil microbial respiration to an extent that plant and microbial growth have been inhibited;*

(vi) *Concentrations in the soil of substances sufficient to inhibit carbon mineralization resulting from a reduction in soil microbial populations;*

(vii) *Concentrations of substances sufficient to restrict the ability to access, develop, or use mineral resources within or beneath the geologic resource exposed to the oil or hazardous substance;*

(viii) *Concentrations of substances sufficient to have caused injury to ground water, as defined in paragraph (c) of this section, from physical or chemical changes in gases or water from the unsaturated zone;*

(ix) *Concentrations in the soil of substances sufficient to cause a toxic response to soil invertebrates;*

(x) Concentrations in the soil of substances sufficient to cause a phytotoxic response such as retardation of plant growth; or

(xi) Concentrations of substances sufficient to have caused injury as defined in paragraphs (b), (c), (d), or (f), of this section to surface water, ground water, air, or biological resources when exposed to the substances." (43 CFR § 11.62(e)).

3.5.2 BIOLOGICAL RESOURCES

As defined in Section 2.2.4, biological resources include fish, birds, mammals, and other organisms. Injury to biological resources occurs when the concentration of the hazardous substance is sufficient to:

"(i) Cause the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations; or

(ii) Exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. §342, in edible portions of organisms; or

(iii) Exceed levels for which an appropriate state health agency has issued directives to limit or ban consumption of such organism." 43 CFR § 11.62(f).

There are several acceptance criteria that must be satisfied by the methods used to determine injury to a biological resource. For instance, the biological response that is being measured must be predominantly the result of exposure to a hazardous substance. That is, injury should not be caused solely by other environmental factors like nutrition, disturbance, trauma, or weather, although exposure to a hazardous substance may contribute to the vulnerability of a resource to other environmental factors. The response that is being measured should have also been documented in free-ranging organisms as well as in controlled experiments, to the extent possible. The experiments being conducted must produce scientifically valid results and an injury determination must be based on a statistical difference in the biological response between samples from populations in the assessment area and in the control area.

3.5.3 GROUNDWATER

Groundwater is water in the saturated zone or stratum beneath the surface of land or water and the rocks or sediments through which groundwater moves. This includes groundwater that meets the definition of drinking water supplies. Injury to groundwater has resulted from the discharge of oil or release of a hazardous substance if the concentration of that substance exceeds a relevant criterion or standard (e.g., drinking water standard) or is sufficient to cause injury to another natural resource. Injury determination occurs on a continuum which begins with "de minimis" injury, then moves into "measurable adverse change" and ends with "per se" injury under the DOI regulations (Blaser 2010). In most cases Trustees chose to present claims for per se injury as doing so provides a rebuttable presumption under the DOI regulations, but they are not limited to claims for per se injury. According to the DOI regulations, per se injury to groundwater has occurred with documentation of:

> *"(i) Concentrations of substances in excess of drinking water standards, established by sections 1411-1416 of the SDWA, or by other Federal or State laws or regulations that establish such standards for drinking water, in ground water that was potable before the discharge or release;*
>
> *(ii) Concentrations of substances in excess of water quality criteria, established by section 1401(1)(d) of the SDWA, or by other Federal or State laws or regulations that establish such criteria for public water supplies, in ground water that before the discharge or release met the criteria and is a committed use, as the phrase is used in this part, as a public water supply;*
>
> *(iii) Concentrations of substances in excess of applicable water quality criteria, established by section 304(a)(1) of the CWA, or by other Federal or State laws or regulations that establish such criteria for domestic water supplies, in ground water that before the discharge or release met the criteria and is a committed use as that phrase is used in this part, as a domestic water supply; or*
>
> *(iv) Concentrations of substances sufficient to have caused injury as defined in paragraphs (b), (d), (e), or (f) of this section to surface water, air, geologic, or biological resources, when exposed to ground water."* 43 CFR § 11.62(c)(1).

As noted above, while injury to groundwater is often defined by the presence of a contaminant in groundwater in excess of a Federally- or State-promulgated standard or criterion, injury and resulting loss of services, and thus damages, may occur even when contaminant concentrations are below such standards. For example, mixtures of contaminants may be present, each at a concentration below its Maximum Contaminant Level (MCL), but in aggregate the contaminants may be of sufficient concentration to adversely affect the potability of the water or other qualities for which the public holds value. Similarly, in some circumstances MCLs or other relevant criteria may not have been promulgated for a particular contaminant. In these instances, it will be necessary to further document how such contaminants or the combination of such contaminants, though not representing per se injury, effectively meet the injury definition above.

3.6 REMEDIATION-RELATED IMPACTS

Remedial actions often do not fully return natural resources and/or lost services to baseline conditions (i.e., the conditions that would have existed had the release of the hazardous substances not occurred). Remedial actions that involve, for example, excavation, containment (e.g., capping), and other physical alterations of the environment, may also result in unavoidable, additional injury that is compensable under the DOI NRDA regulations. The Trustee intends to identify and quantify the extent to which natural resources are returned to their baseline condition after remediation in addition to identifying and quantifying any remedy-induced natural resource injuries. This evaluation will be based on a review of remedial documents, where available, including documents that describe the post-remedy condition of the remediated site. In circumstances where remediation has been completed, or the result of the remedy can be reasonably estimated (i.e., habitat condition and level of contamination), the Trustee may consider the result of the remedy as part of the injury quantification step of the assessment. In circumstances where the ultimate remedy for a particular habitat or resource is unknown, the Trustee may make reasonably conservative assumptions based on available information about the nature and extent of post-remedy conditions and additional injuries caused by a range of likely remedial approaches.

Further, the DOI NRDA regulations state that:

> *"The Assessment Plan shall contain information sufficient to demonstrate that the damage assessment has been coordinated to the extent possible with any remedial investigation feasibility study or other investigation performed pursuant to the [National Contingency Plan]."* 43 CFR § 11.31(a)(3).

This coordination is important for two reasons. First, it can inform the quantification of post-remedy injuries to natural resources as described above. Second, in some cases, cleanup that is beyond the required remediation or additional augmentation of the post-remedial environment may be undertaken as compensation for natural resource damages.

As noted above, where remedial actions have not yet been completed, it may be possible to include additional remediation and/or restoration above and beyond that required by the remedial process to proactively address residual natural resource injuries or service losses. In some cases, this additional remediation may result in an improvement in natural resources and the services they provide above their baseline condition. The Trustee will look for such opportunities to influence the remedial process, where appropriate, to efficiently reduce injuries and compensate for lost services. Any restoration credit for actions proposed as compensation for natural resource injuries will have to receive the approval of the Trustee in advance and may be reviewed by the public as part of restoration planning. Responsible parties should consult with the Trustee and receive input and approval prior to project implementation, to increase efficiency and allow the Trustee to discuss information regarding potential credits with the responsible party.

3.7 SUMMARY OF INJURY DETERMINATION

Based on currently available data and information, it is clear to the Trustee that natural resources surrounding WSTF have been exposed to and injured by the release of Site-related hazardous substances. However, the full scope and magnitude of that injury is not yet known. As such, the Trustee has identified assessment activities that will help determine natural resource injuries resulting from WSTF releases of hazardous substances. These activities and others are described in Chapter 6.

CHAPTER 4 | INJURY QUANTIFICATION

4.1 INJURY QUANTIFICATION

Once injury to natural resources has been documented, the DOI NRDA regulations state that:

> *"…the authorized official shall quantify for each resource determined to be injured and for which damages will be sought, the effect of the discharge or release in terms of the reduction from the baseline condition in the quantity and quality of services…provided by the injured resource."* 43 CFR § 11.70(a)(1).

Further, the regulations state:

> *"In the Quantification phase, the extent of the injury shall be measured, the baseline condition of the injured resource shall be estimated, the baseline services shall be identified, the recoverability of the injured resource shall be determined, and the reduction in services that resulted from the discharge or release shall be estimated"* (43 CFR § 11.70(c)).

When natural resources are injured by the release of hazardous substances, the services they provide may be reduced or eliminated. For example, if hazardous substances in WSTF soils reduce the abundance of soil-dwelling organisms, the insect and small mammal communities may no longer be able to support baseline bird populations, which prey on these organisms. However, the adverse effects that may be caused by the release of hazardous substances into the environment are variable and depend on biological, chemical, and physical factors. For example, increased concentrations of organic carbon in soils and sediments can change the toxic effects of certain hazardous substances. Similarly, certain species are more or less susceptible to the adverse effects of particular hazardous substances.

The purpose of the injury quantification step is to define the scope of natural resource injuries and lost services, and to allow for selection and scaling of primary or compensatory restoration projects. Quantified injuries form the basis for scaling restoration projects designed to compensate the public for lost resources and resource services, consistent with the NRDA goal to restore natural resources.

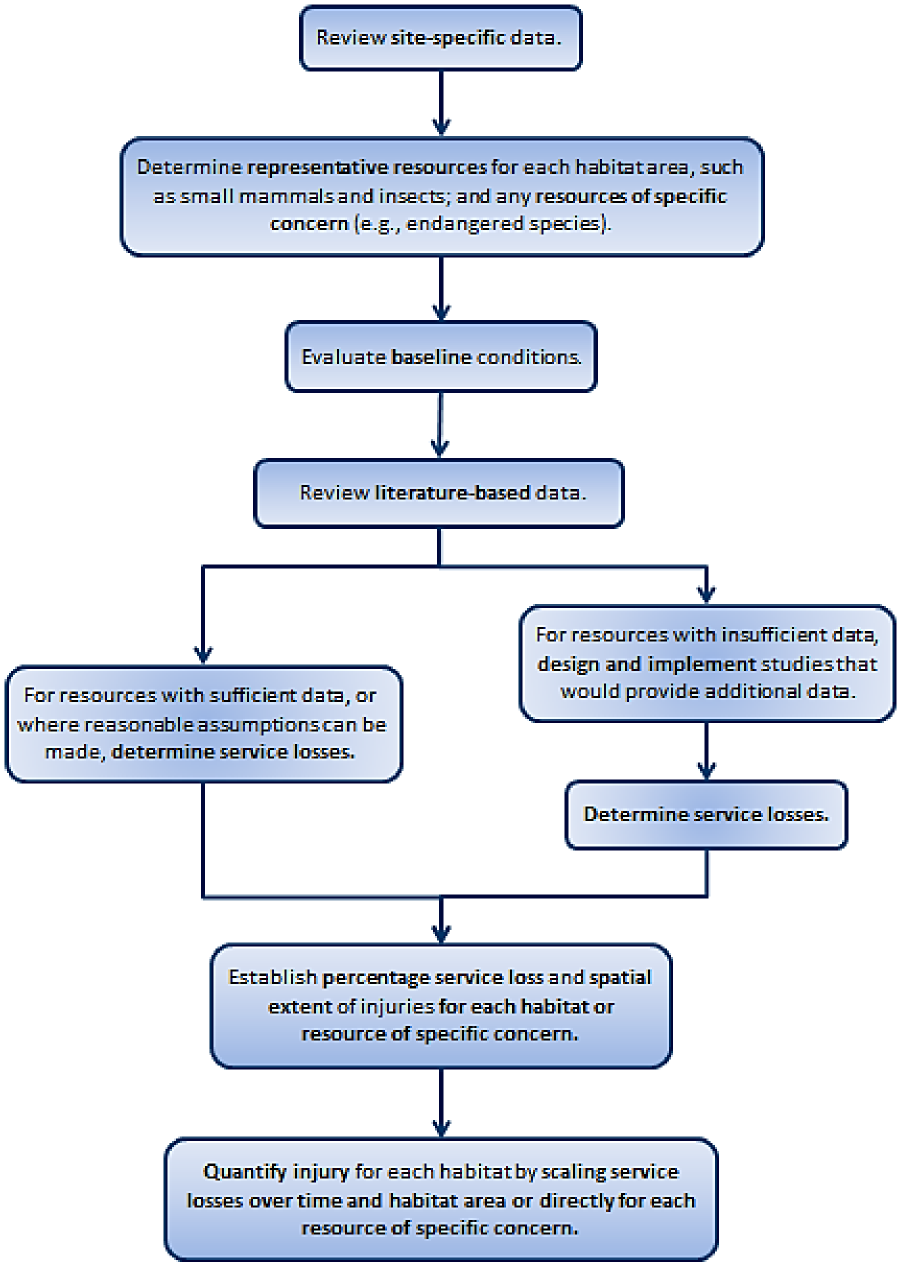
Additionally, per the DOI NRDA regulations, a preliminary determination of the recovery period for the Site must be described (43 CFR § 11.31(a)(2)). Recovery period, as defined in 43 CFR § 11.14(gg), "means either the longest length of time required to return the services of the injured resource to their baseline condition, or a lesser period of time selected by the authorized official and documented in the Assessment Plan." The Trustee will consider factors such as proposed or implemented remedial or restoration activities, natural attenuation, and species' habitat use and sensitivity to contaminants when determining the recovery period. Due to the uncertainty of remedial actions at WSTF (e.g., contaminants with long remediation timelines, as described in Section 1.6.3), at this time the Trustee anticipates that it will take decades for some natural resources and resource services, including in particular groundwater resources, to reach baseline conditions, while other services, such as biological services from vegetation, insects, and small mammals, may be capable of reaching baseline conditions faster. Estimates of recovery periods to baseline condition will be refined based on the results of relevant assessment activities.

Based on current knowledge and understanding of the Site, the Trustee anticipates taking the following approaches for injury quantification. The Trustee may also consider different approaches if new information becomes available as the assessment proceeds.

- **Ecological**: The Trustee anticipates using a habitat equivalency approach (HEA; described in more detail below) in the assessment of ecological injuries. As such, the Trustee will likely quantify ecological injury in terms of lost services on a habitat basis, focusing on geologic resources (soil) and representative wildlife species in each habitat type. The Trustee may also decide to quantify injury to specific resources of concern (e.g., threatened or endangered species, species of special cultural importance) using a resource equivalency approach (REA).
- **Groundwater:** The Trustee anticipates using resource equivalency methods, considering the volume of contaminated groundwater, to quantify groundwater injuries. The use of a volume measure for injured groundwater and to determine the scale of groundwater service losses is supported both by practice in the field of NRDA as well as by the DOI regulations. These regulations state that, at the injury quantification phase for groundwater, "*…the services provided by the ground water that is affected should be determined. This determination may include computation of the volume of water affected, volume of affected ground water pumped from wells, volume of affected ground water discharged to streams or lakes, or other appropriate measures*." (43 CFR § 11.71(i)(4)(i))

The HEA and REA approaches are discussed in greater detail in the sections below and Exhibit 4-1 depicts the approach for injury quantification the Trustee will take in the context of conducting a HEA.

EXHIBIT 4-1 INJURY QUANTIFICATION METHODOLOGY IN THE CONTEXT OF HABITAT EQUIVALENCY ANALYSIS



4.1.1 ECOLOGICAL INJURY QUANTIFICATION APPROACH

Consistent with the DOI NRDA regulations, the Trustee will quantify injury to natural resources based on reductions in the level and type of services provided by resources over time attributable to hazardous substance releases. Specifically, with regard to lost ecological services, the Trustee anticipates quantifying injury to the terrestrial habitat within the WSTF assessment area. Ecological losses include losses to geologic and biological resources and will consider both the direct (e.g., toxic) effects of hazardous substances on natural resources and indirect (e.g., remedial) effects.

The Trustee anticipates applying two variants of equivalency analyses for WSTF: HEA and REA. Both of these methods are commonly applied in the context of NRDA, as they not only provide quantitative measures of lost services, but also can be used within the context of resource-to-resource approaches to scale restoration projects to compensate for natural resource service losses. That is, these methods provide an effective way to produce both quantitative measures of lost services as well as a scale of required restoration projects. HEA typically relies on measures of the percentage service losses per unit of habitat (generating injury estimates expressed in area-time measures such as acre-years). REA measures service losses per unit of resource (generating injury measures such as bird-years). The Trustee will determine whether an equivalency approach makes sense for a given resource as well as any reasonable conservative assumptions that will be applied.

Habitat Equivalency Analysis

The first phase of a HEA involves generation of a quantitative estimate of service loss, while the second phase provides a quantitative estimate of gains from potential restoration projects. HEA is most commonly undertaken when injury or service losses can be said to accrue to a broad range of biological resources within a geographic area. In order to generate resource service loss estimates in the context of HEA, there are two general approaches:

- **Contaminant-centric approaches.** These approaches involve comparisons of measured or modeled contaminant values with either literature-based thresholds, or literature-based or site-specific exposure-response functions, to estimate service losses. These approaches are widely used and are adaptable to broad ranges of case circumstances. Some limitations include the uncertainty regarding the application of literature-based thresholds to site resources, the availability of toxicological information, and the uncertainty associated with developing an exposure-response function based on individual threshold values.
- **Field-centric approaches.** These approaches rely on field-based measures of ecological functions (e.g., percent native plant live cover, native plant species richness). Field-based approaches can be particularly useful when causality of potential field impacts is unlikely to be an issue, and are useful for estimating benefits of restoration projects that are unrelated to contaminant presence. However, field-based measures can be costly to develop, and it may be difficult to tease out adverse effects due to hazardous substances from effects due to other anthropogenic or natural influences (e.g., adverse effects from grazing).

Resource Equivalency Analysis

In the context of ecological injury, REA is most commonly selected to quantify lost ecosystem services when the injury is specific to a particular species or species group, particularly when the nature of the injury includes acute lethality to a known, or estimable, number of organisms. The unit of injury is the number of organisms lost (or their biomass), and may also potentially include their lost future somatic (i.e., physical) growth and/or reproductive potential. Essentially, REA blends population modeling with discounting to put past and future changes in the selected measurement unit into a common present value.

4.1.2 GROUNDWATER INJURY QUANTIFICATION APPROACH

It is anticipated that a REA approach will be used for assessing and scaling restoration for groundwater losses. As noted above, resource equivalency methods are based on balancing the injury to natural resources that has occurred over time with an equivalent amount of restoration, taking into account the nature and duration of the injury and the nature and timing of the restoration. Thus, for a groundwater REA, it is necessary to characterize the baseline quality of the groundwater (as defined in Section 4.2, below), quantify the amount of injured groundwater, and delineate the timeframe of the injury.[7]

The quantity of injured groundwater can be estimated as a static volume, which is the amount of injured groundwater at a given point in time (also referred to as a stock of groundwater). It can alternatively be quantified as a flux, which is the volume of water passing through the aquifer over a unit of time (e.g., on an annual basis). Both types of injury quantification approaches require information about the spatial extent of the groundwater contamination and the physical properties of the aquifer. For example, in order to calculate static volume (or stock), the surface area and the thickness of the groundwater contaminant plume is needed. In addition, the porosity of the aquifer (for these purposes, the fraction of the total aquifer space that contains groundwater) is also needed. Delineating the timeframe of injury includes determining when it began, how it may have changed over time, and when (or if) it will end. Whether injury is quantified as a static volume and/or flux is typically decided based on specific conditions encountered at a site and the types of groundwater restoration being considered. The Trustee anticipates using a static volume calculation to quantify the volume of contaminated groundwater, but may change methods if new information becomes available during the assessment.

Note that the approach to groundwater injuries described here is not intended to address biological injury or injury to surface waters associated with exposure of these resources to contaminated groundwater. Such injuries, if substantive, should be addressed separately.

[7] Here we describe only the information needed for the quantification of groundwater injury. Chapter 5 provides a description of how REA will be used to scale restoration in order to establish an estimate of damages.

Addressing Contamination of the Vadose Zone and Geological Resources

The DOI regulations list geological resources as a separate category of natural resources, and suggest quantification of injury to such resources in terms of "[t]he volume of geologic resources that may act as a source of toxic leachate" (43 CFR § 11.71 (k)(3)). Thus, the Trustee anticipates addressing contamination in the vadose zone as a pathway and reservoir of contaminants, not as a separate injured resource.

4.2 BASELINE

Baseline, as defined in 43 CFR § 11.14(e), is;

> *"…the condition or conditions that would have existed at the assessment area had the discharge of oil or release of the hazardous substance under investigation not occurred."*

As required by the DOI NRDA regulations, the Trustee plans to determine "the physical, chemical, and biological baseline conditions and the associated baseline services for injured resources at the assessment area" and will quantify injury based on the reduction of services from that baseline level (43 CFR § 11.72(a)).

Baseline data should reflect conditions expected in the assessment area had the discharge of oil or release of hazardous substances not occurred, taking into account natural processes and changes that result from human activities. These conditions may be established through the review of historical, pre-release data and information. In many cases, historical information for an assessment area is unavailable or the analytical methods are not comparable to modern methods. Instead, historical or field data from control areas that exhibit similar physical, chemical, and biological conditions as the assessment area, excluding contamination, may be used (43 CFR § 11.72(d)).

Baseline should be conditions "but for the release," holding all other factors constant. Assessment areas with a long-term history of hazardous substance releases have the added challenge of separating confounding changes from true baseline conditions (e.g., long-term changes in species abundance or composition at the Site resulting from causes other than site-specific releases).

The approach that the Trustee will use for establishing baseline conditions may vary by natural resource or the service being assessed. In general, the characterization of these baseline conditions will occur within each specific assessment activity, as necessary (Chapter 6). In the context of ecological or groundwater injury, the Trustee will strive to define resource-specific contaminant concentrations that would be expected in environment surrounding WSTF but for the release of hazardous substances, and will take any service losses caused by baseline concentrations into account when quantifying injury. For example, pre-existing water quality or contamination issues in groundwater will be accounted for.

CHAPTER 5 | DAMAGES DETERMINATION

Once injuries to natural resources in the assessment area are quantified, the Trustee will determine the appropriate scale of restoration required to fully compensate the public, and the cost of that restoration. While damages are "the amount of money sought by the natural resource trustee as compensation for injury, destruction, or loss of natural resources" (43 CFR § 11.14(l)), there is a clear intention in the DOI regulations to focus on the actual restoration of natural resources rather than on valuing the change in the public's willingness to pay to avoid the injury. Specifically,

> *"The measure of damages is the cost of (i) restoration or rehabilitation of the injured natural resources to a condition where they can provide the level of services available at baseline, or (ii) the replacement and/or acquisition of equivalent natural resources capable of providing such services."* 43 CFR § 11.80(b)

Further, in describing the regulations, DOI stated that it:

> *"…does not believe that Congress intended to allow trustee agencies to simply restore the abstract services provided by a resource, which could conceivably be done through an artificial mechanism. For example, nothing in the language or legislative history of CERCLA suggests that replacement of a spring with a water pipeline would constitute "restoration, rehabilitation, replacement, and/or acquisition of equivalent resources." CERCLA requires that natural resource damages be based on the cost of restoring, rehabilitating, replacing and/or acquiring the equivalent of an actual natural resource."* 58 Fed. Reg. 39,339, July 22, 1993

In the 2008 revisions to the DOI NRDA regulations, DOI modified the regulations to express a preference for direct selection and scaling of restoration options, over estimation of the monetary value of lost services. In the preamble to the revised regulations DOI stated, in reference to interim lost services (i.e., compensable values):

> *"We believe that in many cases, restoration-based approaches can lead to timelier, more efficient, and more cost effective [restoration of natural resources and the services those resources provide] —which is the key objective of these revisions. The NRDAR process is streamlined by focusing directly on restoration alternatives that address losses, rather than on first estimating the monetary value of losses and then determining how to address them with appropriate projects. Moreover, the transparency involved in comparing resource gains to resource losses reduces controversy and transaction costs, and encourages collaborative efforts to identify projects that yield high human and ecological benefits relative to their monetary cost."* 73 Fed. Reg. 57,259

5.1 APPROACH TO DAMAGES DETERMINATION

In light of this guidance, there are two general steps the Trustee anticipates taking to determine natural resource damages once injuries have been quantified. These are:

1. Determine the appropriate scale of restoration projects needed to fully compensate for the quantified natural resource injuries.
2. Calculate damages as the cost, in dollars, to perform the restoration projects.

An important component of Step 1 is the consideration of general criteria for evaluation of restoration projects (43 CFR § 11.82(d)), as well as any Site-specific criteria or objectives for particular restoration projects. Factors for consideration explicitly listed in the DOI NRDA regulations include, but are not limited to:

- the technical feasibility of the restoration action,
- the cost-benefit and cost-effectiveness of the restoration,
- results of actual or planned response actions,
- potential for additional injury or adverse effects on human health and safety to be caused by the restoration action,
- the natural recovery period and the ability of the natural resources to recover without restoration, and
- consistency and compliance with Federal, state, and tribal policies (43 CFR § 11.82(d)).

In addition to these restoration criteria, the Trustee may consider additional criteria when identifying, scaling, and selecting restoration projects, such as, for example:

- the relevance of the project to the natural resource damage assessment (i.e., nexus to injury),
- proximity of the project to WSTF,
- potential for immediate and long-term benefits,
- likelihood of providing benefits to multiple natural resources, and
- likelihood of the project proceeding without NRDA funding.

The Trustee may also identify additional criteria as the assessment proceeds. For example, if a particularly sensitive or important biological receptor is determined to be injured as a part of the assessment, the Trustee may prioritize projects that provide benefits for this species.

In addition to considering the criteria above, when selecting and implementing restoration actions, the Trustee will take measures to avoid double counting. Double counting may occur when evaluating damages associated with resources that provide multiple, overlapping benefits and services.

5.1.1 ECOLOGICAL DAMAGES DETERMINATION

As indicated in Chapter 4, the Trustee anticipates using HEA or REA to quantify ecological losses. The Trustee, therefore, also anticipates using these approaches when scaling restoration.

Specifically, use of equivalency-based scaling approaches will mean that the Trustee will identify and quantify the services provided by proposed restoration projects as part of the scaling process. As restoration projects are identified and evaluated, attention will need to be paid to the particular suite of services the restoration projects are anticipated to provide. Whenever possible, the Trustee will endeavor to target restoration that will replace, rehabilitate, restore, or acquire the equivalent of those resources and the services they provide that were found to be injured (i.e., in-kind replacement). In some cases, the Trustee may choose to engage in environmental restoration that is deemed worthwhile (but is not in-kind in nature) if it restores similar resources or resource services as were injured or restores resources or resource services that are deemed to be highly important ecologically when restoration of the same type and quality is unavailable or not possible. In these circumstances, the Trustee will evaluate the relative differences between the type and quality of the injured resources and the resources to be restored, and may adjust the scope or scale of required restoration accordingly. For example, the Trustee may develop compensation ratios to account for potential differences in ecological services provided by different habitat types (e.g., wetland versus open water habitat). Such ratios may be applied to assure that any tradeoffs in the habitats or resources targeted for restoration result in restoration projects that are sufficient to make the public whole.

5.1.2 GROUNDWATER DAMAGES DETERMINATION

As with the damages determination approach for ecological losses described above, the Trustee anticipates identifying, scaling, and determining the cost (as necessary) of restoration projects required to compensate the public for groundwater injuries. There are a wide range of restoration projects that could be performed to restore lost groundwater services, such as prevention of groundwater contamination (e.g., provision of sewer in areas reliant on septic systems). Projects will be chosen based on restoration criteria, and will be scaled using a resource equivalency method – that is, the Trustee anticipates implementing restoration actions to replace the present value of the quantity (e.g., static volume) of groundwater shown to be injured in the injury quantification phase of the assessment.

5.2 RESTORATION AND COMPENSATION DETERMINATION PLAN

The determination of appropriate damages and restoration will be summarized in an RCDP, to be produced by the Trustee. The RCDP will evaluate restoration alternatives and describe the selection process followed in choosing the preferred alternatives. The Trustee will seek input from the public regarding potential restoration projects and the RCDP will be made available to the public for review and comment.

CHAPTER 6 | PROPOSED ASSESSMENT ACTIVITIES

6.1 INTRODUCTION

The preceding chapters have introduced the key components of the WSTF NRDA, and discussed the framework and general approaches for conducting the assessment. The assessment will comprise a series of analyses aimed at assessing the magnitude of natural resource injury resulting from hazardous substance releases from WSTF, and the specific type and scale of restoration projects that will be implemented to make the public whole for the injuries. Preliminary efforts have been completed. In particular, the Trustee conducted a preliminary review of available data as part of the assessment planning process and completed a PAS. The Trustee anticipates beginning the assessment with a more in-depth review and evaluation of available data, followed by the implementation of specific assessment activities. The anticipated efforts likely to be conducted as part of the assessment are described in greater detail below and summarized in Exhibit 6-1.

This Plan represents the Trustee's current understanding of the assessment activities to identify and quantify injuries to natural resources and the services they provide on and around WSTF, and identify and scale restoration. Inclusion of an activity within this Plan does not guarantee that it will be undertaken, and efforts not included within this Plan may be deemed necessary at a later date. This Plan does not limit in any way the extent and nature of analyses that maybe undertaken in the course of the assessment. Rather, it provides a framework within which the Trustee will begin to implement the assessment. As these efforts progress and additional information is generated, the Trustee may modify this Plan, and may provide amendments to this Plan, or portions of this Plan, for public review and comment.

Quality assurance and management protocols for the assessment are included in Chapter 7, which will be used as a guide in the implementation of individual efforts.

6.2 SUMMARY OF PROPOSED ASSESSMENT ACTIVITIES

The proposed assessment activities likely to be conducted as part of the assessment are summarized in Exhibit 6-1 and described in more detail below.

EXHIBIT 6-1 PROPOSED ASSESSMENT ACTIVITIES

CATEGORY / RESOURCE	ASSESSMENT ACTIVITY	SUMMARY OF ASSESSMENT ACTIVITY
ECOLOGICAL	Compilation and Review of Existing WSTF Ecological Data	Compile available data related to ecological resources (e.g., soils, biota) and contaminant exposure and begin to review data to identify information relevant for the ecological assessment.
	Identification of Ecological Contaminants of Concern and Adverse Effects Thresholds	Based on the review of existing information, identify a suite of contaminants of concern and summarize available information on the ecotoxicological impacts of these contaminants of concern. Identify adverse effects thresholds from the literature and/or promulgated standards for use in identifying and quantifying ecological injuries.
	Identification and Quantification of Ecological Impacts due to Remedy	Compile available information on remedial actions completed and planned at WSTF. Determine the potential ecological adverse impacts, and benefits, resulting from the remedial actions.
	Quantification of Ecological Injuries and Service Losses	Analyze resource-use specific information compiled during previous efforts to quantify lost ecological services.
	Determination and Monetization of Ecological Damages	Identify and scale restoration projects needed to compensate for ecological injuries and associated lost services.
GROUNDWATER	Compilation and Review of Existing WSTF Groundwater Data	Compile and review groundwater data contained within available WSTF databases and reports, and identify information relevant for groundwater assessment purposes.
	Quantification of the Volume of Contaminated Groundwater	Quantify injured groundwater volume and time dimensions using existing information and information obtained as a result of activities listed in this Plan.
	Assessment of Groundwater Service Losses	Describe the services provided by groundwater in and around WSTF under baseline conditions and how these services have been impacted by the release of hazardous contaminants, in order to determine the service losses attributable to hazardous substance contamination.
	Determination and Monetization of Groundwater Damages	Identify and scale restoration projects needed to compensate for groundwater injuries and associated lost services.
ALL RESOURCES	Development of a Restoration and Compensation Determination Plan (RCDP)	Compile information and results from the ecological and groundwater assessment activities to develop an RCDP, summarizing restoration alternatives and the Trustee's preferred alternative.

6.3 ECOLOGICAL ASSESSMENT ACTIVITIES

COMPILATION AND REVIEW OF EXISTING WSTF ECOLOGICAL DATA

Objectives: To (1) compile all available data collected to-date through WSTF remedial actions or other sources, including any soil contaminant concentration data and biological information that may exist; (2) review available information to identify data relevant for injury assessment purposes and identify any relevant data gaps; and (3) evaluate available information to assess potential pathways for exposure of biological resources to hazardous substances.

Need/Rationale: Relying on existing data is a priority for the Trustee, since utilizing available information is a cost-effective way to complete the assessment of natural resource injuries. Additionally, compiling and reviewing the available information will allow the Trustee to identify data gaps and make an informed decision on how best to fill those data gaps (e.g., through primary data collection or the use of reasonable conservative assumptions).

Approach: The first step in this assessment activity will involve assembling and reviewing available ecological data. This will include reviewing existing site remedial reports, monitoring reports, and databases. This effort may also include developing a database to house the relevant information for assessing natural resource injuries, as necessary. Reviewing available data will include evaluating the quality of the data for natural resource assessment purposes, and determining the spatial and temporal extent of available information. After reviewing available information, the second component of this assessment activity will involve identifying any relevant data and data gaps for injury assessment purposes. Data gaps may include geographic locations and/or resources with insufficient data to assess natural resource injuries or establish pathways of exposure. Using the available information, a third step will be establishing potential pathways for exposure of biological resources to hazardous substances to narrow resources of concern for future injury quantification efforts. Finally, this activity will also include an evaluation of media and contaminant-specific baseline conditions, which will include, to the extent possible, a characterization of the concentration ranges of hazardous substances expected to be present on and around WSTF, but for WSTF hazardous substance releases.

IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF CONCERN AND ADVERSE EFFECTS THRESHOLDS

Objectives: To (1) summarize available ecotoxicity information pertaining to the primary contaminants of concern; and (2) identify and evaluate those contaminants of concern for which toxicity literature, criteria, and/or standards are not available and develop an approach to address the uncertainty with regard to injury due to these hazardous substances.

Need/Rationale: During preliminary evaluations of existing data, the Trustee identified those contaminants of concern that are the primary injury drivers (i.e., those contaminants that likely contribute the most to injury at their observed concentration in WSTF media). However, during the *Compilation and Review of Existing WSTF Ecological Data* assessment activity, additional contaminants of concern may be identified. Focusing on the primary contaminants of concern will allow the Trustee to narrow subsequent injury efforts to focus on those contaminants most likely to contribute to injury quantification, saving time and resources. During this effort, the Trustee will identify any contaminants of concern for which information on adverse effects is not available will allow the Trustee to develop an approach to address this uncertainty.

Approach: This effort will begin with a review of the information compiled during the *Compilation and Review of Existing WSTF Ecological Data* assessment activity related to the contaminants of concern that are the primary injury drivers. The second component of this assessment activity will require identification of adverse effects thresholds (i.e., site-specific and/or relevant values from the literature, against which the Trustee will compare contaminant concentrations). This will require a compilation of site-specific ecotoxicity information and information from the peer reviewed literature pertaining to the contaminants of concern. Information from the literature will be evaluated for relevance to WSTF habitat and ecological resources. After a review of available ecotoxicity information, a short description of each contaminant will be developed focusing on the sources, pathways, and potential effects of the subject contaminant. As part of this evaluation, contaminants will be identified as having one or more of the following origins: natural sources, WSTF site operations, and/or other anthropogenic sources.

IDENTIFICATION AND QUANTIFICATION OF ECOLOGICAL IMPACTS DUE TO REMEDY

Objective: To determine and quantify ecological impacts and benefits resulting from remedial actions completed and planned to-date at WSTF.

Need/Rationale: In order to determine and quantify ecological injuries and service losses, the Trustee will need to consider potential impacts of remedial actions, both adverse and beneficial impacts.

Approach: This effort will begin with a compilation of available information related to remedial actions completed and planned at WSTF. Information may include site reports describing remedial actions and/or geographic information system layers illustrating the footprint of site remedial actions. Using the available information, the Trustee will estimate the likely impact of the remedial actions on the terrestrial environment and ecological resources using a HEA approach.

QUANTIFICATION OF ECOLOGICAL INJURIES AND SERVICE LOSSES

Objective: To quantify the ecological injures and associated service losses in the terrestrial habitat at and around WSTF in the past, present, and potentially into the future as a result of site-related contamination and associated remedial actions.

Need/Rationale: In order to determine the scale and type of restoration actions required to compensate the public for ecological losses, the Trustee will need to understand the scale and scope of injured resources and service losses.

Approach: This effort involves two steps. The first step involves compiling information obtained from the ecological analyses described above. This information will likely include the degree to which sample concentrations (i.e., in soil, sediment, and biota) exceed identified injury thresholds, information on the adverse effects of varying levels of contamination, an estimate of the impact of site remedial actions, as well as ecological information (e.g., abundance and/or distribution of species, species community health). The second step of this effort is to analyze the compiled data in order to develop the necessary inputs for the "debit" side of the habitat or resource equivalency analysis, including the geographic and temporal scope of losses and the magnitude of losses.

DETERMINATION AND MONETIZATION OF ECOLOGICAL DAMAGES

Objective: To (1) identify restoration criteria for evaluating and ranking potential restoration projects, (2) estimate the scale and scope of restoration projects needed to fully compensate the public for quantified ecological losses, including specific projects if possible, and (3) determine the cost of the restoration actions.

Need/Rationale: In order to compensate the public for injured natural resources and lost services resulting from hazardous releases from WSTF, restoration projects must be identified and scaled appropriately.

Approach: As discussed in Chapter 5, there are a number of ways to estimate natural resource damages. Damages are "the amount of money sought by the natural resource trustee as compensation for injury, destruction, or loss of natural resources" (43 CFR § 11.14(l)). For WSTF, the Trustee is focusing on the implementation of restoration projects that will compensate for the quantified ecological losses. The Trustee will start this effort by identifying specific restoration criteria to use to screen, evaluate, and rank potential restoration projects. After restoration criteria are established, the Trustee will identify a suite of representative restoration projects or types of projects that would restore those injured natural resources and lost services resulting from hazardous substance releases from WSTF. The Trustee will then determine the appropriate scale and scope of restoration actions needed to fully compensate for the quantified injuries. Lastly, the Trustee will estimate damages as the cost, in dollars, to perform the representative restoration actions. The Trustee may decide to focus on identifying the costs of specific restoration actions or on establishing average unit restoration costs for a set of restoration actions.

6.4 GROUNDWATER ASSESSMENT ACTIVITIES

COMPILATION AND REVIEW OF EXISTING WSTF GROUNDWATER DATA

Objectives: To (1) compile all available groundwater data collected to-date through WSTF remedial actions or other sources; (2) review available information and identify data relevant for injury assessment purposes; and (3) identify any relevant data gaps.

Need/Rationale: Relying on existing data is a priority for the Trustee, since utilizing available information is a cost-effective and efficient way to complete the assessment of natural resource injuries. Additionally, compiling and reviewing the available information will allow the Trustee to identify data gaps and make an informed decision on how best to fill those data gaps (e.g., through primary data collection or the use of reasonable conservative assumptions).

Approach: The first step in this assessment activity will involve assembling and evaluating available groundwater data. The Trustee understands that much of the existing groundwater data collected during monitoring and other assessments at WSTF are available in site monitoring reports and groundwater databases. This review will include compiling relevant data into a database for use in injury assessment, and an evaluation of the quality of available data for natural resource damage assessment purposes. The spatial and temporal extent of available data will be evaluated and any data gaps relevant for injury assessment purposes will be identified. Lastly, a series of maps of groundwater contaminant data will be developed as part of this effort.

QUANTIFICATION OF THE VOLUME OF CONTAMINATED GROUNDWATER

Objective: To quantify the volume of injured groundwater in and around WSTF that is attributable to WSTF releases of hazardous substances, and determine the time (i.e., number of years) over which groundwater has been and will continue to be injured, using existing information and information obtained from the other groundwater assessment activities listed in this Chapter.

Need/Rationale: The Trustee will need to understand the quantity of injured groundwater in order to scale and determine the amount of restoration required to compensate the public for any losses.

Approach: Hazardous substance releases from WSTF have resulted in contaminated groundwater, in some cases above drinking water standards. The use of drinking water standards is only one of the possible criteria to determine injury to groundwater. For example, injury to groundwater may also be determined based on a measurable adverse change in the chemical quality of the resource or the potential for groundwater to injure other resources, such as surface water. The Trustee will use available information to quantify the amount of groundwater injured over time, likely as a static (stock) volume. This effort will involve (1) compiling available information on the likely timeframe over which groundwater has been injured at and around WSTF; (2) comparing groundwater contaminant concentrations to identified injury thresholds to determine potential injury; (3) compiling and analyzing information on the horizontal and vertical extent of contamination; and (4) combining these pieces of information on time and extent of injury to estimate the quantity of injured groundwater.

ASSESSMENT OF GROUNDWATER SERVICE LOSSES

Objective: To (1) describe the services provided by groundwater in and around WSTF, (2) define baseline conditions, and (3) determine how these services, which may include use, non-use and *in situ* services, have been impacted by releases of hazardous contaminants.

Need/Rationale: An understanding of the services provided by groundwater that has been contaminated by WSTF releases under baseline conditions is necessary to determine to what extent services have been adversely affected. Identifying groundwater services and determining how these services have been affected, in conjunction with quantifying the volume of injured groundwater, will inform the identification and scaling of appropriate restoration projects to restore, rehabilitate, replace, or acquire the equivalent of the injured resource and any lost services.

Approach: This effort will involve the identification and development of a description of the services that are provided by groundwater in and around WSTF, including their baseline conditions, and how those services have been impacted by contamination. The effort should address the full range of services, including use, non-use, and *in situ* services. The services provided by groundwater resources at and around WSTF will be identified using existing information on the hydrogeologic setting, institutional and legal factors, and current and past use of groundwater resources through interviews with local groundwater resource experts, as necessary.

DETERMINATION AND MONETIZATION OF GROUNDWATER DAMAGES

As discussed in Chapter 5, the Trustee anticipates identifying and scaling restoration projects to compensate the public for groundwater losses using resource equivalency methods and a replacement cost approach, as necessary.

Objective: To identify restoration projects needed to fully compensate the public for quantified groundwater injury and service losses and, if necessary, determine the cost of these restoration actions.

Need/Rationale: In order to compensate the public for injured groundwater resources and service losses resulting from hazardous releases at WSTF, restoration projects must be identified and scaled appropriately.

Approach: The first step for this effort will involve identifying specific restoration criteria to use to screen, evaluate, and rank potential groundwater restoration projects. The second step consists of identifying the appropriate type(s) of restoration project(s) needed to compensate the public for the groundwater resources and services determined to have been lost as a result of WSTF-related contamination. The Trustee will then determine the appropriate scope and scale of identified representative restoration projects needed to fully compensate for the quantified injuries based on the results of the *Quantification of the Volume of Contaminated Groundwater* and *Assessment of Groundwater Service Losses* assessment activities. Lastly, the Trustee will calculate damages as the cost, in dollars, to perform the representative restoration projects. The Trustee may decide to focus on identifying the costs of specific restoration actions or on establishing average unit restoration costs for a set of restoration actions.

6.5 ALL RESOURCES ASSESSMENT ACTIVITIES

DEVELOPMENT OF A RESTORATION AND COMPENSATION DETERMINATION PLAN (RCDP)

Objectives: To compile and organize information and results from the ecological and groundwater assessment activities and develop an RCDP.

Need/Rationale: An RCDP will provide summary information on the results of the assessment, quantified ecological and groundwater injuries and service losses, and a description of potential restoration alternatives or types of projects that would provide restoration for the quantified injuries and service losses. The RCDP may also include the Trustee's preferred alternative for compensating the public for lost resources and resource services resulting from WSTF releases of hazardous substances.

Approach: The first step will involve compiling and organizing information and results from the completed ecological and groundwater assessment activities. Secondly, the Trustee will develop a summary of restoration actions considered and may include a description of the selected preferred restoration alternative(s). This information will be compiled into an RCDP that will be released to the public for review and comment, consistent with 43 CFR § 11.81.

CHAPTER 7 | QUALITY ASSURANCE AND MANAGEMENT

7.1 INTRODUCTION

Many of the management decisions needed to accomplish the WSTF NRDA require the use of environmental data. The compilation, evaluation, reporting, and possibly collection of environmental data are necessary to carry out the functions of the NRDA including identification of data gaps; assessment of the severity, location and extent of injury; and making appropriate decisions as to the needed type and scale of restoration actions. Careful design of assessment activities and appropriate interpretation of results, including consideration of uncertainty and data quality, are essential to achieve these goals.

The Trustee intends to follow the guidelines below in order to ensure that all environmental data and related information relied upon in this NRDA are scientifically valid for their intended use and that the assessment relies on sound analyses and technically accurate information.

7.2 SHARING DATA, SPLIT SAMPLES, AND ANALYTICAL RESULTS

Section 11.31(a)(4) of 43 CFR states that, "The Assessment Plan shall contain procedures and schedules for sharing data, split samples, and results of analyses, when requested, with any identified potentially responsible parties and other natural resource trustees."

If and when the Trustee determines that a study involving primary data collection should be implemented, that study may be developed into a full work plan in collaboration with a Principal Investigator (PI). The work plan will include procedures and schedules for sharing data, split samples, and analytical results with relevant parties, based on the specific data collection and analysis methods, and objectives for the work plan.

7.3 QUALITY ASSURANCE

The DOI NRDA regulations require trustees to develop a Quality Assurance Plan (QAP) that "satisfies the requirements listed in the National Contingency Plan and applicable EPA guidance for quality control and quality assurance plans." 43 CFR § 11.31(c)(2). The Trustee recognizes the importance of data quality; as noted above, many of the management decisions involved in accomplishing the WSTF NRDA ultimately require the use of environmental data. The collection, compilation, evaluation, and reporting of environmental data are necessary to perform the functions of the assessment. It is necessary that the origin and quality of the data used to make these decisions are properly documented so that data gaps may be identified; assessments of the severity, location, and extent of injury are accurate; and thus, appropriate decisions may eventually be made as to the needed type and scale of restoration actions. Also relevant to this effort are the United States Fish and Wildlife Service (FWS) guidelines developed under the Information Quality Act of 2001. All information developed in this NRDA will be in compliance with these guidelines.

This Plan focuses on assessment activities that evaluate existing data. When evaluating existing data, to the extent possible, the study's PI will document the source of all data, available information about quality assurance (QA)/quality control (QC) procedures used by the original investigator, and any data qualifiers or other information restricting application of the data. This approach will also be applied to any new data and/or analyses. To the extent that any new studies are specifically undertaken to support the NRDA process, appropriate study-specific QAPs will be developed according to the general principles described below.

As noted by EPA (2001), QAPs will "vary according to the nature of the work being performed and the intended use of the data" and as such, need to be tailored to match the specific data-gathering needs of a particular project. The Trustee will ensure that individual study plans adequately address project-specific QA issues. The discussion in this document focuses on the elements present in most acceptable study plans.

In general, a study plan must provide sufficient detail to demonstrate that:

- the project's technical and quality objectives are identified and agreed upon;
- the intended measurements, data generation, or data acquisition methods are appropriate for achieving project objectives;
- assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and
- any limitations on the use of the data can be identified and documented (EPA 2001).

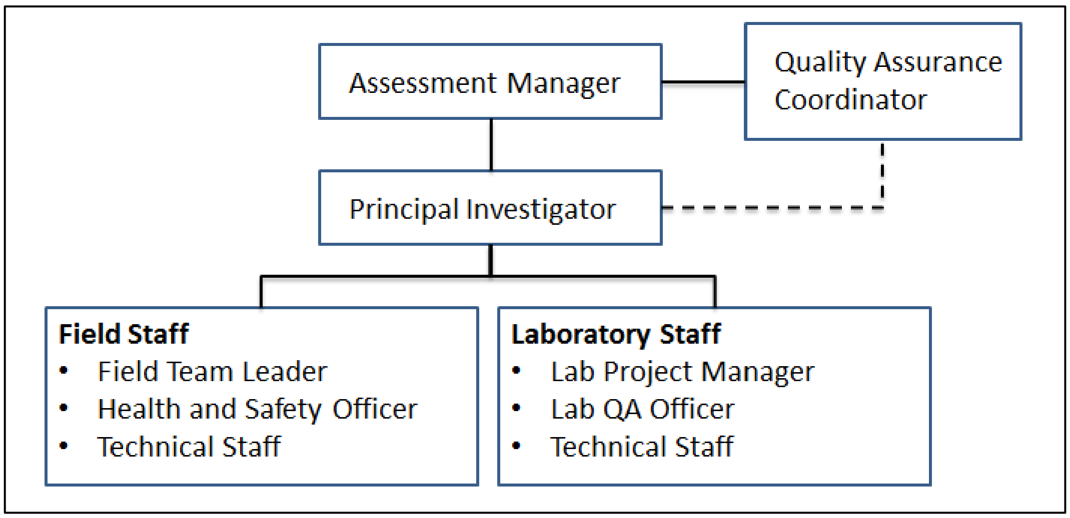
Accordingly, specific study plans developed for this assessment will include the four elements called for by EPA:

- **Project Management** – documents that the project has a defined goal(s), that the participants understand the goal(s) and the approach to be used, and that the planning outputs have been documented;
- **Data Generation and Acquisition** – ensures that all aspects of project design and implementation including methods for sampling, measurement and analysis, data collection or generation, data compiling/handling, and QC activities are documented and employed;
- **Assessment and Oversight** – assesses the effectiveness of the implementation of the project and associated QA and QC activities; and,
- **Data Validation and Usability** – addresses the QA activities that occur after the data collection or generation phase of the project is completed.

7.4 PROJECT MANAGEMENT

Effective implementation of project objectives requires clear project organization, which includes carefully defining the roles and responsibilities of each project participant. Clear personnel structures help ensure that each individual is aware of his or her specific areas of responsibility, as well as clarifying internal lines of communication and authority, which is important for decision-making purposes as projects progress. Individuals' and organizations' roles and responsibilities may vary by study or task, but each person's role and responsibility should be clearly described in the project's study plan. Exhibit 7-1 below presents a generic personnel plan for a NRDA project.

EXHIBIT 7-1 PERSONNEL PLAN



The Assessment Manager is the designated trustee representative with responsibility for the review and acceptance of the project-specific study plan. This individual is also responsible for ensuring that the project's goals and design will meet the broader requirements of this NRDA. The Assessment Manager coordinates efforts with the Quality Assurance Coordinator and oversees the PI.

The QA Coordinator oversees the overall conduct of the quality system. Appointed by the Trustee, this individual's responsibilities include, but are not limited to:

- reviewing/assisting the PI with the development of project-specific study plans;
- conducting audits and ensuring implementation of both project-specific and overall plans;
- archiving samples, data, and all documentation supporting the data in a secure and accessible form; and
- reporting to the Trustee.

To ensure independence, the person serving as QA Coordinator will not serve as either the Assessment Manager or as a PI for any NRDA study.

Study-specific PIs oversee the design and implementation of particular NRDA studies. Each PI has the responsibility to ensure that all health, safety, and relevant QA requirements are met. If deviations from the study plan occur, the PI (or his/her designee) will document these deviations and report them to the Assessment Manager and the QA Coordinator.

The Field Team Leader supervises day-to-day field investigations, including sample collection, field observations, and field measurements. The Field Team Leader generally is responsible for ensuring compliance with all field QA procedures defined in the study plan. Similarly, the Laboratory Project Manager is responsible for monitoring and documenting the quality of laboratory work. The Health and Safety Officer (who may also be the Field Team Leader) is responsible for ensuring adherence to specified safety protocols in the field.

7.5 DATA GENERATION AND ACQUISITION

All studies under the direction of the Trustee that are specifically undertaken in support of the NRDA will have a prepared study plan that will be completed prior to the initiation of any work. These study plans will be submitted to, and approved by, the QA Coordinator or designee. Each study plan should describe and/or include, at a minimum:

- project objectives;
- rationale for generating or acquiring the data;
- proposed method(s) for generating or acquiring the data, including descriptions of (or references to) standard operating procedures for all sampling or data-generating methods and analytical methods;
- types and numbers of samples required;
- analyses to be performed;
- sampling locations and frequencies;
- sample handling and storage procedures;
- chain-of-custody procedures;
- data quality requirements (for instance, with respect to precision, accuracy, completeness, representativeness, comparability, and sensitivity);
- description of the procedures to be used in determining if the data meet these requirements; and
- description of the interpretation techniques to be used, including statistical analyses.

In addition, to the extent practicable, laboratories will be required to comply with Good Laboratory Practices. This includes descriptions of maintenance, inspections of instruments, and acceptance testing of instruments, equipment, and their components, as well as the calibration of such equipment and the maintenance of all records relating to these exercises. Documentation to be included with the final report(s) from each study will include field logs for the collection or generation of the samples, chain-of-custody records, and other QA/QC documentation as applicable.

7.6 ASSESSMENT AND OVERSIGHT

To ensure that the study plan for each project is implemented effectively, the QA Coordinator will review QA/QC plans for all Trustee studies that generate data. The QA Coordinator or designee will also audit all such studies. Audits will include technical system audits (for instance, evaluations of operations) as well as scrutinizing data and reports (for instance, evaluations of data quality and adequacy of documentation).

If, in the professional opinion of the QA Coordinator, the results of an audit indicate a compromise in the quality of the collection, generation, analysis, or interpretation of the data, the QA Coordinator has the authority to stop work by oral direction. Within two working days of this direction, the QA Coordinator will submit to the Trustee a written report describing the necessity for this direction. The Trustee will review the findings of the QA Coordinator and render their own determination.

7.7 DATA VALIDATION AND USABILITY

In addition to the assessment and oversight activities described previously, analytical data will be considered for validation by an independent third party. Prompt validation of analytical data can assist the analyst or analytical facility in developing data that meet the requirements for precision and accuracy. If undertaken, it is expected that data validation will use the project-specific study plans and EPA Guidance on Environmental Verification and Validation (EPA 2002).

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