Waste Classification and Landfill Disposal Criteria

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Waste Classification

Waste identification, characterization, and classification are the critical steps in determining the appropriate management of a waste.
Classification and Land Disposal

- Waste Control Regulation
- Alberta User Guide for Waste Managers
- ERCB Directives 058
- AEW Policy ES-00-PP9 (Landfill Disposal of HW)
- AEW Policy ES-99-PP1 (Deepwell Disposal)
- ERCB Directive 051
Figure 1: **Waste Management Regulatory Responsibilities**

**Origin of Waste**

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**Oilfield**
(regulated by the EUB under the OGCA-D50, D51, D55, D58)

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**Classification**
- generator's responsibility by testing or knowledge

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**Hazardous Recyclable**

**Generators**
- approval may be required for on-site processing
- recycle docket

**Carriers**
- need recycle docket or dangerous good shipping document

**Storers/Brokers**
- approval required based on length of storage or amount stored
- security required
- recycle docket

**Recyclers**
- need approval if recycle more than 10 tonnes/month
- residues must go to approved facility
- security required
- recycle docket

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**Hazardous Waste**

**Generators**
- PIN if waste shipped offsite
- storage requirements
- if on-site treatment above a certain size need approval
- approval may be required based on length of storage or amount stored
- manifest

**Carriers**
- need PIN number
- insurance requirements
- manifest

**Storers/Brokers**
- approval
- need PIN number
- security required
- manifesting

**Treaters/Disposers**
- need PIN number
- need approval or registration
- environmental assessment for commercial incinerators and landfills
- security required
- manifesting responsibilities

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**Non-Oilfield**
(regulated by AENV under EPEA)

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**Non-Hazardous Waste**

**Generators**
- no requirements unless the generators activity is covered by an approval for another reason
- waste must go to an approved facility or disposal approved by Director

**Carriers**
- no specific requirements
- compliance w/ general law

**Storers/Brokers**
- notification required

**Treaters/Disposers**
- approval or registration required
- security required for privately owned waste management facilities

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¹ Oilfield waste is managed by a parallel system and when it enters an EPEA approved facility the above process applies.
Why Testing a Waste?

- **Legal Requirements** (EPEA & WCR)
- **Classification/Management**
  - **Transportation** (EPEA, TDGR, & EIHWHRM)
  - **Storage** (OHS & EPEA)
  - **Treatment/BUW/AIP**
  - **Disposal** (landfills, deepwells, & thermal destruction)
When Testing Is Not Required?

- **Regulatory Reasons** [Schedule 2, s 1(h)]
- **Generator Knowledge**
  - *Previous Testing* (Totals, Rule of Thumb, TCLP, etc.)
  - *Understanding the Process*
  - *MSDS*
Figure 1 - STEPS IN WASTE CLASSIFICATION PROCESS

STEP 1
IS THE SUBSTANCE A WASTE?
(s.1(ii) of the WCR)

YES

STEP 2
IS THE WASTE EXCLUDED?
(Schedule 2 of the WCR)

YES

PART 1 OF THE WCR (HAZARDOUS WASTE) DOES NOT APPLY

NO

STEP 3
IS THE WASTE LISTED IN TABLES 3 OR 4 OF THE GUIDE?

YES

NO

STEP 4
DOES THE WASTE MEET ANY OF THE CHARACTERISTICS IN SECTION 1, SCHEDULE 1 OF THE WCR?

YES

HAZARDOUS WASTE

NO

NON-HAZARDOUS WASTE
STEP 1 - Is the substance a waste? (or a Recyclable?)

- product or material derived from waste,
- dust suppressing agents,
- fluids used to maintain oil/gas reservoir pressure, or
- soil conditioning agents.

Oilfield Waste - Waste produced by the upstream oil and gas sector (OGCA, Regulations, and Directives)

http://www.ercb.ca/portal/server.pt
Waste Classification

STEP 2 - **Is the waste excluded?**
i.e., not regulated as HW because it is listed in

- **Schedule 2 of the WCR** (not regulated as HW), or
- **Part 1A of the Guide**, pages 9-23

(Examples: drained oil filters, CKD, ashes from fossil fuels, TV, computers, fluorescent light lamps, etc.)

http://www qp alberta ca (AB Legislation)
http://environment alberta ca/02806 html (User Guide)
Waste Classification

Substances not regulated as HW (listed in the *Guide*, Part 1A, pages 9-23):

- TDGR “p” wastes
- Common substances that may present hazardous characteristics (such as activated carbon, asbestos, fabrics, straw, petroleum crude, etc.) but have been de-listed by the Basel, OECD, or AENV.
Waste Classification

STEP 3 - Is the waste listed in Tables 3 or 4 of the Guide?

- Table 3 (waste types from specific and non-specific sources, and AB series)
- Table 4 (off-spec chemicals 4A and 4B and containers)

http://environment.alberta.ca/02806.html
Waste Classification

STEP 4 – Does the waste show any of the characteristics identified in Schedule 1 of the WCR?

- Flammable (f.p. ≤ 60 °C)\(^1\) – Class 3 or 4
- Reactive (includes oxidizers) – Class 4 or 5
- Corrosive (pH < 2 or pH > 12.5) – Class 8
- Toxic (acute or chronic) – Class 6.1 or Class 9.3
- PCB ≥ 50 mg/kg, D&D, containers, empty containers, D&D

\(^1\) Reference to TDGR recent changes (f.p. & class 9).
Flammable Waste

- **Liquids**: f.p. < 60° C, closed cup test (class 3, flammable liquids)

- **Solids contaminated with flammable liquids**: f.p. < 60° C, closed cup test but disconnect the stirrer (class 4.1 flammable solids)

- **Readily combustible solids**: combustible burn test / burning rate test (class 4.1, flammable solids S waste)

- **Spontaneously combustible solids**: test for pyrophoric or self heating substances (class 4.2, flammable solids)

- **Solids that in contact with H₂O emit a flammable gas or spontaneously ignite** (class 4.3, water-reactive substances)

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1 TEST METHODS:

- ERCB Directive 58, 1996
  
Toxic Waste – Acute

It is an **acute toxic** waste because it has

- an oral toxicity $\text{LD}_{50} \leq 500 \text{ mg/kg}$ (liquids) or $200 \text{ mg/kg}$ (solids)\(^1\),
- a dermal toxicity $\text{LD}_{50} \leq 1000 \text{ mg/kg}$, or
- an inhalation toxicity $\text{LC}_{50} \leq 10000 \text{ mg/m}^3$ at NPT

\(^1\) The 1993 and 1996 versions of the WCR stipulated an oral toxicity $\text{LD}_{50} \leq 5000 \text{ mg/kg}$ with no distinction between liquids and solids.
Toxic Waste – Chronic (leachable)

It is toxic because it is in a dispersible form and produces a toxic leachate\(^1\) that has one or more of the

- chemicals in Table 1 at levels \(\geq 100\) mg/L (former 9.2 TDGR substances)

- chemicals in Table 2 at levels \(\geq\) the indicated limits (former 9.3 TDGR substances)

\(^1\) The TCLP leachate results are expressed in milligrams of substance per liter of solution or leachate extract.
“Dispose”, when used with respect to waste at a landfill or by deepwell injection, means the intentional placement of waste on or in land as its final resting place [s 1(p) WCR]
Land Disposal

- Landfill Classification (WCR)
  - Class I Landfills, Class II Landfills, and Class III
- Deepwell Classification (D51)
  - Class Ia, Class Ib, Class II, Class III, and Class IV
Landfill Disposal

Class III Landfills (for “inert waste”, only)

“Inert waste” means solid waste that, when disposed of in a landfill or re-used, is not reasonably expected to undergo physical, chemical or biological changes to such an extent as to produce substances that may cause an adverse effect, and includes, but is not limited to, demolition debris, concrete, asphalt, glass, ceramic materials, scrap metal and dry timber or wood that has not been chemically treated” [WCR, s 1(w.1)].
Landfill Disposal

- **Class II Landfills** (solid non-hazardous waste, only)
  - Waste pass applicable criteria
    - Show no core hazardous characteristics, and
    - Pass the TCLP when applicable)
  - Requires waste classification
  - Core vs. TCLP leachable waste
  - Rule of Thumb (total conc. vs. TCLP leachate conc.)
  - Units (mg/kg vs. mg/L)

1 Reference to PCBs (< 50 mg/kg) and tabled limits for specific solvents, halogenated organic compounds, and metals.
Landfill Disposal of HW

Class I Landfills (specific HW, s 13 WCR)

- Applies to solid HW, only.
- 13(2)(a) and 13(2)(b) – HW w/ solvents and/or HOX\(^1\) “… combined concentration less than 1000 mg/kg …”
- 13(2)(c) – Solid HW not ignitable, reactive, or corrosive under the conditions of disposal
- 13(2)(d) – Solid HW that produces a waste extract w/ metal levels less than specific values in mg/L.

\(^1\) Reference to PCBs (< 50 mg/kg) and tables for specific solvents, AOX and metals.
Landfill Disposal

Rule of Thumb (worst case scenario):

Total vs. TCLP leachates

“If the total concentration of the chemical of concern in a solid waste (including excavated CS) expressed in mg/kg divided by twenty produces a number that is less than the corresponding value in Table 2 of the Guide, then the waste is not a HW due to the presence of that constituent.”
Representative soil samples from an industrial site show a total concentration for lead between 140 mg/kg and 600 mg/kg. Is the soil potentially hazardous?

Assumptions:
- 20 is the dilution factor for the TCLP, and
- all the lead in the sample will be fully extracted into the TCLP leachate solution.

Calculation (best scenario)
- $140 \text{ mg/kg} / 20 = 7.0 \text{ mg/kg}$
- Assessment: $7.0 \text{ mg/L} > 5.0 \text{ mg/L}$. From Table 2 of the User Guide we see that the WCR limit for Pb in 5.0
- Conclusion: This means that this soil potentially shows hazardous characteristics but still apparently suitable to be put to various uses.
## Alberta Tier I vs. WCR

- Tier I concentrations for some metals are not consistent with WCR HW criteria (Table 2 Guide)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WCR TCLP (mg/L)</th>
<th>Alberta Tier 1 (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural area</td>
<td>Agricultural</td>
</tr>
<tr>
<td>Arsenic</td>
<td>5.0</td>
<td>17</td>
</tr>
<tr>
<td>Cadmium</td>
<td>1.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Lead</td>
<td>5.0</td>
<td>70</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.2</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: WCR TCLP leachate concentrations in mg/L vs. Alberta Tier 1 in mg/kg
Waste Classification and Disposal

- Correlation between total concentrations and TCLP leachate concentrations
  - Example 1: Pb contaminated soil
  - Example 2: Foundry baghouse dust
EXAMPLE 1: *Lead Contaminated Soil from Lead-Acid Battery Recycling Facility*

Four composite samples from each one of the contaminated spots were collected and tested for the following parameters:

- pH;
- Total metals (Cd, Cr, Cu, Pb, Ni, Zn, and U); and
- TCLP for metals identified above.

Is this soil hazardous? Is it suitable for recycling? Where can it be disposed of?

The results are summarized below in the Table 2.

Table 2 – Analytical Summary for Samples Collected from Lead Contaminated Soil
(Total, TCLP, and modified TCLP for metals)

<table>
<thead>
<tr>
<th>Metals</th>
<th>#06 Total</th>
<th>#06 TCLP</th>
<th>#06 Modified TCLP</th>
<th>#07 Total</th>
<th>#07 TCLP</th>
<th>#07 Modified TCLP</th>
<th>#08 Total</th>
<th>#08 TCLP</th>
<th>#08 Modified TCLP</th>
<th>#09 Total</th>
<th>#09 TCLP</th>
<th>#09 Modified TCLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>59</td>
<td>0.083</td>
<td>0.007</td>
<td>524</td>
<td>0.810</td>
<td>&lt;0.003</td>
<td>13</td>
<td>0.033</td>
<td>&lt;0.003</td>
<td>21</td>
<td>0.057</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td>Cr</td>
<td>699</td>
<td>0.047</td>
<td>&lt;0.006</td>
<td>860</td>
<td>0.296</td>
<td>&lt;0.006</td>
<td>428</td>
<td>0.058</td>
<td>&lt;0.006</td>
<td>656</td>
<td>0.059</td>
<td>&lt;0.006</td>
</tr>
<tr>
<td>Cu</td>
<td>922</td>
<td>0.41</td>
<td>0.01</td>
<td>237</td>
<td>0.48</td>
<td>0.05</td>
<td>741</td>
<td>0.50</td>
<td>0.01</td>
<td>889</td>
<td>0.41</td>
<td>0.03</td>
</tr>
<tr>
<td>Pb</td>
<td>294000</td>
<td>278</td>
<td>0.83</td>
<td>11900</td>
<td>95.2</td>
<td>0.06</td>
<td>17100</td>
<td>203</td>
<td>0.14</td>
<td>10100</td>
<td>125</td>
<td>0.12</td>
</tr>
<tr>
<td>Ni</td>
<td>32</td>
<td>2.71</td>
<td>&lt;0.02</td>
<td>176</td>
<td>0.30</td>
<td>&lt;0.02</td>
<td>29</td>
<td>0.13</td>
<td>&lt;0.02</td>
<td>31</td>
<td>0.10</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Zn</td>
<td>479</td>
<td>5.06</td>
<td>0.137</td>
<td>3400</td>
<td>174</td>
<td>0.123</td>
<td>420</td>
<td>8.48</td>
<td>0.034</td>
<td>262</td>
<td>3.11</td>
<td>0.032</td>
</tr>
</tbody>
</table>
**Example 2:** *Foundry Baghouse Dust*

Four samples collected over a period of two months, analyses were done for the following parameters:

- Total metals (As, Ba, B, Cd, Cr, Pb, and Hg); and
- TCLP for the same metals.

The results are summarized below in the Table 3.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Criteria (mg/L)</th>
<th>09/20 Total</th>
<th>TCLP</th>
<th>10/24 Total</th>
<th>TCLP</th>
<th>10/28 Total</th>
<th>TCLP</th>
<th>11/01 Total</th>
<th>TCLP</th>
<th>11/06 Total</th>
<th>TCLP</th>
<th>11/08 Total</th>
<th>TCLP</th>
<th>11/19 Total</th>
<th>TCLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>5.0</td>
<td>&lt;30</td>
<td>&lt;0.005</td>
<td>&lt;30</td>
<td>0.0007</td>
<td>&lt;30</td>
<td>0.0006</td>
<td>&lt;30</td>
<td>&lt;0.005</td>
<td>&lt;30</td>
<td>&lt;0.005</td>
<td>&lt;30</td>
<td>&lt;0.005</td>
<td>&lt;30</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Ba</td>
<td>100.0</td>
<td>377</td>
<td>0.010</td>
<td>475</td>
<td>&lt;0.001</td>
<td>345</td>
<td>0.010</td>
<td>274</td>
<td>0.025</td>
<td>278</td>
<td>0.010</td>
<td>270</td>
<td>&lt;0.001</td>
<td>249</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>B</td>
<td>500.0</td>
<td>167</td>
<td>4.78</td>
<td>118</td>
<td>4.73</td>
<td>108</td>
<td>5.19</td>
<td>75</td>
<td>4.34</td>
<td>97</td>
<td>3.82</td>
<td>74</td>
<td>4.47</td>
<td>98</td>
<td>4.47</td>
</tr>
<tr>
<td>Cd</td>
<td>0.5</td>
<td>697</td>
<td>33.3</td>
<td>656</td>
<td>33.8</td>
<td>757</td>
<td>37.9</td>
<td>585</td>
<td>31.5</td>
<td>596</td>
<td>26.1</td>
<td>524</td>
<td>26.8</td>
<td>663</td>
<td>26.8</td>
</tr>
<tr>
<td>Cr</td>
<td>5.0</td>
<td>2070</td>
<td>&lt;0.003</td>
<td>1376</td>
<td>&lt;0.003</td>
<td>1190</td>
<td>&lt;0.003</td>
<td>957</td>
<td>&lt;0.003</td>
<td>1300</td>
<td>&lt;0.003</td>
<td>984</td>
<td>&lt;0.003</td>
<td>1570</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td>Pb</td>
<td>5.0</td>
<td>46600</td>
<td>255</td>
<td>34000</td>
<td>271</td>
<td>42100</td>
<td>260</td>
<td>56200</td>
<td>350</td>
<td>45100</td>
<td>350</td>
<td>47700</td>
<td>169</td>
<td>49500</td>
<td>169</td>
</tr>
<tr>
<td>Hg</td>
<td>0.1</td>
<td>1.7</td>
<td>0.0024</td>
<td>1.15</td>
<td>0.0002</td>
<td>3.08</td>
<td>0.0026</td>
<td>2.17</td>
<td>0.001</td>
<td>1.42</td>
<td>0.001</td>
<td>0.95</td>
<td>0.0007</td>
<td>2.45</td>
<td>0.0018</td>
</tr>
</tbody>
</table>
Example 3

**PRODUCED SAND - Analytical Data**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OILY SAND</th>
<th></th>
<th>CLEAN SAND</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (mg/kg)</td>
<td>TCLP (mg/L)</td>
<td>Total (mg/kg)</td>
<td>TCLP (mg/kg)</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purgeables</td>
<td>2.1</td>
<td>&lt; 100</td>
<td>&lt; 0.5</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>Extractables</td>
<td>1400</td>
<td>560</td>
<td>36</td>
<td>&lt; 0.5</td>
</tr>
<tr>
<td>Chloride</td>
<td>5620</td>
<td>374</td>
<td>40.7</td>
<td>5.1</td>
</tr>
<tr>
<td>Flash Point</td>
<td>&gt; 60° C</td>
<td></td>
<td>&gt; 60° C</td>
<td></td>
</tr>
<tr>
<td>Metal scan</td>
<td>(trace levels =&gt; not relevant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTEX</td>
<td>(not detectable)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**QUESTIONS**

- Is this waste hazardous? Is the testing appropriate?
- Is the cleaned sand an inert waste? Can it suitable to be used in reclamation of a gravel pit?
Landfill Disposal of HW

- AEW Policy ES-00-PP9 (2000)
  - Toxic Leachate Waste
  - Disposal of Solid HW at Class I Landfills
  - Test Required: TCLP
  - Units in mg/L, except for PCBs
Landfill Disposal of HW


“In the interim, while the *Guide* is being updated, the TCLP test should be used as the standard test method to assess whether or not solid hazardous waste containing one or more halogenated (excluding polychlorinated biphenyl) or non-halogenated organic compounds or leachable metals can be landfilled.”

**Units in mg/L except for PCBs.**
Landfill Disposal of HW

- Shall we test for each and every chemical identified in s 13 of the WCR? No!...

- Hydrotest fluids (waste w/ methanol): fp, toxicity
Analytical Protocols - Examples

The objective in conducting analytical determinations is to gather the maximum information at minimal cost without jeopardizing the quality of the data. The testing has to be comprehensive enough to characterize the waste for purposes of classification and, more importantly, for proper management.

In designing an analytical protocol, common sense should prevail in testing wastes only for those chemical constituents that are reasonably expected to be present and in consideration of the following:

- knowledge of the waste (prior testing, MSDS, etc.)
- raw materials, products, and by-products;
- technologies, chemical processes, and reactions;
- operational and waste management practices;
- classification criteria;
- indicator parameters;
- storage, treatment, and disposal alternatives; and
- compliance with clean-up criteria.
(1) **Refinery Site**

An example is given in Table 1, where petroleum hydrocarbons and heavy metals were the major contaminants at one refinery site.

### Table 1 – Analytical Protocol for Soil-Sludge Mixture from an Oil Refinery

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Classification</th>
<th>Treatment</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TPH</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>BTEX&lt;sup&gt;1&lt;/sup&gt;</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>TCLP metals&lt;sup&gt;2&lt;/sup&gt;</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Total metals&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Flash point</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Heat value</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- BTEX: benzene, toluene, ethyl benzene, and xylenes
- Metals in leachate (TCLP): As, Cd, Cr, Pb, and Hg.
- Total Metals: As, Cd, Cu, Pb, Hg, Ni, and Zn.
In assessing the characteristics of spent filters for purposes of waste class classification, the following data from at least four filters of the same type should be gathered over time:

- **Waste identification:**
  - Type of filter, mass, and process in which was used

- **Analytical parameters:**
  - Free liquids (Paint Filter Liquid Test)
  - BTEX (leachables and totals)
  - TPH
  - Flash point
  - Flammability
  - TCLP for metals
  - Heat value
Questions?

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