

Environmental Cost Element Structure

*Developed by the
Environmental Cost Engineering Committee (EC²)*

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Acronyms

Acronym	Terms
A/PEG	Glycolate/Alkali Metal//Polyethylene Glycol
ACE Team	Applied Cost Engineering Team
A/E	Architect Engineer
AST	Aboveground Storage Tank
BRA	Baseline Risk Assessment
BTEX	Benzene, Toluene, Ethyl benzene, and Xylene
BTU	British Thermal Unit
CDF	Confined Disposal Facility
CEP	Catalytic Extraction Process
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
CLP	Certified Laboratory Procedure
CMS	Corrective Measure Study
COA	Code of Account
COE	Corps of Engineers
CW	Circulating Well
CWM	Chemical Warfare Materials
D&D	Decontamination and Decommissioning
DNAPL	Dense Non-Aqueous Phase Liquids
DOD	Department of Defense
DOE	Department of Energy
EA	Each
EA/YR	Each per Year
EC ²	Environmental Cost Engineering Committee
ECAS	Environmental Cost Analysis System
ECES	Environmental Cost Element Structure
EM	Environmental Management
EPA	Environmental Protection Agency
ER	Environmental Restoration
FRTR	Federal Remediation Technology Roundtable
FS	Feasibility Study
GAC	Granular Activated Carbon
GIS	Geographical Information System
HEC	High Energy Corona
HEPA	High Efficiency Particulate Air
HQ	Headquarters
Hr.	Hour

HRS	Hazard Ranking System
HTRW	Hazardous, Toxic, and Radioactive Waste
ICEG	Interagency Cost Estimating Group
ISV	In-situ Vitrification
LNAPL	Light Non-Aqueous Phase Liquids
LS	Lump Sum
LS/YR	Lump Sum per Year
LSA	Low Specific Activity
LTSM	Long-Term Surveillance and Maintenance
LTS	Long-Term Stewardship
M	Meter
M/YR	Meters per Year
M ²	Meter Square
M ² /YR	Meter Square per Year
M ³	Cubic Meter
M ³ /YR	Cubic Meter per Year
MGD	Million Gallons per Day
O&M	Operations and Maintenance
OB	Open Burn
OD	Open Detonation
OE	Ordnance and Explosives
OECD	Organization of Economic Cooperation and Development
OR	Oak Ridge
PA/SI	Preliminary Assessment/Site Investigation
PCB	Polychlorinated Biphenols
PCP	Pentachlorophenol
PPE	Personal Protection Equipment
PRP	Potentially Responsible Party
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch Gauge
QA	Quality Assurance
QC	Quality Control
RA	Remedial Action
RBC	Rotating Biological Contactor
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RL	Richland
SLTM	Surveillance and Long-Term Maintenance

SRS	Savannah River Site
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TCE	Trichloroethene
TNT	Tri-Nitro-Toluene
UOM	Unit of Measure
UST	Underground Storage Tanks
UV	Ultraviolet
UXO	Unexploded Ordnance
VECP	Value Engineering Change Proposals
VOC	Volatile Organic Compound
WBS	Work Breakdown Structure
WM	Waste Management

Environmental Cost Element Structure

Introduction

Background

The Environmental Cost Engineering Committee (EC²) developed the Environmental Cost Element Structure (ECES) as an enhancement to the existing Hazardous, Toxic, and Radioactive Waste - Work Breakdown Structure (HTRW-WBS).

The (EC²)'s new ECES is an enhancement to the original HTRW-WBS and was developed to further enhance cost management by providing a consistent and comprehensive structure across all project phases. It was developed using an iterative process with input from federal agencies and industry. Experts from several disciplines participated including engineers, cost estimators, project/program managers and contract personnel. The iterations occurred over the past several years -- from the inception of the original HTRW-WBS through the present. The ECES benefits from an intense analytical effort, the knowledge gained from the maturation of the environmental industry, and incorporation of past user's experiences.

In developing its final recommendation, the (EC²) reviewed the cost structures currently in use by the *U.S. Environmental Protection Agency (EPA)*, *U.S. Navy*, *U.S. Corps of Engineers (COE)*, *U.S. Department of Energy (DOE)*, and the international *Organization for Economic Cooperation and Development (OECD) -- Decommissioning Tasks Work Breakdown Structure*.

The existing cost structures that were consulted or incorporated include:

- COE Promise System WBS
- DOE Richland Operation Office, Environmental Restoration Project Suggested Studies and Design WBS Dictionary
- DOE Preferred Alternative Matrix (listing many technologies by media and contaminant application)
- EPA Remedial Investigation/Feasibility Study WBS
- EPA Remedial Design WBS
- EPA Remedial Design Oversight WBS
- EPA Remedial Action WBS
- EPA Remedial Action Oversight WBS
- Navy Studies and Design WBS
- Navy Technology List
- OECD Decommissioning Tasks Work Breakdown Structure

The ECES incorporates the best ideas from these systems into one comprehensive structure that includes three important enhancements.

1. The new structure is organized in a matrix format by project life-cycle phase.
2. The scope has been expanded to include waste management and additional technologies.
3. The new structure includes auxiliary units of measure (or metrics) which affect cost (e.g., data on extraction wells has been expanded to include metrics for diameter, depth, and flow rate for each well verses the original structure which only included data on the total number of wells).

Purpose, Intended Use, and Application

The ECES is a comprehensive hierarchical list of work activities (tasks, items, or products) that may be required to accomplish *environmental restoration, waste management, facility decontamination and decommissioning, or other environmental projects*. Its activity-based structure provides a consistent and visible cost management framework, with sufficient detail and coverage of project types, so that it can be used by government agencies and private industry in the United States and other countries to track project costs.

The ECES is a jointly developed cost structure that can improve cost management and cost estimating by standardizing historical cost reporting. Each agency will determine how and when their existing cost systems will be modified to implement the ECES.

While primarily a cost structure, the ECES can also serve as a model for developing a WBS. A WBS provides a framework for managing the cost, schedule, and performance objectives of a project. The WBS framework allows the project to be separated into logical component parts and making the relationship of the parts clear. It defines the project in terms of hierarchically related action-oriented elements. Each element provides logical summary points for assessing technical accomplishments and for measuring cost and schedule performance.

The (EC²) recommends that agencies using the ECES and associated dictionary routinely report costs to level three in the cost structure. More detailed reporting levels (i.e., levels four and beyond) are provided to allow agencies to address high risk, high value, or high technological interest areas of projects.

In addition to its cost management and project management functions, the ECES can also be used to support a number of other program and project functions. These functions include:

- bid solicitation, collection, and evaluation
- communicating project data between installations, complexes, agencies, and industry
- providing a project checklist
- cost and schedule estimating
- historical cost/schedule data collection
- historical project data collection (e.g., technology deployments, project conditions)
- validating and calibrating cost estimates and software tools
- establishing and disseminating best practices and lessons learned.

Several agencies intend to incorporate this structure into existing and future cost estimating models, databases, and other similar software tools and systems.

Overall Structure

Figure 1 illustrates the hierarchical nature of the ECES cost structure, which allows detailed cost data at level three to be summarized into higher level cost elements in a standardized fashion. The (EC²) recommends the ECES as a common standard through its top three levels. The use of level four or lower is optional. Each level of the ECES is briefly described in the following sections.

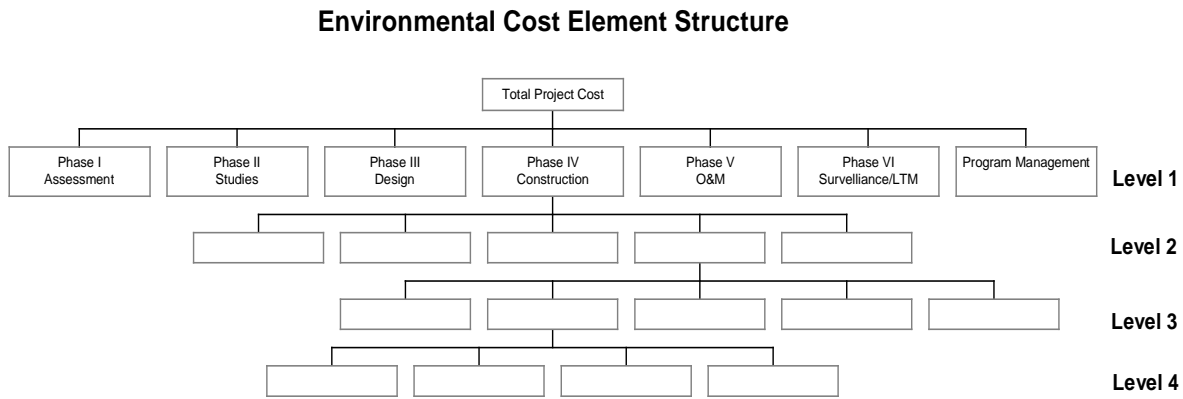
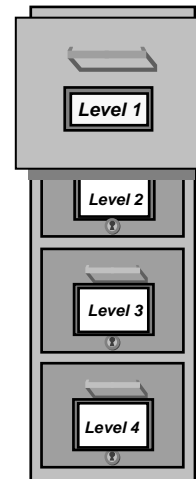


Figure 1 – Hierarchical Structure of the Environmental Cost Element Structure

Level 1

Level 1 of the structure includes seven cost categories. The first six categories represent the six life-cycle phases of an environmental project. The final category, Program Management, Support and Infrastructure, is included to address costs that are not attributable to a distinct project or are program management costs. Throughout the rest of the document, the level one cost element for Program Management, Support and Infrastructure will be referred to as phase 8, to simplify references to the level one cost elements. Phase 7 is reserved for future use.

With minor variations in the definitions, these project life-cycle categories apply to all environmental projects and programs including environmental remediation, waste management, decontamination and decommissioning, ordnance and explosive retrievals, underground and above ground storage tanks, and other environmental work.



Phase 1: Assessment - Assess and inspect site, prepare site inspection reports.

Phase 2: Studies - Risk Assessment, characterization and investigations, development and analysis of treatment or remediation options, and treatability studies.

Phase 3: Design - Engineering design and pre-construction activities of treatment or remediation alternatives.

Phase 4: Construction - Construction of selected treatment or remediation alternatives. Includes start-up, but excludes all operations.

Phase 5: Operations and Maintenance (O&M) - Includes all operations and maintenance for the selected treatment or remediation alternatives. Phase ends when clean up or waste treatment goals are met.

Phase 6: Surveillance and Long-Term Maintenance (SLTM) - Operations have ceased or were not integral to selected treatment or remediation alternatives.

Phase 7: Reserved

Phase 8: Program Management, Support and Infrastructure - Program wide activities that are required, but cost is not specific to a single or distinct project.

Figure 2 illustrates the life-cycle nature of the seven level one cost elements.

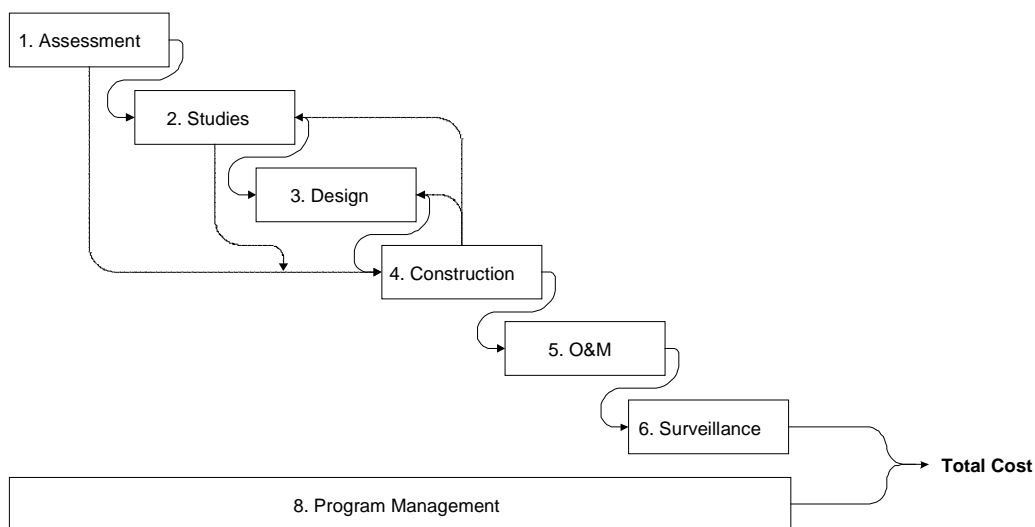


Figure 2 - Level One Cost Categories

Level 1 of the dictionary is designated by using the numbers 1 through 6 to represent the six life-cycle phases in the first column or first space in the ECES system. For example, 1.xx.xx represents phase 1 activity. Program management and overhead costs are assigned the number 8 in first column (i.e., 8.xx.xx).

Subproject Identification (Optional)

The subproject identifier, positioned between level 1 and level 2 ECES elements may or may not be utilized by the user. This identifier is optional because not all projects have subprojects. The letter “i” has been reserved for Interim Action projects and the letter “X” has been reserved to indicate “all.” An example use of an optional subproject identifier may be the use of “r” to denote the Resource Conservation and Recovery Act (RCRA) related activity or use “c” to represent the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) related activities. The use of the optional subproject identifier is designated in an ECES in the following way: **4.i.xx.xx** to denote a phase 4 interim action activity. See section on Optional Subproject Identifier -- Subproject Identification for more information.

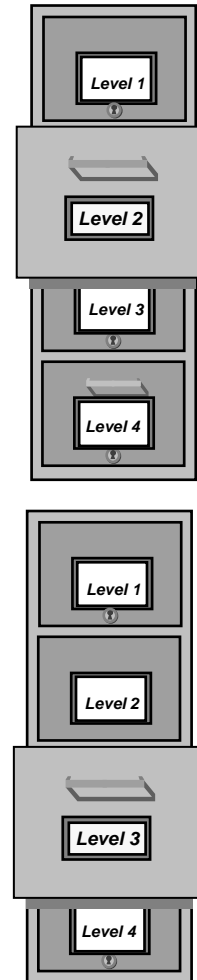
Level 2

Level 2 of the ECES represents major elements necessary to perform work in an environmental project. There are 34 elements included in this structure. The level 2 structure and level 2 dictionary are explained in detail in later chapters.

It should be noted that in the level 2 structure, level 2 elements are marked with life-cycle phase numbers in the left columns. These numbers represent the applicability of that phase to that element. This is not necessarily all inclusive. There may be cases where that element may be applicable for a phase that is not marked. This structure is flexible, and the user can use other phases even though they are not marked in the columns.

Level 3

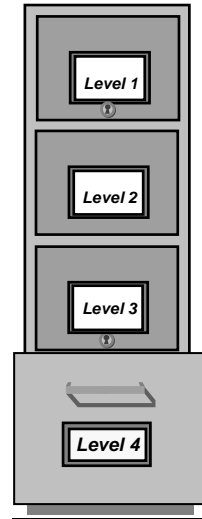
Level 3 of the structure consists of more detailed elements required to perform the tasks at the level 2 of the ECES. See the structure for the level 3 elements, and the level 3 ECES dictionary, in the following sections, for more detailed description of the element, their uses, the components which comprise of the elements, and other information.



Level 4 (Optional)

The use of the level 4 ECES elements is optional. To aid agencies that elect to use level 4, the (EC²) developed detailed ECES elements for Construction and Operations and Maintenance, but not for environmental technologies (ECES components under X.21 to X.30).

For environmental cleanup technologies, the (EC²) agreed to include a limited set of elements based on the Federal Remediation Technologies Roundtable (FRTR) recommendations. For environmental cleanup technologies, individual agencies, programs, or organizations can use a more detailed set of level 4 elements, as long as the elements can be summarized to the FRTR level 4 elements.



Note that the ECES considers all possible items and activities by including the “Other” items at level 2 and lower levels. The “Other” items are designated by the number “X.9x.xx” These “X.9x.xx” elements are reserved for activities which are unique or for special tasks that cannot be described closely by available elements.

Units of Measure -- Metrics

Another important aspect of this structure is the assignment of units of measure or metrics. As used in this document, the term “metrics” is defined as measurable parameters associated with each element of the ECES. Metrics are assigned to each level element of the ECES. The primary units of measure (UOM) for each ECES element is defined as the single most important parameter associated with that element for each phase.

Example Use of the ECES

This example will show how to use the ECES throughout the life-cycle of the project. This is a hypothetical project involves a site that may or may not be contaminated with organic and inorganic hazardous waste.

Project Description

The site is located in the Mid-Atlantic region of the country with very sandy soil and shallow groundwater. The assessment conducted discovered that the groundwater is contaminated with benzene, toluene, ethylbenzene, and xylene (BTEX), lead, and high levels of arsenic. As part of phase 2 studies, it was also found that the contaminants pose an unacceptable risk to a nearby community. Based on a clean up technology alternative study, engineers will select groundwater pumping followed by coagulation/flocculation/precipitation and ion exchange as a final step. The treatment units need to treat approximately 1 million gallons of groundwater per day. To remove the BTEX, an Ultraviolet Photolysis will be used. A treatment train will be designed and constructed to clean up the site. The technologies (treatment train) will be housed in a treatment train facility. The O&M cost which contribute to the O&M of the all the treatment train technologies will be captured as cost of the treatment train facility. For those O&M costs which can be clearly identified for the specific technology, that cost will be captured under that technology. These technologies will operate for 15 years, and the site will allow natural attenuation to reduce the trace amount of contaminates left. The following is an example of ECES which covers the life-cycle of the project.

Sample Project Cost Structure

Phase 1 --Assessment

ECES CODE	ECES Title
1.02.01	Project Management/ Support/Administration
1.03.01	Workplan (for Preliminary Assessment)
1.03.02	Chemical Data Acquisition Plan
1.03.03	Sampling and Analysis Plan
1.07.01	Site Reconnaissance
1.07.03	Site Contaminant Survey/Radiation Monitoring
1.07.15	Monitoring Well
1.07.04	Hydrogeological Investigation (Groundwater)
1.07.08	Air Monitoring and Sampling
1.07.09	Groundwater Monitoring and Sampling
1.07.11	Soil Sediment Sampling
1.09.01	Prepare and Ship Environmental Sample
1.08.01	Air/Gas Sample Analysis
1.08.02	Groundwater Sample Analysis
1.08.04	Soil/Sediment Sample Analysis
1.09.04	Provide Sample Management
1.09.08	Data Reduction, Tabulation, and Evaluation/Analysis

Phase 2 -- Studies

ECES CODE	ECES Title
2.02.01	Project Management/ Support/Administration
2.02.03	Regulatory Interaction
2.02.04	Institutional Controls
2.03.01	Workplan (for RI/FS)
2.03.04	Health and Safety Plan
2.03.10	Risk Assessment Plan
2.03.11	Technical Goals and Objectives
2.07.15	Monitoring Well
2.04.02	Human Health Risk Assessment
2.04.05	Environmental Investigation Report
2.04.08	Evaluate Alternatives
2.04.10	Document Feasibility
2.04.16	Engineering Evaluation/Cost Analysis

Phase 3 -- Design

ECES CODE	ECES Title
3.02.01	Project Management/ Support/Administration
3.02.03	Regulatory Interaction
3.04.17	Record of Decision
3.04.11	Environmental Management Project Design
3.04.13	Facility Design

Phase 4 – Construction

ECES CODE	ECES Title
4.02.01	Project Management/ Support/Administration
4.02.03	Regulatory Interaction
4.03.01	Workplan (for RA/Construction)
4.04.19	Post Construction Design Report
4.05.01	Mobilization
4.05.29	Communications
4.05.31	Overhead Electrical Distribution
4.07.09	Groundwater Sampling and Monitoring
4.08.02	Groundwater Sample Analysis
4.18.01	Extraction Wells
4.11.04	Treatment Train Facility (to house the technologies below)
4.24.15	Coagulation/Flocculation/ Precipitation
4.24.07	Ion Exchange
4.24.13	Ultraviolet Photolysis
4.05.36	Demobilization

Phase 5 – Operations and Maintenance

ECES CODE	ECES Title
5.02.01	Project Management/ Support/Administration
5.02.03	Regulatory Interaction
5.07.08	Air Monitoring and Sampling
5.07.09	Groundwater Sampling/ Monitoring (ongoing and not technology specific)
5.08.01	Air/Gas Sample Analysis (ongoing and not technology specific)
5.08.02	Groundwater Sample Analysis
5.11.04	Treatment Train Facility (O&M)
5.24.15	Coagulation/Flocculation/ Precipitation
5.24.07	Ion Exchange
5.24.13	Ultraviolet Photolysis

Phase 6 – Surveillance and Long-Term Monitoring

ECES CODE	ECES Title
6.02.01	Project Management/ Support/Administration
6.02.03	Regulatory Interaction
6.07.08	Air Monitoring and Sampling
6.07.09	Groundwater Sampling/ Monitoring Sampling (ongoing and not technology specific)
6.08.01	Air/Gas Sample Analysis (ongoing and not technology specific)
6.08.02	Groundwater Sample Analysis
6.02.04	Institutional Controls
6.26.06	Extraction Wells (after well P&A to ensure no contaminant pathway)
6.06.02	Outdoor Surveillance and Maintenance

**Phase 8 – Program Management and
Program Cross-Cutting (optional)**

ECES CODE	ECES Title
8.01.01	Personnel Resources
8.01.02	Program Support
8.01.03	Program Infrastructure
8.01.04	Government Personnel Resources
8.01.05	Government-Program Support
8.01.06	Government-Program Infrastructure

Environmental Cost Element Structure Dictionary

Level 1 Dictionary

Generic Cost Categories

The seven current cost categories in the generic level one dictionary are:

Phase 1: Assessment -- Assess and inspect site, prepare site inspection reports.

Phase 2: Studies -- Risk assessment, characterization and investigations, development and analysis of treatment or remediation options, and treatability studies.

Phase 3: Design -- Engineering design and pre-construction activities of treatment or remediation alternatives.

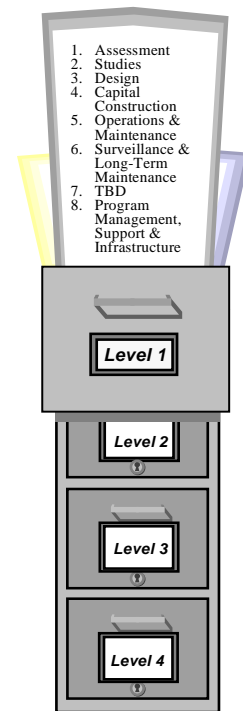
Phase 4: Construction -- Construction of selected treatment or remediation alternatives. Includes start-up, but excludes all operations.

Phase 5: Operations and Maintenance -- Includes all operations and maintenance for the selected treatment or remediation alternatives. Phase ends when clean up or waste treatment goals are met.

Phase 6: Surveillance and Long-Term Maintenance -- Operations have ceased or were not integral to selected treatment or remediation alternatives.

Phase 7: This number is reserved for future use.

Phase 8: Program Management, Support and Infrastructure -- Includes overhead or program-wide activities that are required to implement environmental projects not specific to a distinct project. Phase 8 is used to represent those activities that are not readily segregated into phases one through six (i.e., program-wide or crosscutting activities). These activities are not generally associated with individual projects, but are essential in order to plan and implement the collected projects that comprise the majority of the



program. These activities apply to both government/owner and prime contractor (M&O, M&I contractors for DOE).

Program-Specific Cost Category Definitions

The seven categories listed above apply to environment restoration, waste management, and facility D&D projects, but there are slightly different definitions for each as shown below:

For environmental restoration projects conducted under CERCLA, the phases are:

1. Preliminary Assessment/Site Investigation (PA/SI)
2. Remedial Investigation/Feasibility Study (RI/FS)
3. Remedial Design (RD)
4. Remedial Action (RA)
5. O&M
6. Post-Closure Surveillance and Long-Term Monitoring

For environmental restoration projects conducted under RCRA, the phases are:

1. RCRA Facility Assessment
2. RCRA Facility Investigation/Corrective Measures Study (RFI/CMS)
3. Design portion of Corrective Measures
4. Corrective Measures
5. O&M
6. Post-Closure Surveillance and Long-Term Monitoring

For waste management projects the phases are:

1. Preliminary Planning - Waste/Special Material Operations
2. Pre-Conceptual Design/Research and Development
3. Waste Management Facility Design
4. Waste Management Facility Construction
5. Waste Management Facility O&M
6. On-Site Storage/Disposal Facility Surveillance and Long-Term Monitoring

For facility D&D projects the phases are:

1. Pre-Decommissioning Actions
2. Facility Shutdown/Decommissioning and Research and Development
3. D&D Design

4. D&D Construction
5. D&D Operations & Maintenance
6. Post-Closure Facility Surveillance and Long-Term Monitoring

While the definitions for these phases are different, they each represent the same life-cycle phases for their respective project types. For the purposes of this structure and dictionary, only the generic titles mentioned above will be included in the following definitions of ECES elements. Each second-level and third-level element definition is structured to consider the effect that each phase has on the definition for that element. If the definition for an element changes according to phase, it will be documented.

Subproject Identification

There is an optional level category (field or column in the matrix format) between the level 1 (i.e., phases 1 through 6) and the level 2 ECES elements. This level is optional because not all projects have subprojects. An example of a project with subprojects may be where the same site (waste release site or single area of contamination) has more than one substantially different technical approach. For instance, a single project may require contaminated soil (hot spot) excavation and capping as well as groundwater pump and treat. In this case the project may be better organized by according to subproject. There could be one (or two) subproject(s) to address the soil excavation and capping, and another subproject to address groundwater.

In the matrix format, this optional level appears between the six phases and the numbering for the second level. The conventions for using this optional level are as follows:

- If there are subprojects, then alpha characters will be used starting with the letter a. It is unlikely that any one project would have more than five subprojects, but there is no established limit. If there are more than five, then it may be desirable to divide the project into two or more projects.

- If an element such as “Community Relations” has application to all subprojects then the letter X will be used. The numbering for this ECES element would then be:

- 1.X.02.02 for phase 1 c 2.X.02.02 for phase 2 -- etc.

However, if the distinction of "Community Relations" is important, then it may be numbered:

- 1.A.02.02 for phase 1 -- 2.A.02.02 for phase 2 -- etc.

- 1.B.02.02 for phase 1 -- 2.B.02.02 for phase 2 -- etc.

- If the same ECES element is required for more than one subproject, then it will be repeated accordingly. For example, if “Contaminated Soil Collection” for phase 4 activities in subproject -- A, and subproject -- C, then this ECES element will be used twice.

- 4.A.19.02 for subproject--A and 4.C.19.02 for Subproject--C.

Further, let say that the ECES element “Disposal Tipping Fees” are required for all Subprojects during phase 4. The numbering for these ECES elements would then be:

- 4.A.33.03 for subproject--A, 4.B.33.03 for subproject--B, and 4.C.33.03 for subproject--C

OR

- 4.X.33.03 for all subprojects if the distinction for this element is not important between subprojects.
- If there are no subprojects, then there will be no alpha characters in the ECES number. In this case the numbering for the ECES element "Disposal Tipping Fees" for phase 4 would be:
 - 4.33.03

This optional level is not considered to be one of the ECES levels. Whether or not it is used, the first level of the ECES is still phases 1 through 6 and 8, and the second level is still the 34 major ECES elements from Program Management Support and Infrastructure to Disposal -- Commercial.

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Level 2 Structure

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