Mining Waste Treatment Technology Selection

Tutorial

This is a brief tutorial on the use of the ITRC Mining Waste Web-based technical and regulatory guidance document.

Overview Page

The Mining Waste Technology Selection site is designed to allow the user to quickly identify a list of technologies that have been demonstrated at sites with mining-influenced water, solid mining waste, or both. The scrolling photos on the opening page are taken from mine sites around the United States.

Note several essential points before beginning:

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Mining Waste Treatment Technology Selection

Introduction

Mining is essential to the economy of the United States, but historical mining practices and the absence of routine mined-land reclamation, remediation, and restoration have led to legacy sites with significant environmental and human health impacts. New mining operations continue to have severe waste issues that must be addressed during and after the actual mining operation. Some new operations occur in areas with legacy environmental sites where the actual material contains sufficient residual mineralization such that further development, remining, and subsequent reclamation of the waste are economically viable. Some current operations even have the infrastructure in place to co-manage the cleanup of legacy waste while in operation. Understanding and addressing potential impacts at many of these sites are often complex, involving multiple environmental media spread over large areas. Remedial solutions are often lengthy, expensive, and unacceptable to the regulated and regulatory communities, as well as to the public.

Before Jackson County Iron Mine, WI After

Overview Page *(continued)*

A printable version of each page can be downloaded by clicking on the upper right corner of the page below the banner. Please remember that this command prints only the page you are viewing. There are 22 individual technologies and 59 case studies that can be printed separately. Because of the number of pages involved, we don't recommend printing the entire series of documents.

Overview Page *(continued)*

The left sidebar allows you to navigate easily through the website. It also allows you to visit the ITRC Mining Waste Team public page and the ITRC home page. The home page has up-to-the-minute news about ITRC, other ITRC teams, guidance documents, Internet-based training, and the ITRC Industrial Affiliates Program for site owners and consultants wishing to participate in ITRC. You can also navigate to the ITRC Disclaimer and Acknowledgements page from the sidebar.

Overview Page *(continued)*

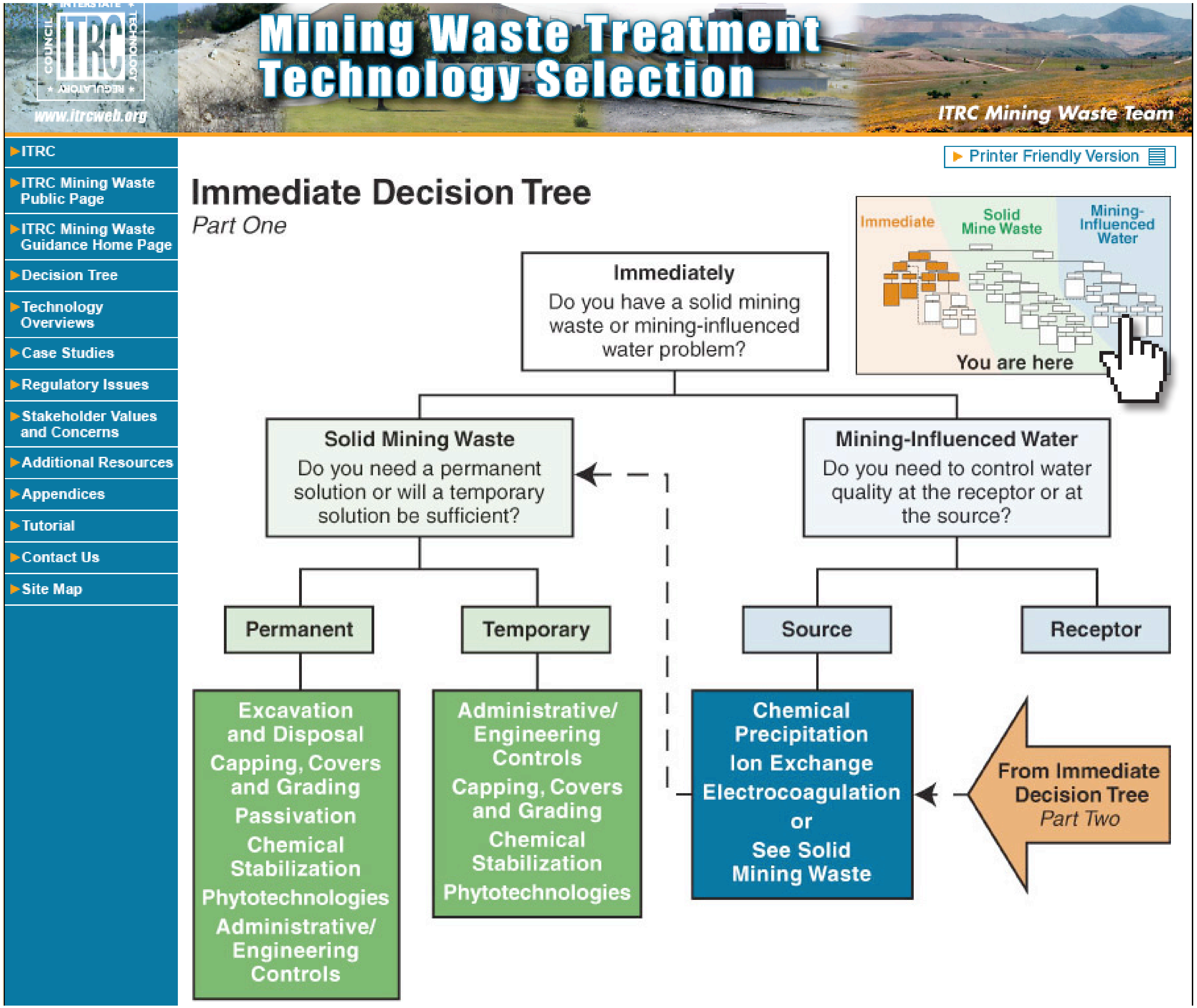
The Appendices section works the same way.

Decision Tree

The guidance is set up to help a user select applicable technologies by responding to a few simple, intuitive questions.

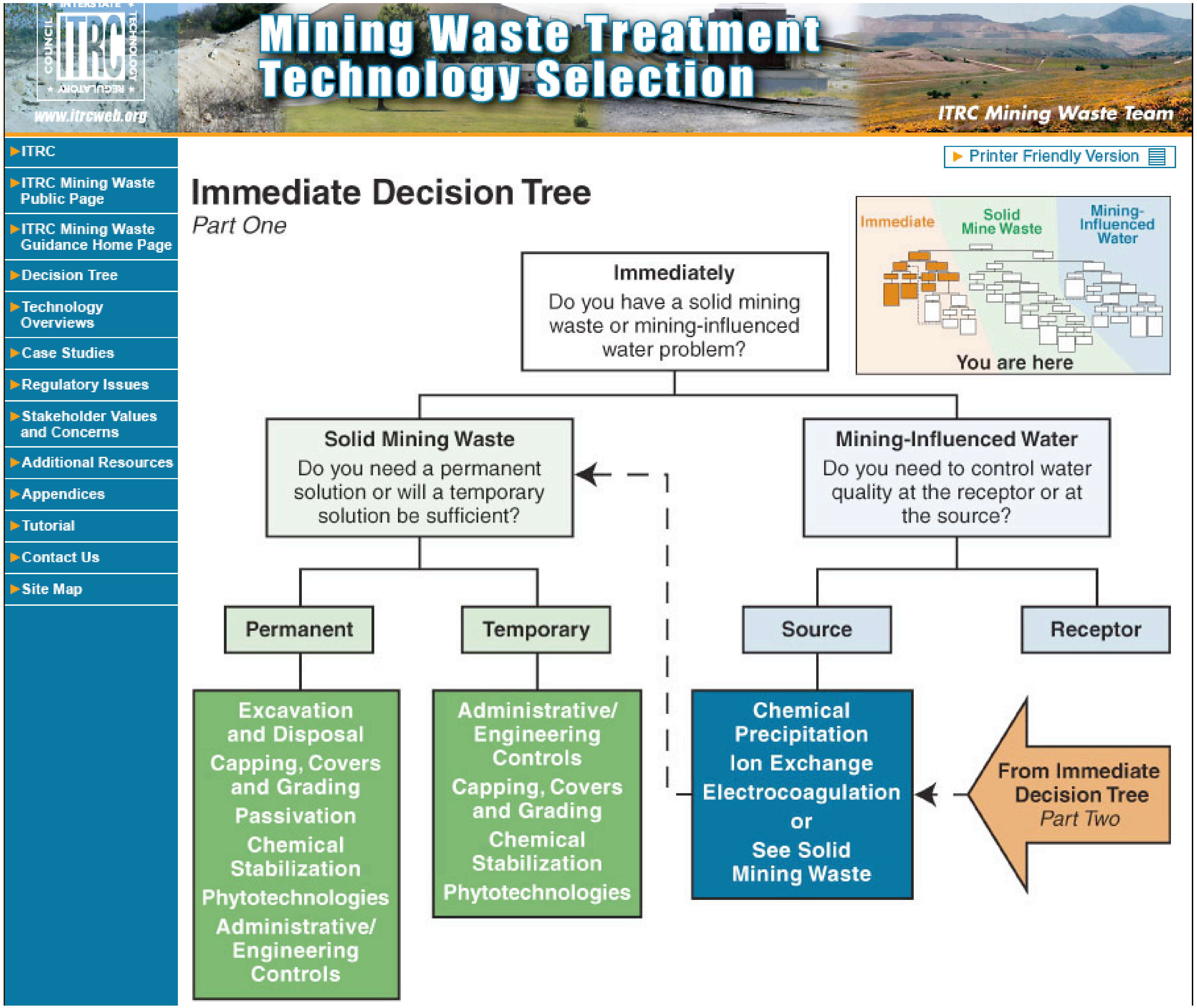
Decision Tree *(continued)*

Some terms used in the guidance may have multiple definitions. We have provided definitions where they may be helpful. For example, on this initial decision tree, the user may choose between a solution that can be implemented "immediately" versus a solution that to be implemented over a longer period of time. As you move the cursor over the "Immediate Decision Tree," the definition for "immediate" as used in this guidance is revealed. Likewise, the "Long Term" decision tree shows the definition used in this guidance for "long term."



Decision Tree *(continued)*

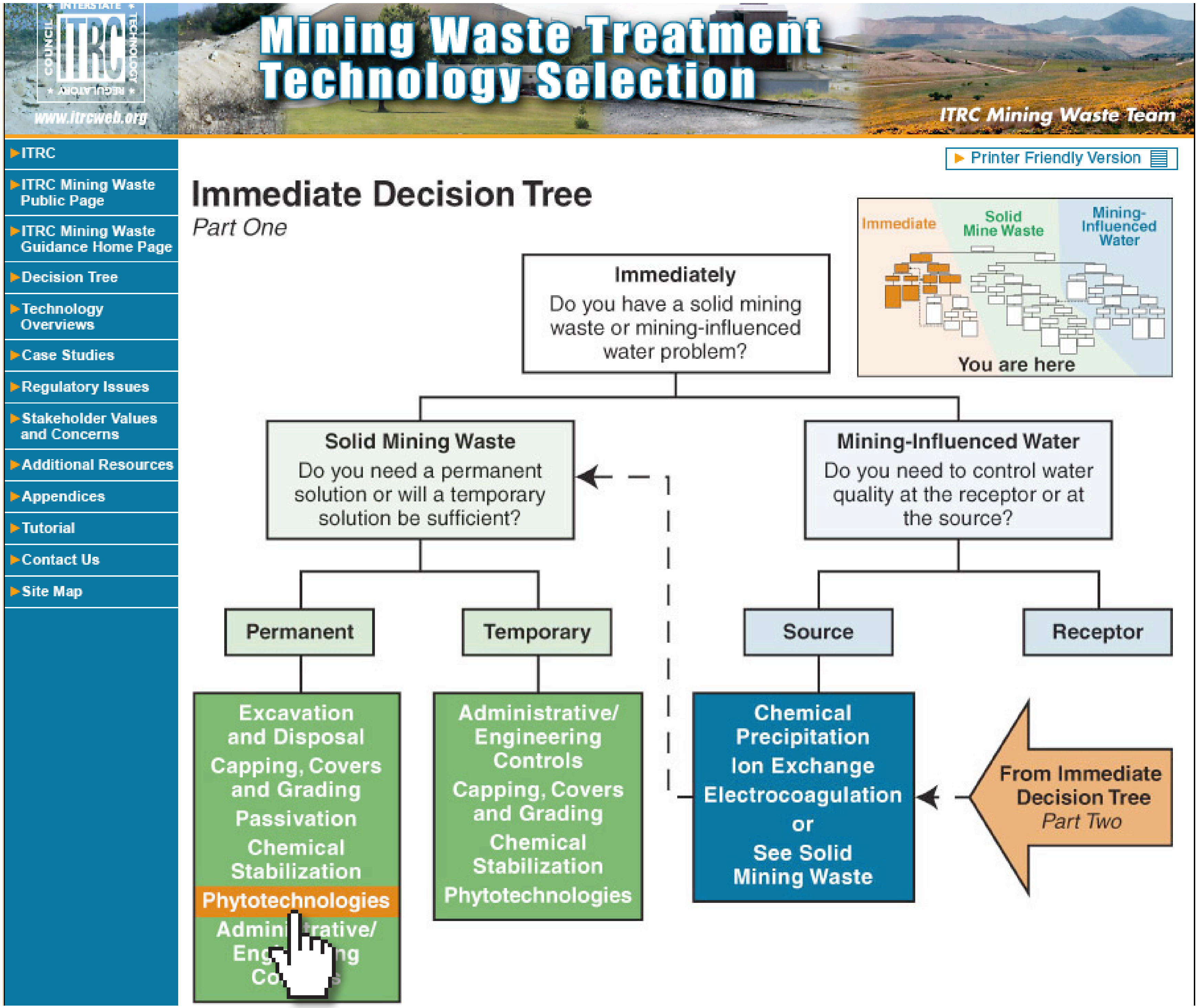
When you click on the Immediate Decision Tree, you will see a small diagram in the upper right that shows you where in the decision tree you are and where else you can go. The section of the decision tree you are in is colored; the other parts are white.



Decision Tree *(continued)*

If you need a technology for solid mining waste that can be implemented immediately, follow the flow lines down through the Solid Mining Waste Decision Tree. You must decide whether you need a permanent solution or if a temporary solution will be sufficient. If you need a permanent solution, move down the decision tree to the green box containing the technologies that are applicable to that site situation. There you can choose among the following:

- Excavation and Disposal
- Capping, Covers and Grading
- Passivation
- Chemical Stabilization
- Phytotechnologies
- Administrative and Engineering Controls



Technology Overview

To learn about one of these technologies, simply click on its name. This link takes you to the technology overview.

Technology Overview as part of a Web-based Technical and Regulatory Guidance

Phytotechnologies

1. Introduction

Click Here **to view case study table at the end of this document.**

Phytotechnologies use plants to remediate various media impacted with different types of contaminants. Phytotechnologies can be applied to address certain issues associated with mining solid wastes and mining-impacted waters. Phytotechnologies can also stabilize tailings and act as a hydraulic control for drainage, thereby decreasing e
environment. Implementation of phytotechnologies is a common compon
establishment of a plant cover as a final remedy. However, in certain cas
metals from contaminated media. Establishing phytotechnologies require
equates to an investment of time up-front; however, these systems, once
document provides an overview of the ITRC document *Phytotechnology*
Revised (ITRC 2009), highlighting the key concepts relevant to using phy
impacted waters. Please refer to the full document for more thorough gui

2. Applicability

There are six basic phytoremediation mechanisms that can be used to cl
rhizodegradation, phytohydraulics, phytoextraction, phytodegradation, a
mechanisms used to address contaminants depend not only on the type
goals. Typical goals include containment through stabilization or seques
detoxification, degradation, metabolization, or mineralization; or both. To
selected, designed, developed, implemented, and operated using detail
climate conditions, analytical needs, operation and maintenance (O&M)
protection of the environment.

Table 1-1. Summary of phytotechnology mechanisms (ITRC 2009)

Mechanism	Description	Cleanup goal
Phytosequestration	The ability of plants to sequester certain contaminants in the rhizosphere through exudation of phytochemicals and on the root through transport proteins and cellular processes.	Containment

10. Case Studies

Table 10-1. Case studies including phytotechnologies

Ely Copper Mine, VT, phytosequestration
Kerramerican NPL, ME, phytohydraulics
Magmont Mine, MO, phytosequestration
Black Butte Mercury Mine, OR, phytosequestration
Gribbons Basin, MI, phytosequestration, phytohydraulics
Valzinco Mine, VA, phytosequestration
Copper Basin, TN, phytosequestration
Sequatchie Valley Coal Mine, TN, phytosequestration, phytohydraulics
Bark Camp, PA, phytosequestration, phytohydraulics
Annapolis Lead Mine Site, MO, phytosequestration
UP Mines, MI, phytosequestration
Boston Mill, AZ

Technology Overview

(continued)

To view case studies where the technology has been used in a mining waste situation, simply scroll to the case study table at the end of the document.

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2.1 Phytosequestration

Phytosequestration reduces the mobility of the contaminant and prevents migration to soil, water, and air are as follows:

- Phytochemical complexation in the root zone. Phytochemicals can be exuded into the rhizosphere, leading to the precipitation or immobilization of target contaminants in the root zone. This mechanism of phytosequestration may reduce the fraction of the contaminant that is bioavailable.
- Transport protein inhibition on the root membrane. Transport proteins associated with the exterior root membrane can irreversibly bind and stabilize contaminants on the root surfaces, preventing contaminants from entering the plant.
- Vacuolar storage in the root cells. Transport proteins are also present that facilitate transfer of contaminants between cells. However, plant cells contain a compartment (the "vacuole") that acts, in part, as a storage and waste receptacle for the plant. Contaminants can be sequestered into the vacuoles of root cells, preventing further translocation to the xylem.

Case studies using phytosequestration include the following:

- The Ely Copper Mine in Vermont is using a vegetative cover for mitigation of ecological risk and reducing bioavailable metals. As a means to neutralize acids in copper mine tailings, greenhouse studies found that mixing tailings from an active OMYA limestone mining operation can be used, together with compost, to neutralize and improve soil.
- The Boston Mill site in Cochise County, Arizona used phytostabilization to jump-start native plant establishment on a barren section o[illegible] the Boston Mill site approximately 1.5 acres containing high concentrations of heavy metals (Pb, As, Hg, Zn, Cu, Fe, Mn, Cd, a[illegible]e study describes greenhouse feasibility trials and outlines process to establish plants, through seeding.

2.2 Phytohydraulics

Plants significantly affect local hydrology. Phytohydraulics is the ability of vegetation to transpire sources of surface water and groundwater. The vertical migration of water from the surface downward can be limited by the water interception capacity of the aboveground canopy and subsequent evapotranspiration through the root system. If water infiltrating from the surface is able to percolate below the root zone, it can recharge groundwater. However, the rate of recharge depends not only on the rooting depth of the species, but on the soil characteristics as well (ITRC 2009). The horizontal migration of groundwater can be contained or controlled (USEPA 2000) using deep-rooted species such as prairie plants and trees to intercept, take up, and transpire the water. One class of trees that has been widely studied in phytotechnologies are the phreatophytes, which are deep-rooted, high-transpiring, water-loving trees that send their roots into regions of high moisture and that can survive in conditions of temporary saturation (Gatliff 1994). Typical phreatophytes include species within the *Salicaceae* family, such as cottonwoods, poplars, and willows.

Case study using phytohydraulics:

- Kerramerican NPL in Maine uses phytohydraulics (revegetation) as part of a multi-component geosynthetic cover system as part of an effort to repair soil cover and provide drainage diversion.

2.3 Phytoextraction

Phytoextraction refers to the ability of plants to take up contaminants into the roots and translocate them to the aboveground shoots or

Technology Overview

(continued)

You will also encounter the names of, and links to, case studies in the text as you read the technology overview. Either way, the name of the case study, "Boston Mill," for instance, is a link to the case study.

Each pathway in the decision tree works in the same manner.

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Case Studies

If you would rather see all the case studies included in this guidance, click on "Case Studies" in the left sidebar.

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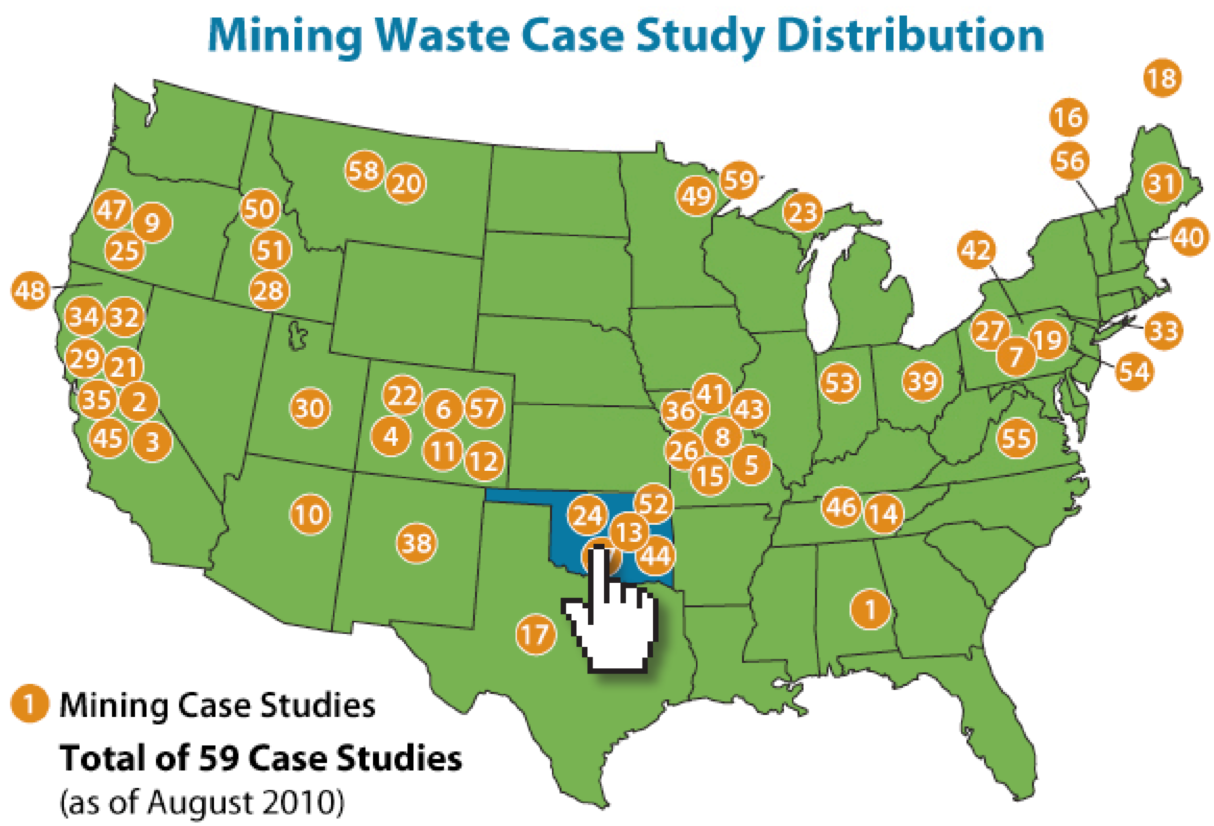

Case Study Table

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Alpine County - Confidential Mine Site	Chemical Precipitation	3
Golinsky Mine	Biochemical Reactor	21
Iron Mountain Mine	Capping, Covers and Grading; Chemical Precipitation	29
Keystone Mine	Constructed Treatment Wetlands	32

Case Studies *(continued)*

By clicking on a state in the map, for instance "Oklahoma," you are moved to that section of the case study table that contains all the case studies collected from Oklahoma sites.

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Oklahoma		
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McNeely Green Reclamation Tar Creek Superfund Site	Excavation and Disposal; Capping, Covers and Grading; Backfilling & Subaqueous Disposal	37
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I-99 Remediation Site	Capping, Covers and Grading; Excavation & Disposal	27
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Texas		

Case Studies *(continued)*

Move the cursor to any of the case study titles and click to open the case study.

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Case Study as part of a Web-based Technical and Regulatory Guidance

McNeely Green Reclamation Tar Creek Superfund Site Ottawa County, Oklahoma

1. Site Information

1.1 Contacts

David Cates
Oklahoma Department of Environmental Quality
707 N. Robinson
P.O. Box 1677
Oklahoma City, OK 73101-1677
Telephone: 405-702-5124
E-mail: david.cates@deq.state.ok.us

1.2 Name, Location, and Description

McNeely Green Reclamation Tar Creek Superfund Site, longitude 36.9833222, latitude 94.7836611

The McNeeley Green site is located in the NW/4 of Section 23-T29N-R23E in Ottawa County, Oklahoma (Figure 1-1) and contains 54 acres of mine waste, locally called "chat," lying in a flat rural agricultural setting. The site is part of the Tar Creek Superfund Site of northeast Oklahoma, which resulted from wastes associated with abandoned lead and zinc mines of the Tri-State Mining District that operated from the early 1900s through 1970. Mining here consisted of underground room and pillar mines about 200 feet below land surface. Processing of the lead and zinc sulfide ores occurred at mills located about every 40 acres (due to leasing requirements of the Native American–owned lands) and resulted in many large piles of chat covering the approximately 40 square mile superfund site. At the mills, the ore was processed by crushing and simple gravity separation methods initially, and later floatation was employed. The resulting waste rock, chat, is composed of mainly chert with minor amounts of limestone and dolomite with particle sizes ranging from 9.51 mm to less than 0.075 mm, with most of the mass in the coarser sizes. Much of the original chat volume is gone due to its use as aggregate in asphalt and concrete, gravel for roads, rock metal for railroads, and general fill material. About 35 million cubic yards of chat remains to be dealt with at the site. The recent record of decision calls for continued chat sales for aggregate in asphalt as the remedy.

Case Studies *(continued)*

The selected page, "McNeely Green Reclamation Tar Creek Superfund Site: Ottawa County, Oklahoma," is displayed.

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(GARD) Guide.

Because of the size, complexity and number of media affected in any given mine waste site, it may be necessary to go through the decision trees several times to select appropriate technologies to address the issues presented in a site.

Prevention (INAP)'s Global Acid Rock Drainage (GARD, 2009) Guide defines "passive treatment" as follows:

"Passive treatment refers to processes that do not requires regular human intervention, operations, or maintenances. It should typically employ natural constriction material, (e.g., soils, clays, and broken rock), natural materials (e.g., plant residues such as straw, wood chips, manure, and compost) and promote growth of natural vegetation. Passive treatment systems use gravity flow for water movement. In some arid climates, it might also included use of evaporation or infiltration (e.g., soil amelioration and neutralization) of small volumes of ARD."

The GARD Guide 2009 goes on to define "active treatment" as follows:

"Active treatment refers to technologies requiring ongoing human operations, maintenance, and monitoring based on external sources of energy (electrical power) using infrastructure and engineered systems."

Active and passive treatment has always stirred controversy because any definition is wrought with subjectivity. This guidance is no exception and prefers to recognize the inherent gray area between active and passive by inferring that some technologies are simply more passive than others. Our recommendation is to look carefully at all the technologies available to treat surface water and allow the site access and cost guide your decisions. This guidance is not a substitute for careful thought and an understanding of your site characteristics.

Situations such as contaminated sediments in a surface-saturated environment are not uncommon at mine sites. In as much as contaminated sediments are not restricted to mine waste sites, ITRC has contaminated sediment guidance (completion date June 2011), emphasizing the potential assessment of bioavailability and describing the process of assessing exposure through the human and multiple ecological pathways. If the contamination is not in a saturated "contaminated sediment" environment the soil, sediment or dust may require treatment or removal from the indoor environment. Often dust and yard soils have accumulated over the years and provide significant human exposure.

Mine spoils and other mine waste may require complete removal and disposal to prevent further human exposure or to prevent it from impacting the surface and or groundwater. In other instances the mine solid waste may be treated in place or controlled using barriers to isolate the mine solid waste from producing future exposure or impacting water flowing through the site. In still other instances the characteristics of the mine waste, the volume of the mine waste, or even the landmass covered by the mine waste requires that exposure be controlled using access controls to the site. Administrative and engineering controls are certainly not the preferred alternative; however, cost and sometimes public pressure to preserve the historic nature of the local mining culture dictate that the waste remain as it was and access be restricted to protect those nearby.

Click Here for a Dynamic/Interactive Periodic Table of the elements

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How to use this site

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Before — Jackson County Iron Mine, WI — After

Other Resources

Remember, for a longer version of a how to use this site, including a description of several case studies, please click on “Register for Free IBT Training on Document.”

Click Here to register now for the ITRC free Internet-based training on “Mining Waste Treatment Technology Selection.”

Close the browser window to exit this tutorial and return to the ITRC Mining Waste Web-based technical and regulatory guidance document.