CHAPTER 6 – DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

6.0 INTRODUCTION AND SUMMARY OF ASSESSMENT

In this Chapter, the remedial alternatives that survived the initial screening in Chapter 5, are subjected to a more detailed evaluation under the criteria specified in Rule 530(5) of the Part 201 rules (R. 299.7530(5)). The purpose of this analysis is to develop additional information about each alternative so that an objective recommendation of an appropriate remedy can be made. The detailed evaluations of the alternatives presented in this chapter are based on many technical assumptions. A summary of these assumptions is provided in Appendix D. The alternatives and other information discussed in this chapter are presented on Table 3.

As discussed below, all of the remedial alternatives reviewed in this Chapter are equally protective of the environment. Currently, the Unit E is contaminated with a significant plume of 1,4-dioxane that has expanded under the City of Ann Arbor. Because of the depth of the contamination and the fact that the City's municipal water supply relies on water drawn from the Huron River, the plume does not present an imminent current threat to public health and safety or to the environment. All of the alternatives that are examined involve interception or reduction in contaminant levels to acceptable levels before reaching potential receptors. Of these equally protective alternatives, Alternative 6, Active Remediation Proximate to Huron River, is the preferred option because it avoids the disruption of the City neighborhoods and the uncertainty regarding the practical feasibility of the alternatives that would attempt to contain the leading edge of the plume closer to its current location.

Each of the alternatives that attempts to contain the leading edge of the plume near its current location would cause disruption of established neighborhoods, significant use of public and private rights-of-way for transmission pipelines and infrastructure, traffic interruptions, construction-related safety risks to residents, and incongruous use of property given the residential (and recreational) uses above the plume. The City of Ann Arbor and local residents have already expressed their concern that neighborhoods and streets not be unnecessarily interrupted. The detailed evaluation presented in this Chapter establishes that the "leading edge" alternatives offer no environmental benefit over remedial Alternative 6, which involves investigating the fate of the plume and, if necessary, interception, capture, treatment, and disposal at a location near the Huron River that would involve less disruption.

Because of the current location of the leading edge of the plume, each of the "leading edge" alternatives necessarily requires the installation of lengthy transmission pipelines. As previously discussed, the equally lengthy construction horizon for these alternatives (after obtaining necessary access) and the continued migration of the plume calls into question the practical feasibility of these alternatives. At a minimum, the goal of capturing the leading edge of the plume would be compromised because the recovery wells would have to be placed well downgradient of the current leading edge to ensure that capture could be still achieved when the infrastructure became available.

From a cost standpoint, monitored attenuation with institutional controls (remedial Alternative 2) is the least costly alternative. PLS, however, does not believe that this alternative adequately addresses political and societal concerns and it is not favored for this reason. All of the other options are extremely costly. Based on current dollars, the selected Alternative 6 is the most expensive option, but is in the same order of magnitude as the other alternatives. This alternative has the advantage, however, of avoiding the disruptions associated with the other active remediation alternatives, while providing the same level of protection.

6.1 CRITERIA FOR ANALYSIS

Rule 530(5) of the Part 201 rules (R. 299.7530(5)) lists nine factors to be used for the detailed evaluation of remedial alternatives. These factors are:

1. Assessment of the effectiveness of the alternative in protecting the public health, safety, and welfare and the environment and in responding to the remedy selection factors identified in R 299.5601 and R 299.5603.

2. Refinement and specification of alternatives in detail.

3. Detailed cost estimation, including operation and maintenance costs, over time, of implementing the final remedy.

4. Evaluation of engineering implementation, reliability, and constructability.

5. Evaluation of technical feasibility

6. Analysis of whether recycling, reuse, waste minimization, waste biodegradation, waste destruction, or other advanced, innovative, or alternative technologies are appropriate.

7. An analysis of any adverse environmental impacts, methods of mitigation, and costs of mitigation, including those adverse impacts, which may result from, planned demolition activities.

8. Analysis of the risks and impacts remaining after implementation of the remedy.

9. Analysis of the extent to which the alternative attains a degree of cleanup or control of hazardous substances that complies with legally applicable or relevant and appropriate requirements, rules, criteria, limitations, and standards of state and federal environmental law.

In addition, as required by the first factor, the evaluation will also consider the selection factors identified in R 299.5601 and R 299.5603. Although some of these factors are similar to those listed in Rule 530, they are all listed below for completeness:

1. The effectiveness of alternatives in protecting the public health, safety, and welfare and the environment.

2. The long-term uncertainties associated with the proposed remedial action.

3. The persistence, toxicity, mobility, and propensity to bioaccumulate of the hazardous substances.

4. The short and long-term potential for adverse health effects from human exposure.

5. Costs of remedial action, including long-term maintenance costs.

6. Reliability of the alternatives.

7. The potential for future remedial action costs if an alternative fails.

8. The potential threat to human health, safety, and welfare and the environment associated with excavation, transportation, and redisposal or containment.

9. The ability to monitor remedial performance.

10. For remedial actions that require the opportunity for public comment under section 20120d of the act, the public's perspective about the extent to which the proposed remedial action effectively addresses requirements specified in Part 201 and the Part 201 rules.

6.2 DETAILED ANALYSIS OF ALTERNATIVES

Eight alternatives survived the screening process. The alternatives are evaluated in detail, as required by Rule 530 in the subsections that follow. The remainder of this section discusses those Rule 530 factors that have been judged to be equivalent for the eight surviving alternatives.

6.2.1 Evaluation of Common Criteria

The evaluation of each of the alternatives is equivalent for a number of the criteria. In order to avoid unnecessary repetition within the discussion of the individual alternatives, the evaluation under these criteria is summarized below:

Assessment Of The Effectiveness Of The Alternative In Protecting The Public Health, Safety, And The Environment

Currently, the Unit E is contaminated with a significant plume of 1,4-dioxane that has expanded under the City of Ann Arbor. Because of the depth of the contamination and the fact that the City relies on municipal water drawn from the Huron River, the plume does not present an imminent current threat to public health and safety or to the environment.

All of the alternatives that were examined involve interception or reduction in contaminant levels to acceptable levels before reaching potential receptors. The only differences between alternatives from this standpoint do not appear to be material. The "leading edge" alternatives (all but 2 and 6) would attempt to prevent expansion of areas of contamination above drinking water criterion. Alternative 2 would not, by design, contain the plume at all, while Alternative 6 would contain the plume as necessary prior to any potential impact on downgradient receptors. These distinctions make little or no practical difference in terms of protection of public health and the environment. Under any alternative, no one would actually be consuming groundwater contaminated with 1,4-dioxane. Over time roughly the same area of Unit E would contain detectable levels of 1,4-dioxane (no matter which alternative is selected) because, by design, even the "leading edge" alternatives do not capture all of the 1,4-dioxane. Finally, it is not possible to quantify the difference in area inside a "leading edge" containment alternative versus alternatives 2 and 6. This is because all of the leading edge alternatives are subject to significant uncertainty (in timeliness) because of access and other practical implementation issues. At a minimum, the goal of capturing the leading edge of the plume near its current location would be compromised because the recovery wells would have to be placed well downgradient of the current leading edge to ensure that capture could be still achieved when the infrastructure became available.

Alternative 2 and Alternative 6 would allow the plume (as defined by concentrations above 85 ppb of 1,4-dioxane) to migrate within the Unit E beyond the current estimated contours. This movement, however, does not itself have a different impact on the public health and safety or the environment. Both alternatives protect downgradient receptors. In addition, under all of the options, the termination criteria are the same and the flow paths for any residual 1,4-dioxane (<85 ppb) would be the same, even under the "leading edge" options considered below.

Analysis Of Whether Recycling, Reuse, Waste Minimization, Waste Biodegradation, Waste Destruction, Or Other Advanced, Innovative, Or Alternative Technologies Are Appropriate

Recycling and reuse would require collection of 1,4-dioxane, dissolved in groundwater at part per billion levels. The miscibility of the contaminant with water and the large volume of water that must be processed each minute to control the Unit E plume make recycling 1,4-dioxane impossible. Chemical oxidation to destroy the contaminant is the only practical means for handling the contaminant.

Ex-situ treatment raises the possibility that groundwater, once it has been treated to remove 1,4-dioxane, could be consumed as either drinking water or process water. At this time PLS does not consider reuse of water after treatment to be viable because the primary customer for consumption of the water (the City of Ann Arbor) does not need the water supply and may justifiably reject it as presenting an unnecessary and unacceptable risk for its customers. No significant industrial consumer of water has been identified in proximity to Unit E. Accordingly, there does not appear to be any realistic opportunity at this time to recycle or reuse (as opposed to discharge) treated groundwater and this factor will not be discussed under the individual alternatives analyses.

Analysis Of The Risks And Impacts Remaining After Implementation Of The Remedy

The risks posed by the Unit E contamination are very low at this point in time. In general, greater risks are generated by construction and operations of the remedial systems than by the presence and continued migration of 1,4-dioxane in Unit E. The risks presented by the construction and implementation that are common to the surviving alternatives (except for monitored attenuation) are summarized below:

Construction – Construction of recovery and injection wells, pipelines, and treatment facilities employs traditional civil and mechanical engineering practices and contractor methods. Though the scope of design and construction will differ among alternatives, the relative reliability of the practices and methods will reduce risks and impacts to levels that are essentially equivalent.

Operations – Monitoring and/or operations of the remedial systems will not pose significantly different risks or impacts because automatic and manual control systems will be interlocked with critical function or parameter sensors. This will reduce the probability and duration of system upsets to essentially equivalent probabilities among active alternatives.

Post-operations – Each alternative will operate until 1,4-dioxane concentrations in the targeted portion of Unit E have been reduced to or below 85 ppb. Therefore, the risks and impacts remaining after the post-operations period do not differ materially among the alternatives.

6.2.2 Detailed Evaluation of Individual Alternatives

Based on the above unified comparison of alternatives to Rule 530 criteria, the remedial alternatives will be evaluated in detail with respect to four criteria below.

1. Detailed cost estimation, including operation and maintenance costs

2. Engineering implementation, reliability, and constructability

3. Technical feasibility

4. Adverse environmental impacts of remediation, including methods and costs of mitigation

5. Protection of public welfare and the public's perspective

6.2.2.1 Alternative 2 - Monitored Natural Attenuation and Institutional Controls

Alternative 2 would include monitoring of groundwater conditions and contaminant movement while controlling potential exposure risks through either restrictive covenants or a local ordinance.

Changes in contaminant levels in the groundwater would be monitored by periodic sampling of groundwater from monitoring wells. Samples would be analyzed for 1,4-dioxane and selected monitored natural attenuation (MNA) parameters. It is expected that with the passage of time, the concentration of 1,4-dioxane in the Unit E will fall below the applicable standards.

The components of this alternative include: (1) initial hydrogeological investigations to determine the fate of 1,4-dioxane in the Unit E plume, (2) installation of a monitoring well network, (3) long-term monitoring of the contaminant in Unit E, and (4) development and implementation of institutional controls to control exposure consistent with Part 201.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Costs for monitored natural attenuation are presented in Table 4 and detailed in Appendix E. Alternative 2 is estimated to be the least costly, longest duration alternative.

Engineering Implementation, Reliability, And Constructability:

Implementation – Implementation of the hydrogeological investigation and monitoring well network will require access to appropriate parcels of land. The difficulty of obtaining access is not known at this time. Institutional controls will require either restrictive covenants (restricting groundwater use) for each property owner proximate to the Unit E, or the passage by the City of Ann Arbor of an ordinance restricting groundwater use consistent with Section 20120b(5) of Part 201. Due to the large number of potentially affected properties, obtaining restrictive covenants from each property owner would be complicated and difficult and may not be possible without cooperation of a large number of individuals. The City of Ann Arbor has discretion as to whether to adopt and ordinance and is entitled to exercise that discretion in a manner it deems appropriate. At a minimum such an ordinance will be subject to extensive public scrutiny and possibly hearings prior to action, with no certainty as to the result.

Reliability – Natural processes attenuate 1,4-dioxane under Alternative 2. These are self-sustaining and, therefore, extremely reliable, though potentially slow.

Constructability – Constructing monitoring wells is an established process. Access to monitoring well sites for installation may present challenges, depending on the property owners. In the past, PLS has been able to obtain access for this type of project.

Technical Feasibility: Long-term access to and maintenance (and replacement) of monitoring wells presents a moderate challenge that should be resolved with access to the well location for construction.

Adverse Environmental Impacts Of Remediation, Including Methods And Costs Of Mitigation: This alternative does not create potentially significant adverse impacts during remediation. Migration of the plume under this scenario does not increase risks because the risks are controlled through institutional controls.

Protection Of Public Welfare And Public Perspective: This alternative involves a temporary disruption of neighborhoods due to the need to install monitoring wells for investigation and long-term monitoring. Use of public right-of-way can minimize infringement on private property. The impact on public welfare in comparison to other alternatives appears to be minimal.

From a political and societal standpoint, groundwater remedies that rely on institutional controls are controversial and tend to be viewed as "not as good" as pro-active remedies. One of the objectives of the Feasibility Study is to describe the alternatives more fully so that a more informed public opinion can form over whether an alternative is, in fact, "as good" overall as another. It is currently not known whether there will be sufficient public support to implement this option. The possibility that a consensus around this remedy may fail due to political and societal concerns is deemed by PLS to be high. This alternative cannot be implemented without adequate public support.

6.2.2.2 Alternatives 3a, 3c and 3e - Groundwater Pumping - Pipeline to and Treatment at Wagner Road

Three alternatives (3a, 3c, and 3e) survive in this group. All three share the following common characteristics:

- recovery of groundwater from multiple vertical wells,
- transmission of recovered water through individual pipelines, which combine with others up stream of a new pipeline,
- transmission of the total flow of all individual wells through the new pipeline to the PLS facility,
- chemical oxidation of 1,4-dioxane without production of by-products at concentrations that pose risks, and
- disposal of treated water.

Figures 6, 7, and 8 show the general layout of Alternatives 3a, 3c, and 3e, respectively.

<u>Alternative 3a</u> – Pipeline to Wagner Road facility where treated groundwater would be transmitted through a new pipeline to the Huron River for disposal under an NPDES permit.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Costs for ozone and hydrogen peroxide treatment followed by discharge to the Huron River are presented in Table 5 and detailed in Appendix E. Costs for UV/Hydrogen peroxide treatment followed by discharge to the Huron River are presented in Table 6 and detailed in Appendix E. Alternative 3a is ranked as the sixth least expensive alternative.

Engineering Implementation, Reliability, And Constructability:

<u>Implementation</u> – Design, construction, and operations of water recovery, treatment, and disposal systems would utilize well-tested engineering and construction techniques and methods. In addition, PLS staff has extensive experience and expertise in ex-situ treatment of contaminated groundwater, including the receipt, storage, and transmission of hydrogen peroxide. As a result, start-up and operation of the treatment system should proceed quickly and uneventfully.

Also, the discharge of treated water into the Huron River will have to be done pursuant to a new NPDES permit. This involves an application, draft permit, public comment, final permit, followed by the possibility of a contested case. It is possible that implementation could be delayed until all permit issues and appeals are resolved. Based on PLS' experience with its NPDES permit for discharge into Honey Creek, the possibility of permit issues creating implementation problems is considered to be moderate.

Reliability – Pilot testing indicated that a combination of ozone and hydrogen peroxide can destroy 1,4-dioxane during the time available for ex-situ treatment during high-volume groundwater pumping to control the plume. The technology is suitable to the contaminant and the planned groundwater pumping rate. PLS intends to phase-in this technology at the PLS facility for existing discharges to Honey Creek. Bromate formation can be an issue with the use of ozone and hydrogen peroxide, but is expected to be manageable to meet anticipated NPDES permit conditions. If ozone-hydrogen peroxide is not acceptable, UV/hydrogen peroxide can be used, although it is significantly more expensive. This is the technology currently in use at the PLS facility under its current NPDES permit.

Groundwater recovery wells and pumps, pipelines, and ex-situ treatment vessels have been shown to be reliable during the chemical oxidation remediation of shallower 1,4-dioxane contaminated aquifers. Periodic inspection and cleaning of wells, pumps, and pipelines will maintain the mechanical efficiency of the system.

Ozone and hydrogen peroxide are energetic and reliably degrade 1,4-dioxane when applied in sufficient quantity. To assure the latter, 1,4-dioxane in the recovered groundwater will be measured periodically and the treatment system operating conditions changed as needed.

Constructability – This option presents difficult constructability problems.

The most significant constructability concern is access to public and private property for the construction of transmission pipelines for untreated water (from purge wells to PLS) and treated water (to the Huron River). The length of the pipelines involved means that a large number of third parties will have an interest in the project, any one or more of whom may raise challenges to the use of his or her property by PLS for the pipelines. Although access is always an unknown for all of the options, those that involve significant transmission pipelines, such as this option, are considered to be more problematic because the scope of the access question increases dramatically. Under this alternative, access would have to be obtained from at least three governmental units as well as private landowners.

The law governing access to private property for the purpose of installing transmission pipelines is untested and resort to the courts in any event creates a significant uncertainty in the outcome. Until access is obtained, pipelines cannot be constructed. Until pipelines can be constructed, the plume cannot be captured. While the plume continues to move, capture using this option becomes a "moving target." Accordingly, constructability concerns for this option are heightened and are considered high.

As discussed above, the construction of water recovery, treatment, and disposal systems would use proven engineering and construction methods, and does not present heightened concerns.

A treatment facility, including hydrogen peroxide storage and ozone generation systems, as well as ex-situ treatment chambers will be built at the PLS Wagner Road facility. Ample area and utilities are available at this location.

Technical Feasibility: This option raises some concerns regarding technical feasibility. From an engineering standpoint, the longer the pipelines, the more problematic it becomes to assure that the system is adequately pressurized and protected. In general, pipelines are most efficient and reliable when their length and the horsepower of pumps can be minimized. This option involves an estimated 33,748 linear feet of pipeline carrying untreated or treated groundwater. While it is feasible to design such a pipeline, the requirements that private and/or public right of way owners may demand to assure safety are undetermined. Based on past experience (with transmission lines in Evergreen and the horizontal well) the question of the safety of any design will be raised and may be an obstacle to timely installation of an acceptable system.

The time needed to obtain access and construct the pipelines also raises a technical concern. This alternative attempts to capture the leading edge of the plume near its current location. The leading edge changes with time. The amount of time needed for development, comment and approval of a design and layout, for securing access, for road closures and construction, is undetermined. Comparable municipal utility projects (storm and sewer reconstruction, for example) have taken a year or more, even without the disputes regarding access and design safety that can be anticipated during this project. During the undetermined time it will take to accomplish these tasks the plume will continue to move. Movement of the plume may render the design obsolete (causing the need for realignment) and may cause additional delay in addressing the contamination. PLS considers the likelihood of this concern arising to be high.

As for the treatment aspects of this option, pilot testing indicated that a combination of ozone and hydrogen peroxide can destroy 1,4-dioxane during the time available for ex-situ treatment during high-volume groundwater pumping to control the plume. The technology is suitable to the contaminant and the planned groundwater pumping rate. PLS intends to phase-in this technology at the PLS facility for existing discharges to Honey Creek

Adverse Environmental Impacts Of Remediation, Including Methods And Costs Of Mitigation: The potential adverse impacts of alternative 3a are leaks or accidents during receipt and storage of hydrogen peroxide, generation of oxygen and ozone, transmission and use of both oxidants, and transmission of treated and untreated water via long large diameter underground pipelines. However, these risks are not deemed to be unacceptable because the transmission and storage of such materials in other contexts is routine. Leaks of untreated groundwater are not of concern because of the relatively low levels of dissolved 1,4-dioxane and its relatively high clean-up goals for most exposure pathways. Treated water, prior to discharge to the Huron River, does not pose any significant potential risks, other than erosion due to unlikely, large-volume, pipeline leaks. While PLS does not view leakage from the pipelines as a significant risk, this issue has been raised in the past and has caused significant dispute with respect to transmission pipelines elsewhere in the project area. This concern is discussed above in the sections on Constructability and Technical Feasibility.

This option will require an NPDES permit for the discharge. The NPDES permit will account for environmental impacts on the Huron River in accordance with state and federal law. The discharge point is expected to be downstream of drinking water intakes and is not expected to raise any new issues.

Monitoring of the treatment building interior and periodic inspection and repair of the remedial equipment and pipelines are low-cost efforts well suited to control of these potential impacts.

Protection Of Public Welfare And Public Perspective: This alternative involves significant disruption of public and private use of property along the length of the pipelines during construction, with some minor subsequent disruption for operation and maintenance. Use of public right-of-way can minimize infringement on private property, although street and lane closings may still be necessary during the installation of the pipelines. The impact on public welfare in comparison to other alternatives appears to be significant.

During previous public meetings, concerns about disruption for installation of infrastructure were expressed, albeit in the context of interim response proposals. Public perception of whether the disruption caused by this option when weighed with the benefits of this and other options is not known, but is expected to be a concern. This concern is particularly relevant under this option given the length of the pipelines and number of persons potentially affected.

<u>**Alternative 3c**</u> – Pipeline to PLS facility for treatment, where treated water would be injected into the Unit E through multiple new wells at locations where 1,4-dioxane levels are less than 85 ppb, but greater than 1 ppb.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Costs for ozone and hydrogen peroxide treatment followed by discharge to the Huron River are presented in Table 7 and detailed in Appendix E. Costs for UV/Hydrogen peroxide treatment followed by discharge to the Huron River are presented in Table 8 and detailed in Appendix E. This alternative is ranked as the fifth least expensive option.

Engineering Implementation, Reliability, And Constructability:

<u>Implementation</u> – Alternative 3c differs only slightly from 3a. The difference is the use of multiple injection wells rather than a pipeline and outfall to the Huron River for treated water disposal. Injection wells require maintenance, especially to assure long-term reliability, and may have to be rehabilitated or replaced from time to time. This is not considered to be a significant implementation concern.

Groundwater discharge will have to be authorized by MDEQ. Although it is expected that certain technical issues may be raised (see below), groundwater discharge is expected to be less controversial than surface water discharge, particularly in this case where Unit E has already been impacted.

<u>Reliability</u> – Alternative 3c utilizes the same system components as 3a with one exception. Treated groundwater will be injected into Unit E through multiple injection wells rather than piped to the Huron River. The injection wells and small-diameter pipelines to each should be as reliable as the Huron River discharge if they are maintained, as described above. The ex-situ destruction of 1,4-dioxane will be managed in the same manner as described in 3a.

<u>Constructability</u> – For the reasons discussed in connection with Alternative 3a, construction of a transmission pipeline for untreated water is expected to raise constructability issues. Fewer property owners, however, would be involved because only one leg of pipeline (from leading edge to PLS) will be constructed. Because of the length of the transmission pipeline, the number of property owners involved, public concerns about safety and reliability, and uncertainty regarding timing (as explained above), this is considered to be a major concern for this option.

As discussed above, the construction of water recovery, treatment, and disposal systems would use proven engineering and construction methods.

A treatment facility, to house hydrogen peroxide storage vessels, ozone generation systems, and ex-situ treatment chambers will be built at the PLS Wagner Road facility. Ample area and utilities are available.

Technical Feasibility: In addition to the shared issues associated with constructing pipeline from the extraction wells back to the PLS facility, the defining challenge associated with this alternative is locating a sufficient number of injection wells that are able to accept the necessary volume of water and do so without disruption of containment or other remedial objectives. Injection well locations must be carefully chosen to minimize dilution and, more importantly, deflection of the plume, both of which would reduce the effectiveness and efficiency of the plume and extend the remediation. In addition, injecting the same amount of water into the plume as extracted will make capturing the plume difficult. A compensating potential benefit of this alternative is that the injection wells would likely be placed on PLS property, thus making the construction of injection wells and pipelines from the treatment center simpler than alternatives where wells would be installed off site.

No NPDES permit will be required, although permission from MDEQ to discharge to groundwater will be necessary. Technical concerns over whether such permission will be granted are considered comparable to the issuance of an NPDES permit. Bromate formation can be an issue with the use of ozone and hydrogen peroxide, but is expected to be manageable to meet anticipated regulatory requirements. If ozone-hydrogen peroxide is not acceptable, UV-peroxide can be used, although it is significantly more expensive.

Adverse Environmental Impacts Of Remediation, Including Methods And Costs Of Mitigation: See analysis for Alternative 3a. The only difference is that there will need to be MDEQ approval of a groundwater discharge for this alternative instead of the NPDES permit required for Alternative 3a. This approval will resolve questions regarding adverse environmental impacts of injection of treated groundwater.

Protection Of Public Welfare And Public Perspective: This alternative involves significant disruption of public and private use of property along the length of the pipelines during construction, with some minor subsequent disruption for operation an maintenance. Use of public right-of-way can minimize infringement on private property, although street and lane closings may still be necessary during the installation of the pipelines. The impact on public welfare in comparison to other alternatives appears to be significant, although it may be slightly less than for Alternative 3a due to the fact that the pipeline to the Huron River will not be needed.

During public meetings on interim response proposals, concerns about disruption for installation of infrastructure were expressed although in the context of the lack of an overall plan. Public perception of whether the disruption caused by this option when weighed with the benefits of this and other options is not known, but is expected to be a concern.

<u>Alternative 3e</u> – Pipeline to PLS facility for treatment to be followed by discharge to Honey Creek under an amended NPDES permit.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Costs for ozone and hydrogen peroxide treatment followed by discharge to the Honey Creek (Alternative 3e-1) are presented in Table 9 and detailed in Appendix E. Costs for UV/Hydrogen Peroxide treatment followed by discharge to the Honey Creek (Alternative 3e-2) are presented in Table 10 and detailed in Appendix E. Alternative 3e is estimated to be the third least costly alternative.

Engineering Implementation, Reliability, And Constructability:

<u>Implementation</u> – Design, construction, and operations of water recovery, treatment, and disposal systems would utilize well-tested engineering and construction techniques and methods. In addition, PLS staff has extensive experience and expertise in ex-situ treatment of contaminated groundwater, including the receipt, storage, and transmission of hydrogen peroxide. As a result, start-up and operation of the treatment system should proceed quickly and uneventfully.

PLS' current NPDES permit would also have to be amended to authorize the discharge of treated water into the Honey Creek. Based on PLS' experience with its current NPDES permit, the possibility of permit issues creating implementation problems is considered to be high.

Reliability – Pilot testing indicated that a combination of ozone and hydrogen peroxide can destroy 1,4-dioxane during the time available for ex-situ treatment during high-volume groundwater pumping to control the plume. The technology is suitable to the contaminant and the planned groundwater pumping rate. PLS intends to phase-in this technology at the PLS facility for existing discharges to Honey Creek. Bromate formation can be an issue with the use of ozone and hydrogen peroxide, but is expected to be manageable to meet anticipated NDPES permit conditions. If ozone-hydrogen peroxide is not acceptable, UV-peroxide can be used, although it is significantly more expensive. This is the technology currently in use at the PLS facility under its current NPDES permit.

Groundwater recovery wells and pumps, pipelines, and ex-situ treatment vessels have been shown to be reliable during the chemical oxidation remediation of shallower 1,4-dioxane contaminated aquifers. Periodic inspection and cleaning of wells, pumps, and pipelines will maintain the mechanical efficiency of the system.

Ozone and hydrogen peroxide are energetic and reliably degrade 1,4-dioxane when applied in sufficient quantity. To assure the latter, 1,4-dioxane in the recovered groundwater will be measured periodically and the treatment system operating conditions changed as needed.

Constructability – This option presents difficult constructability problems.

The most significant constructability concern is access to public and private property for the construction of transmission pipelines for untreated water (from purge wells to PLS). These considerations are the same as for Alternative 3a, although the concern is somewhat lessened because the pipeline to the Huron River is not needed.

Technical Feasibility: Except as provided below, this alternative raises the same concerns as described for Alternative 3a.

In addition, this alternative will require an amendment to PLS' current NPDES permit for the discharge. The NPDES permit will account for environmental impacts on the Honey Creek. PLS has had a series of permits for its current discharges to that watercourse and intervernors have consistently raised technical and legal issues about the discharge. Based on past experience the likelihood of a permit contest raising technical issues is high.

Protection Of Public Welfare And Public Perspective: This alternative involves significant disruption of public and private use of property along the length of the pipelines during construction, with some minor disruption thereafter for operation and maintenance. Use of public right-of-way can minimize infringement on private property, although street and lane closings may still be necessary during the installation of the pipelines. The impact on public welfare in comparison to other alternatives appears to be high. In addition, discharge to Honey Creek has been the source of significant public concern (and opposition). This alternative can be expected to engender significant public debate.

6.2.2.3 Alternatives 4a & c - Groundwater Pumping – Treatment near Maple Road

Two alternatives in this group remain. Both of these alternatives share:

- recovery of groundwater from multiple vertical wells,

- transmission of recovered water through individual pipelines, which combine with others or proceed directly to a water treatment compound built on PLS-owned or PLS-leased property at or near Maple Road,

- chemical oxidation of 1,4-dioxane without production of by-products at concentrations that pose risks, and

- disposal of treated water.

Figures 9and 10 show the general layout of Alternatives 4a and 4c, respectively.

<u>**Alternative 4a**</u> – Treatment at a location near Maple Road, followed by transmission through a new pipeline to the Huron River for disposal under an NPDES permit.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Alternative 4a is ranked as the fourth least costly alternative. Its preliminary scope and cost estimate are in Table 11 and detailed in Appendix E.

Engineering Implementation, Reliability, And Constructability:

<u>Implementation</u> – Alternative 4a differs from 3a only in the elimination of the pipeline from Maple Road to the PLS Wagner Road facility and the path of the discharge pipeline to the Huron River. Therefore, the design, construction, and operations of water recovery, treatment, and disposal systems used would be the same well-tested engineering and construction techniques and methods. As a result, construction, start-up, and operations of the treatment system would proceed uneventfully.

Liability insurance for chemical oxidation treatment of groundwater in a residential and commercial neighborhood rather than at the Wagner Road facility may be a significant cost.

<u>Reliability</u> – Groundwater recovery wells and pumps, pipelines, and ex-situ treatment vessels have been shown to be reliable during the chemical oxidation remediation shallower 1,4-dioxane contaminated aquifers, as discussed in Alternative 3a. Periodic inspection, cleaning, and repair of the remedial system components would maintain the performance of the overall system.

Hydrogen peroxide and ozone can reliably degrade dissolved 1,4-dioxane in recovered groundwater. Periodic monitoring and adjustment of the system would maintain destruction performance.

<u>Constructability</u> – As discussed in 3a above, the construction of water recovery, treatment, and disposal systems would use proven engineering and construction methods. The ex-situ oxidation treatment equipment could be modified to optimize performance, as has the Unit C and D system from time to time.

A treatment facility will be built on property near Maple Road, owned or leased by PLS. Area and utility service may be limited at this location.

Access to public and private property for construction and maintenance of remedial systems and structures would be important. Recovery well locations would be those specified in alternatives 3a, 3c, 4c, or 5; therefore, access would be no more or less difficult to secure. Overall, access for Alternative 4a is anticipated to be less difficult to secure than for Alternative 3a, due to elimination of the pipeline to the Wagner Road facility.

Technical Feasibility: See Alternative 3a.

Adverse Environmental Impacts Of Remediation, Including Methods And Costs Of Mitigation – As for the other active remedial alternatives, the most significant potential adverse impacts of 4a include leaks or accidents during receipt and storage of hydrogen peroxide, generation of oxygen and ozone, and transmission and use of both oxidants. Leaks of untreated groundwater are again a lesser concern because of the relatively low levels of dissolved 1,4-dioxane and its relatively high clean-up goals for most exposure pathways. Treated water transmission and discharge does not pose any significant potential risks, other than erosion due to large-volume leaks.

Monitoring of the treatment building interior and periodic inspection and repair of the remedial equipment are low-cost efforts well suited to control of these potential impacts.

Protection Of Public Welfare And Public Perspective: This alternative involves significant disruption of public and private use of property along the length of transmission pipelines to Maple Road and then to the Huron River during construction, with some minor subsequent disruption for operation and maintenance. Use of public right-of-way can minimize infringement on private property, although street and lane closings may still be necessary during the installation of the pipelines. The treatment system would have to be installed in either a retail area bordering residential neighborhoods and Veterans Park, in Veterans Park itself, or in the surrounding neighborhoods. This is not consistent with current land uses and may raise public objection and legal challenges (for zoning or other public safety reasons).

The impact on public welfare in comparison to other alternatives appears to be significant.

During public meetings on interim response proposals, concerns about disruption for installation of infrastructure were expressed, although in the context of the lack of an overall plan. Public perception of whether the disruption caused by this option is acceptable when weighed against the benefits of this and other options is not known, but is expected to be a concern. For this option, the length of the pipelines and number of affected persons heightens this concern.

<u>Alternative 4c</u> – Ozone and hydrogen peroxide treatment followed by injection into Unit E through multiple new wells at locations where 1,4-dioxane levels are less than 85 ppb but exceed 1 microgram per liter under a Part 22 permit.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Scope and costs for Alternative 4c are detailed in Appendix E and summarized in Table 12. Alternative 4c is ranked as the seventh least costly alternative.

Engineering Implementation, Reliability, And Constructability:

<u>Implementation</u> – Alternative 4c differs from 4a in the elimination of the pipeline from Maple Road to the Huron River. The design, construction, and operations of water recovery, treatment, and disposal systems used would again use well-tested engineering and construction techniques and methods. As a result, construction, start-up, and operations of the treatment system is anticipated to be uneventful.

Liability insurance for chemical oxidation treatment of groundwater in a residential and commercial neighborhood may be a significant cost.

Reliability – Groundwater recovery wells and pumps, pipelines, and ex-situ treatment vessels have been shown to be reliable during the chemical oxidation remediation of Units C and D, as discussed above. Periodic inspection, cleaning, and repair of the remedial system components would be required but easily accomplished.

Hydrogen peroxide and ozone would reliably degrade dissolved 1,4-dioxane if the system were periodically monitored and adjusted.

Constructability – As discussed above, the construction of water recovery, treatment, and disposal systems would use proven engineering and construction methods. The ex-situ oxidation treatment equipment could be modified on-site to optimize performance, as has the present Unit C&D ex-situ oxidation units.

A treatment facility will be built near Maple Road, on property owned or leased by PLS. The availability of area and utility service may be limited at this location.

Access to public and private property would remain critical for construction and maintenance of remedial systems and structures. Access for Alternative 4c is anticipated to be less difficult to secure than for Alternative 3c, due to elimination of the pipeline to the Wagner Road facility.

Technical Feasibility: The defining challenge associated with this alternative is locating a sufficient number of injection wells that are able to accept the necessary volume of water and do so without disruption of containment or other remedial objectives. Injection well locations must be carefully chosen to minimize dilution and, more importantly, deflection of the plume, both of which would reduce the effectiveness and efficiency of the plume and extend the remediation. In addition, injecting the same amount of water into the plume as extracted will make capturing the plume difficult, particularly under this alternative because of the proximity of the extraction and injection wells.

No NPDES permit will be required, although permission from MDEQ to discharge to groundwater will be necessary. Technical concerns over whether such permission will be granted are considered comparable to the issuance of an NPDES permit. Bromate formation can be an issue with the use of ozone and hydrogen peroxide, but is expected to be manageable to meet anticipated regulatory requirements. Unlike Alternative 3c, UV/hydrogen peroxide technology is not available at this location if the ozone-hydrogen peroxide technology does not prove feasible.

Adverse Environmental Impacts Of Remediation, Including Methods And Costs Of Mitigation: As for the other active remedial alternatives, the most significant potential adverse impacts of 4c include leaks or accidental releases of hydrogen peroxide, oxygen, and ozone. Untreated groundwater leaks are of less concern because of the low levels of dissolved 1,4-dioxane and its relatively high clean-up goals. Treated water transmission and discharge does not pose any significant potential risks, other than erosion or flooding due to pipeline leaks, which would be expected to be smaller than for a single discharge line to the Huron River.

Monitoring of the treatment building and inspection and repair of the remedial equipment are low-cost and effective control methods for these potential impacts.

Protection Of Public Welfare And Public Perspective: This alternative involves some disruption of public and private use of property along the length of the pipelines connecting extraction and treatment and injection points during construction, with some minor subsequent disruption for operation an maintenance. If injection wells can be installed on retail property, concerns about inappropriate infrastructure in neighborhoods or in Veterans Park may be mitigated somewhat. However, the treatment system would have to be installed in either a retail area bordering residential neighborhoods, in Veterans Park, or in the surrounding neighborhoods. This is not consistent with current land uses and may raise public objection and legal challenges (for zoning or other public safety reasons).

During previous public meetings, concerns about disruption for installation of infrastructure were expressed albeit in the context of interim response proposals. Public perception of whether the disruption caused by this option when weighed with the benefits of this and other options is not known, but is expected to be a concern.

The impact on public welfare in comparison to other alternatives appears to be significant, primarily because of the need to locate treatment and injection facilities in areas used for retail, residential or recreational uses.

6.2.2.4 Alternative 5 - Groundwater Pumping – Injection into Deep Formation

Purged groundwater would be conveyed to PLS' Wagner Road facility and then injected, without treatment, into a deep well located at the PLS Wagner Road facility.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Alternative 5 scope and costs are presented in Table 13 and detailed in Appendix E. Alternative 5 is estimated to be the second least costly remedial alternative.

Engineering Implementation, Reliability, And Constructability:

Implementation – From an engineering standpoint, the design, construction, and operation of water recovery, treatment, and deep disposal well systems would involve well-tested engineering and construction techniques and methods. Such wells are commonly used in Michigan and others have been permitted for the Mt. Simon formation, including one such well formerly located at the PLS facility. Assuming that adequate capacity exists to accept the expected volumes of water, there do not appear to be any engineering issues that would disrupt implementation.

The well would have to be permitted under the federal UIC program, which involves preparation of an application, study of the formation, public comment, and the issuance by USEPA of an enforceable permit. Commercial UIC well permits, which would allow the permit holder to accept liquid waste from other enterprises, have been controversial. Permits for disposal of the permit holder's wastewaters, however, have been far less contentious. In this case, the untreated groundwater would be non-hazardous liquid waste that, with the exception of 1,4-dioxane, would not contain any hazardous substances above non-background levels. PLS does not anticipate significant implementation issues raised by the permit process.

Reliability – Groundwater recovery wells, pumps, and pipelines have been shown to be reliable during the remediation of shallower 1,4-dioxane contaminated aquifers. Deep injection well construction methods and pumps able to inject into deep formation have been available and in use for decades. All components would perform well if inspected and cleaned periodically.

Constructability – As discussed above, the construction of water recovery, treatment, and disposal systems would use proven engineering and construction methods.

The deep injection well and associated pumps and controls would be constructed on PLS property. Access to public and private property would be needed for construction and maintenance of recovery wells and the pipeline to the Wagner Road facility. The constructability issue related to construction of the transmission line are the same as for Alternatives 3a and 3c. Although only one leg of the pipeline would be required, this is still considered to be a significant potential obstacle. The recovery wells would be the same as for alternatives 3a, 3c, 4a, and 4c. Acquisition of access rights for recovery wells would be no less difficult.

A deep disposal well for hazardous material must be permitted as a Class I Underground Injection well by the United States Environmental Protection Agency. A Class I well was previously permitted, constructed, used, and abandoned on the PLS Wagner Road property. This historic use may or may not shorten the permitting time for a new deep disposal well. Regardless, the need for a permit is not considered to be a significant concern.

Technical Feasibility: Licensed, deep, injection wells exist throughout Michigan. Many of these inject into the Mt. Simon, or shallower formations. Well construction techniques, pumps able to inject liquids into deep formations, and experienced sub-contractors are available. A deep injection well formerly existed and was used for several years at the PLS facility, although at much lower flow rates than would be needed for capturing the Unit E plume. Since the Interim Feasibility Study was submitted PLS has continued to analyze the information available on the Mt. Simon formation to verify that adequate flow rates can be injected beneath the PLS facility on Wagner Road. At this point, PLS believes this Alternative may be technically feasible, but additional study is needed to confirm this conclusion. PLS will revisit this analysis if its preferred alternative is determined not to be acceptable.

Adverse Environmental Impacts Of Remediation, Including Methods And Costs Of Mitigation: This option presents the same (minimal) risks with respect to the need for a transmission pipeline for untreated water. Injection into the Mt. Simon formation places the water beyond the reach of human and environmental receptors and is considered safe. Reliability of the injection well must be tested in accordance with applicable regulations to safeguard against leaks. At the PLS facility, the aquifers above the Mt. Simon formation are already contaminated with 1,4-dioxane so there is no additional risk if the system were to fail. This alternative does not present significant adverse environmental risks.

6.2.2.5 Alternative 6- Groundwater Pumping with Active Remediation and Treatment Proximate to Huron River.

This alternative is similar to Alternatives 3a and 4a in that extraction wells would be used to control the plume and the purged groundwater would be conveyed to the Huron River via a new pipeline and then treated and discharged to the river under a new NPDES permit. The feature that distinguishes this alternative from the other active remediation alternatives, is that the groundwater extraction, if necessary, would occur at a location closer to the Huron River. By implementing the active remediation proximate to the Huron River, this alternative would minimize the community disruption, potential delays, and uncertainties associated with the installation of the longer pipelines necessary under the other alternatives, while still being protective of any potential receptors. The institutional controls called for under Alternative 2 would not be required because, in the event that groundwater monitoring data indicate 1,4-dioxane concentrations at a receptor will exceed a Part 201 Generic Cleanup Criteria (e.g., water entering the Huron River with 1,4-dioxane above GSI or approaching drinking water wells at levels above 85 ppb), an active groundwater remedial system would be implemented. Thus, this alternative is not dependant on governmental decisions beyond PLS' control.

Detailed Cost Estimation, Including Operation And Maintenance Costs: Costs for the hydrogeological investigation, monitoring, and the active remediation system that may be needed are presented in Table 14 and detailed in Appendix E. Alternative 6 is estimated to be the most expensive option (assuming active remediation is implemented).

Engineering Implementation, Reliability, And Constructability:

Implementation - Design, construction, and operations of water recovery, treatment, and disposal systems would utilize well-tested engineering and construction techniques and methods. In addition, PLS staff has extensive experience and expertise in ex-situ treatment of contaminated groundwater, including the receipt, storage, and transmission of oxidants. As a result, start-up and operation of the treatment system should proceed quickly and uneventfully.

Reliability – The initial hydrogeological investigation will be used to predict the fate of the Unit E plume. The actual migration of the plume would then be closely monitored with the placement of additional monitoring wells. Such investigatory techniques are considered reliable. The contemplated active remediation plan involves installation of groundwater recovery wells, pumps and pipelines. Groundwater recovery wells and pumps, pipelines, and ex-situ treatment vessels have been shown to be reliable during the chemical oxidation remediation of shallower 1,4-dioxane contaminated aquifers. Periodic inspection and cleaning of wells, pumps, and pipelines will maintain the mechanical efficiency of the system.

Groundwater recovery wells and pumps, pipelines, and ex-situ treatment vessels have been shown to be reliable during the chemical oxidation remediation of shallower 1,4-dioxane contaminated aquifers. Periodic inspection and cleaning of wells, pumps, and pipelines will maintain the mechanical efficiency of the system.

Ozone and hydrogen peroxide are energetic and reliably degrade 1,4-dioxane when applied in sufficient quantity. To assure the latter, 1,4-dioxane in the recovered groundwater will be measured periodically and the treatment system operating conditions changed as needed. This technology is currently under evaluation and appears to be promising. However, if it proves infeasible or inappropriate, the U-V oxidation system currently in use at the PLS site, or some other appropriate substitute, will be implemented.

Constructability – As discussed above, the construction of water recovery, treatment, and disposal systems would use proven engineering and construction methods and should not present any particularly difficult challenges.

A treatment facility, as well as ex-situ treatment chambers, will need to be built at a location near the Huron River if active remediation is required. Recovery and injection wells must be placed at or very near locations determined by an analysis of the hydrogeoloical system. Similarly, pipelines are most efficient and reliable when their length and the horsepower of pumps can be minimized. As with all of the other alternatives, access is an uncertainty. Given enough lead-time, however, access at an appropriate location can be obtained. Also, interference with conflicting land uses and residential neighborhoods is expected to be minimized using locations near the river.

Technical Feasibility: Pilot testing indicated that a combination of ozone and hydrogen peroxide can destroy 1,4-dioxane during the time available for ex-situ treatment during high-volume groundwater pumping to control the plume. The technology is suitable to the contaminant and the planned groundwater pumping rate. This technology (if successful) is planned for phase in at the PLS facility for existing discharges to Honey Creek. It is expected that by the time the active remediation system under this alternative is implemented, the technology will have seen significant field use. It is also possible that some other new technology may be developed that is superior. In any event, UV-Ozone or a suitable substitute can be implemented in the event ozone and hydrogen peroxide is not effective.

Adverse Environmental Impacts Of Remediation, Including Methods And Costs Of Mitigation: The potential adverse impacts of Alternative 6 remediation are leaks or accidents during receipt and storage of hydrogen peroxide, generation of oxygen and ozone, and transmission and use of both oxidants. However, these risks are not deemed to be unacceptable because the transmission and storage of such materials in other contexts is routine. Leaks of untreated groundwater are not of concern because of the relatively low levels of dissolved 1,4-dioxane and its relatively high clean-up goals for most exposure pathways. Treated water, prior to discharge to the Huron River, does not pose any significant potential risks, other than erosion due to unlikely, large-volume, pipeline leaks.

Monitoring of the treatment building interior, routine operation and maintenance, and periodic inspection and repair of the remedial equipment and pipelines will control the potential impacts.

Protection Of Public Welfare And Public Perspective: This alternative involves a temporary disruption of commercial areas due to the need to install monitoring wells for investigation and long-term monitoring. Use of public right-of-way can minimize infringement on private property. The impact on public welfare in comparison to other alternatives appears to be minimal.

Public support for this alternative depends on whether the contemplated plan to implement active remediation closer to the Huron River as necessary is viewed to be as "as good" as the other active remediation alternatives. Alternative 6 has the advantage of not causing long term (and in some cases, permanent) disruption of neighborhoods by incongruous uses, and of not raising fear over risks (reasonable or not) of failure of a pipeline carrying untreated water. Land uses near the river are more compatible with treatment (if needed) and this alternative would not require extensive pipelines.

CHAPTER 7 OVERALL RESPONSE PLAN AND WAIVER REQUEST

7.0 Introduction

Consistent with the conclusions set forth in PLS' Interim Feasibility Study, Alternative 6 is evaluated as the best available remedial alternative. In its April 13, 2004 response to the Interim Feasibility Study, however, the MDEQ indicated that this Alternative, in its current form, was not acceptable because it permitted the plume to expand beyond its current location and did not include active remediation at the leading edge of the plume or contaminant removal through naturally occurring biological or chemical processes as required by Rules 299.5705(5) and (6). The MDEQ also stated that it would not agree to waive these rules without additional upgradient source control.

While PLS does not agree with the Department's evaluation of Alternative 6, as a "stand alone" response action, PLS is willing to address the expressed concerns by combining its preferred alternative with the aggressive interim response activities described in Chapter 4.

7.1 Overall Response Plan

7.1.1 Interim Response – Mass Removal

Immediately upon approval by the MDEQ, PLS will propose and then implement an Interim Response Work Plan that will include purging, in the relative near-term, a total of approximately 450 gpm from two locations: a) approximately 250 gpm from three or four extraction wells on or near the PLS Wagner Road facility; and b) 200 gpm from an extraction well located immediately adjacent to Maple Road. The purged groundwater from the on-site purging will be treated by PLS' current on-site treatment system and discharged to the Honey Creek Tributary pursuant to the current NPDES permit. Purged water from the Maple Road purge well will be treated by PLS' mobile ozone/H2O2 treatment system and reinjected via two injection wells located north and south of the extraction wells.

The proposed interim response has a number of important benefits:

- Because of the limited amount of infrastructure required by these responses, PLS will be able to begin removing the mass of 1,4-dioxane from the most highly contaminated areas of the Unit E plume within a reasonable timeframe. The proposed interim responses could be implemented in months as compared to the years that would be needed to install the infrastructure for any of the "leading edge" alternatives.

- These interim responses will capture and treat the most highly contaminated groundwater before it migrates east of Maple Village, where all of the potential receptors are located. The combined purge rate of 450 gpm is comparable to the 570-650 gpm that would be necessary to capture the leading edge of the plume and would remove a much greater mass of 1,4-dioxane due to the higher concentrations at the purge locations.

- These interim response activities will provide additional assurance that groundwater contamination will never reach a receptor at levels above applicable standards and will, therefore, greatly reduce the possibility that the purging proximate to the Huron River contingency will need to be implemented.

- Eliminating the need for capturing the plume near the Huron River will avoid the disruption associated with installing the necessary infrastructure associated with that contingency.

- The aggressive purging included in this plan satisfies the active remediation requirement of Rule 299.5705(5) -- under any interpretation of that rule -- and provides the additional upgradient source control that the MDEQ has indicated would be needed to support a successful waiver request with respect to Rule 299.5705(6).

7.1.2 Final Response Plan

In addition to the work required by the MDEQ-approved interim response plan described above, PLS would also be legally obligated to implement the work described in the previous Chapters with regard to Alternative 6, including the implementation of a MDEQ-approved monitoring plan and the active remediation contingency near the Huron River, if the monitoring demonstrated that potential receptors were threatened. MDEQ stated in its comments on the interim FS that Alternative 2, Monitored Natural Attenuation and Institutional Controls, will not be considered by MDEQ without the addition of source control near Wagner Road and near Maple Road, and a contingency for addressing the exceedence of GSI at the Huron River. Alternative 6, coupled with the proposed interim responses, satisfies the elements suggested in this comment.

PLS believes that this combination of approaches best balances the benefits to be gained by quickly attacking the most contaminated portions of the plume and the need for an overall plan that avoids, to the extent possible, disruption of the community, while still being protective of all potential receptors.

7.2 Waiver Request

The MDEQ has indicated that PLS' preferred alternative is not consistent with Rules 299.5705(5) and (6) and that a waiver of these rules pursuant to Section 18(5) and (6), MCL 324.20118(5) and (6), would have to be granted in order for that alternative to be acceptable. As noted in the Interim Feasibility Study, PLS does not agree that a waiver of these rules is a legal necessity. But setting that disagreement aside, PLS believes that it would be appropriate for the MDEQ to grant a waiver of these rules under the circumstances present here. The purpose of this section is to present the elements for a request for such a waiver, so that MDEQ may evaluate whether it may exercise its discretion to grant one as allowed by law.[3]

After consultation with MDEQ, it appears that there is no detailed guidance regarding the preparation of an application for a waiver of Rule 705. An internal document provided by MDEQ states: "It is the responsibility of the person seeking a waiver to document that they qualify (i.e., release was not grossly negligent or intentional, as described above) and to document which justification for the waiver (see Section 20118(6)) is applicable to their situation. Section 20118(6)(d) is the most commonly used basis for a waiver."[4]

In the absence of guidance, PLS is providing details here organized by section references to Section 18 of Part 201, MCL 324.20118. The area covered by the waiver request is shown on Figure 11. Only Section 20118(6)(d) requires institutional controls as an element of a waiver. Therefore, although some have suggested that institutional controls will be a necessary element of any type of waiver request at this site, the status of those controls as applies to the PLS site are only discussed in connection with Section 20118(6)(d).

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[3] Rule 705(6) requires active remediation of the aquifer. PLS believes any option presented here for consideration will meet the requirements of this rule. Accordingly, a waiver for this requirement, which is also permitted under section 18 of Part 201, is not requested at this time.

[4] **FOQRT LESSONS LEARNED,** undated, provided by MDEQ via email dated May 28, 2004.

7.2.1 MCL 324.20118(5) – Protection of Public Health, Safety, Welfare and the Environment

Section 18(5) requires the MDEQ to make a finding that the selected remedial action is adequately protective of the public health, safety, welfare and the environment. The basis for such a conclusion can be found in various places in this Feasibility Study. PLS has provided information to show that under the recommended alternative, public health, safety, and welfare is protected by employing an interim response that will reduce concentrations of 1,4-dioxane to levels below applicable criteria before it reaches identified human receptors either through surface or groundwater. The most comprehensive compilation of groundwater level data available, the City's Montgomery Well WHPA report indicates that the plume will not flow toward the Montgomery well, but rather will follow an east northeast path directly to the Huron River, well below of the City's Barton Pond water intake. Moreover, it is now clear that the City has no intention of putting this well back into service, based on its decision to stop using the well when trace levels were detected in February 2001, and, more recently, to sue PLS for the cost or replacing this well with a new one.

With respect to the Ann Arbor Township wells, the conservative modeling analysis attached to this Feasibility Study shows that concentrations at those receptors will not exceed 85 ppb once the selected remedy is implemented in the unlikely event that the plume turns in their direction, rather than flowing directly into the Huron River. Neither the two Ridgmor wells nor the Uof M wells are in the flow path of the plume, but even if the plume did flow toward these wells and levels reached unacceptable levels before they were removed from service as scheduled, PLS will make arrangements to connect them to municipal water or, in the case of the Uof M wells, to restrict them to non-drinking water uses.

The environment is protected because the plume will naturally disperse to acceptable levels before environmental receptors are reached. The GSI criterion will not be reached at the Huron River, even without interim response as called for in the selected alternative. Aside from the Huron River, there are no pathways for contamination above criteria to cause other issues.

7.2.2 MCL 324.20118(6) -- Specific Waiver Conditions

Section 18(6) identifies four conditions, any one or more of which must be present to support a waiver request. Pall believes facts supporting several of these conditions are present here. They are outlined below.

(a) Compliance with R 299.5705(5) or R 299.5705(6), or both, of the Michigan administrative code is technically impractical.

As outlined in Chapters 5 and 6, each of the "leading edge" alternatives are impractical because of the technical difficulties. Although the word is not specifically defined in Part 201, based on its dictionary definition, "impractical" means, "unwise to implement or maintain in practice; incapable of dealing efficiently with practical matters, especially financial matters."[5] The following factors (all detailed elsewhere in the Feasibility Study) establish that the containment options are technically impractical: (1) the volume of water that would have to be captured, which renders reliable reinjection impossible (2) the distance that must be crossed to move the water to either a treatment site and/or disposal location and the difficulties associated with installing such an extraordinary amount of infrastructure; (3) the difficulties in engineering an effective capture system given the uncertainties regarding the timeframe for installing the necessary pipelines and related equipment; (4) the cost and level of effort required to meet the standards;

[5] See The American Heritage Dictionary of the English Language

and (5) the fact that the net environmental benefit to be obtained from capture is not commensurate with (1)-4.

PLS strongly believes that any attempt to capture the leading edge of the plume would be fruitless and potentially catastrophically expensive and litigious. PLS would have to assume an unacceptable risk that even after the expenditure of tens of millions of dollars without achieving a commensurate environmental benefit, some portion of the plume may still escape, leaving PLS in the same legal jeopardy that it now faces.

(b) The remedial action selected or approved will, within a reasonable period of time, attain a standard of performance that is equivalent to that required under R 299.5705(5) or R 299.5705(6) of the Michigan administrative code.

Based on its understanding of the MDEQ's interpretation of this provision, PLS is not seeking a waiver under this subsection.

(c) The adverse environmental impact of implementing a remedial action to satisfy R 299.5705(5) or R 299.5705(6), or both, of the Michigan administrative code would exceed the environmental benefit of the remedial action.

<u>Benefits</u>

The potential benefits to be gained by a containment remedy that would comply with R 299.5705(5) are limited. All seven of the surviving alternatives, including Alternatives 2 and 6, which would not contain the plume, are equally protective of the public health and the environment. All assure that receptors are not exposed to 1,4-dioxane levels in excess of allowable criteria. The only differences between alternatives from this standpoint do not appear to be material. The five "leading edge" alternatives (all but 2 and 6) would by design prevent expansion of areas of contamination above drinking water criterion. Alternative 2 would not, by design, contain the plume at all, while Alternative 6 would contain the plume as necessary prior to any potential impact on downgradient receptors. These distinctions make little or no practical difference in terms of protecting the public health and the environment. Under any alternative, no one would actually be consuming groundwater contaminated with 1,4-dioxane above acceptable criteria. And over time, roughly the same area of the Unit E would contain detectable levels of 1,4-dioxane (no matter which alternative is selected) because, by design, even the "leading edge" alternatives would allow concentrations of 1,4-dioxane below 85 ppb to continue to migrate. For this reason, as long as no one will be drinking the water, the "benefit" of protecting a portion of the plume from concentrations over the drinking water cleanup criterion is negligible if not completely absent. Finally, it is not possible to quantify the difference in area inside a "leading edge" containment alternative versus alternatives 2 and 6. This is because all of the leading edge alternatives are subject to significant uncertainty (in timeliness) because of access and other practical implementation issues. As discussed above, it is not necessary to undertake mass removal, let alone containment, in order to obtain the "benefit" of protecting downgradient receptors.

Even if the Ridgmor wells are ultimately affected (and it doesn't appear that they will be), they are already scheduled to be taken out of service. The Montgomery Well was removed from service because 1,4-dioxane was detected at 2 ppb. As alleged in the City's lawsuit, the City of Ann Arbor has no intention of restarting this well, even if the legally enforceable "leading edge" is captured since detectable levels of 1,4-dioxane may still reach the well. Groundwater modeling demonstrates that the proposed interim response can attain all of the other objectives satisfactorily.

Detriments to the Environment

The pumping and treatment of 1,4-dioxane contaminated groundwater is not an environmentally benign process. The intrusive measures involved in the purging and treatment of groundwater in order to achieve partial restoration of the aquifer results in more environmental harm that is gained. The following examines the negative environmental impacts that would be expected if groundwater is extracted at a rate of 500 gpm (well below the 570 to 650 gpm that would be needed to capture the leading edge), transferred to the PLS for treatment, and discharged into the Honey Creek Tributary. This is not an exhaustive list.

Groundwater Water Level Decline

If PLS is required to pump 500+ gpm from the Unit E aquifer, the combined groundwater remedation at the PLS site would involve the extraction of over 1,800 gpm of groundwater on a continuous basis. Water level decline is a natural response to pumping from an aquifer. Water level declines of approximately 12 feet have been observed in the Pall site area as a result of the aggressive pumping underway in the Unit C3 and D2 Aquifers. This decline would increase if groundwater were to be extracted from Unit E. Water level decline from pumping Unit E would eventually manifest itself in all overlying aquifer or water bearing deposits. Water level declines ultimately result in a reduction of discharge to surface waters, lowering of surface water levels, and a reduction in the capacity of an aquifer to support other uses.

To put the magnitude of the proposed purging in context, the recent well-known *Nestle* groundwater removal litigation is a good example. In that case, a lawsuit was commenced over the proposed withdrawal of 300 to 400 gpm, with no demonstrated reduction in water table levels. As mentioned earlier, adding 500+ gpm for the Unit E would make the volume of PLS's purge program three times larger than that in *Nestle.*

Surface Water Level Decline

The importance of considering ground water and surface water as a single resource has become increasingly evident in recent years(Winter, et al). Excessive groundwater extraction can result in groundwater level declines that eventually result in surface water level declines. The aggressive groundwater pumping associated with the Unit C2 and D2 aquifers has already lowered groundwater in some locations by approximately 12 feet. Continued pumping at PLS plus additional purge operations to contain the E plume at Maple Village would lower the groundwater, and the surface water bodies even more. The time lapse between the pumping of groundwater in an area and the noticeable reduction of surface flow further complicates the situation as the time lag may be as brief as a single growing season or as long as 30 or 40 years. Because of this time factor, a cause-and-effect relationship between pumping and reduced stream flow may not be readily apparent.

Surface water bodies in the area of the Pall site include the Honey Creek Tributary, First, Second and Third Sister Lakes. It is likely that the surface water levels in these water bodies will be lowered as a result of aggressive pumping

Pumping and Transmitting Water

Electrical energy is consumed during the pumping and transmission of groundwater. Groundwater weighs approximately 8 pounds per gallon. Lifting and transporting this relatively heavy fluid requires a significant amount of energy. Pumps for water lifting and transmission are generally powered by electricity. Energy consumption for the movement of 500 gpm of water has been calculated as part of this Feasibility Study (Appendix E).

The approximate depth to groundwater (i.e. an approximate pumping level) in the Unit E is 50 feet. Lifting water that height from four wells and transmitting it to a treatment center at Pall and then discharging it to the Honey Creek Tributary is estimated to consume approximately 1235 kWh/day. This equates to approximately 450,775 kWh of annual energy consumption. Over the course of the cleanup, it is estimated that over 9,000,000 kWh of energy would be consumed. For comparison, the average household consumes approximately 25 Kwh/day, thus the energy devoted to pumping would supply the needs of approximately 50 households per day.

Treatment of Water

Pall currently uses Ultraviolet light and hydrogen peroxide for the ex-situ treatment of 1,4-dioxane. This is a very energy intensive process. The approximate electrical usage for UV/H202 treatment at a 500 gpm treatment rate is 9840 kWh/day (approximately 400 households). If treatment were to be by ozone/H202, the approximate energy cost for a 500 gpm rate would reduce to approximately 3600 kWh/day (approximately 144 households).

The production of electricity creates air emissions. The USEPA air emission factors for electric generating plants are indicated in the tables below. By calculating the potential or estimated coal and gas usage resulting from the pumping at Pall, the estimated emissions from electric power generation using coal can be calculated. From these estimates the potential emissions form energy consumption can be calculated.

Estimated Emissions from Electric Power Generation (Coal)

Energy Use (kWh/day)	Btu/day	Btu Value of Coal (Btu/lb)	Coal Usage (lb/day)	Coal Usage (ton/year)
Pumping/Transfering Water - 1,235	4,215,055	13,000	324	59
Treating water with UV/H202 - 9,840	33,583,920	13,000	2,583	471
Treating water with Ozone/H202 - 3,600	12,286,800	13,000	945	172

Pollutant	Emission Factor (lb/ton Coal)[1]	Coal Usage (tons)	Emissions (tons/Year)
CO	0.5	59	0.01
Lead	0.00042	59	0.00001
Nox	11	59	0.33
SO2	32.8	59	0.97
PM2.5	0.025	59	0.001
PM10	0.054	59	0.002
PM Total	0.012	59	0.0004

Pollutant	Emission Factor (lb/ton Coal)[1]	Coal Usage (tons)	Emissions (tons/Year)
CO	0.5	471	0.12
Lead	0.00042	471	0.0001
Nox	11	471	2.59
SO2	32.8	471	7.73
PM2.5	0.025	471	0.01
PM10	0.054	471	0.01
PM Total	0.012	471	0.003

Pollutant	Emission Factor (lb/ton Coal)[1]	Coal Usage (tons)	Emissions (tons/Year)
CO	0.5	172	0.04
Lead	0.00042	172	0.00004
Nox	11	172	0.95
SO2	32.8	172	2.83
PM2.5	0.025	172	0.002
PM10	0.054	172	0.005
PM Total	0.012	172	0.001

USEPA, 1998 - SCC: 1-01-002-02, External Combustion Boilers, Electric

Estimated Emissions from Electric Power Generation (Natural Gas)

Energy Use (kWh/day)	Btu/day	Btu Value of Natural Gas (Btu/CF)	Natural Gas Usage (CF/day)	Natural Gas Usage (MMCF/year)
1,235	4,215,055	1,020	4,132	2
9,840	33,583,920	1,020	32,925	12
3,600	12,286,800	1,020	12,046	4

Pollutant	Emission Factor (lb/MMCF)[1]	Natural Gas Usage (MMCF)	Emissions (tons/year)
CO	84	2	0.084
Lead	0.0005	2	0.0000005
NOx	100	2	0.10
SO2	0.6	2	0.001
PM Total	7.6	2	0.00760
VOC	5.5	2	0.0055

Pollutant	Emission Factor (lb/MMCF)[1]	Natural Gas Usage (MMCF)	Emissions (tons/year)
CO	84	12	0.50
Lead	0.0005	12	0.000003
NOx	100	12	0.60
SO2	0.6	12	0.00
PM Total	7.6	12	0.05
VOC	5.5	12	0.03

Pollutant	Emission Factor (lb/MMCF)[1]	Natural Gas Usage (MMCF)	Emissions (tons/year)
CO	84	4	0.17
Lead	0.0005	4	0.000001
NOx	100	4	0.20
SO2	0.6	4	0.001
PM Total	7.6	4	0.015
VOC	5.5	4	0.011

USEPA 1998- SCC: 1-01-006-02, External Combustion Boilers, Electric Power Generation, Natural Gas

Chemical Usage During Treatment

A significant amount of chemicals are required for the treatment of 1,4-dioxane. If 500 gpm of water were to be treated using UV/H202, the following mass of chemicals would be consumed per day:

Chemical	Mass (pounds/day)	Mass (pounds/year)	Mass (pounds/20 year)
Acid	2,556	932,940	18,658,880
Peroxide	1076	392,740	7,854,800
Caustic	4,529	1,652,720	33,054,400

If 500 gpm is treated by peroxide/ozone, the chemical mass/volume is reduced to:

Chemical	Mass (pounds/day)	Mass (pounds/year)	Mass (pounds/20 years)
Peroxide	648	236,520	4,730,400
	Volume (cubic feet)	Volume (cf)	Volume (cf)
Liquid Oxygen	21,600	7,884,000	157,680,000

Chemical Discharge to Surface or Groundwater

The discharge of treated groundwater necessarily results in alteration of the natural water chemistry, whether it is discharged to surface water or reinjected into the aquifer. PLS has already had one failure of its chronic toxicity criteria in connection with its surface water discharge. PLS has altered its treatment process and developed its ozone treatment technology to address this concern, but when compared to the nonexistent environmental benefit of treating the additional Unit E water, it is not clear that even the minimal risks associated with the discharge of treated groundwater are worth it.

Other Environmental Concerns

Mixing of water from different aquifers or water bearing zones.
Damage to trees during infrastructure installation
Increased truck traffic and related energy usage and air emissions – Necessary to deliver chemicals
Increased potential for spills during transportation of treatment chemicals.

(d) The remedial action provides for the reduction of hazardous substance concentrations in the aquifer through a naturally occurring process that is documented to occur at the facility and both of the following conditions are met:

The Unit E plume is subject to natural processes (physical, chemical, or biological) that act to reduce the mass, toxicity, volume and concentrations of 1,4-dioxane. At a minimum, these in-situ processes include dispersion, dilution and sorption and biodegradation.

The physical processes of dispersion and dilution have been documented to occur at the PLS site and are working to reduce 1,4-dioxane concentrations anywhere plumes have migrated, including the Unit E plume. For example, these processes have played an important role in reducing 1,4-dioxane concentrations in the Western System, another plume associated with the PLS site. Over a 15-year monitoring period, the portion of the Western plume that exceeds the 85 ug/l drinking water criteria has reduced in size by approximately 90% (1988 total area of 2,677,728 ft^2 vs. 2001 total area of 301,835 ft^2). This significant reduction is consistent with a discontinuous source and a 1,4-dioxane plume subject to natural attenuation (the reduction of mass/concentrations due to naturally occurring physical, chemical and biological processes). These processes will continue to reduce the area where 1,4-dioxane concentrations exceed 85 ug/l.

In addition, the current distribution of the Unit E plume demonstrates that vertical, longitudinal and transverse dispersion of the plume is occurring.

Sorption of 1,4-dioxane onto soil is also occurring at the site, but given the low portioning coefficients for 1,4-dioxane, sorption is not expected to influence the Unit E plume as much as other physical processes such as dispersion and dilution. Retardation factors derived from column tests and from field-derived estimates range from 1 to 1.6 (Priddle and Jackson, 1991).

Although PLS has not specifically studied the effects of biodegradation at the PLS site, this well documented process is certainly occurring. As discussed in Section 1.4.1 (Environmental Characteristics) of this Feasibility Study, the aqueous aerobic half-life of 1,4-dioxane is estimated between 672 and 4,320 hours (28 and 180 days), based on data using unacclimated aerobic aqueous screening test data (Sasaki 1978; Kawasaki 1980; Howard et al. 1991). The aqueous anaerobic half-life of 1,4-dioxane is estimated to be between 2,688 and 17,280 hours (112 and 720 days), based onestimated aqueous aerobic biodegradation half-life (Howard et al. 1991).

(i) It has been demonstrated that there will be no adverse impact on the environment as the result of migration of the hazardous substances during the remedial action, except for that part of the aquifer specified in and approved by the department in the remedial action plan.

The area for which a waiver is sought is shown on the attached Figure 11. The waiver area includes the existing Unit E plume as shown on the map, plus the corridor ahead of the plume delineated with dashed lines. For a waiver for Alternative 6 with interim response, the inside dashed lines (light green) show the area of Unit E covered ahead of the plume.

The environmental impacts of all of the reviewed alternatives for remediation of Unit E have been discussed in Sections 5 and 6 of the Feasibility Study. The impacts associated with the proposed alternative, which includes interim response, are discussed this Section in general and in Section 7.22 (c) in particular. The groundwater model documentation attached as Appendix C shows that with interim response, there should be no environmental impacts outside of the zone identified in Figure 11, for which a waiver is sought. This is a conservative model and it is likely the actual zone of influence will prove to be smaller.

(ii) The remedial action includes enforceable land use restrictions or other institutional controls necessary to prevent unacceptable risk from exposure to the hazardous substances, as defined by the cleanup criteria approved as part of the remedial action plan

PLS had hoped that the City of Ann Arbor would agree to adopt an ordinance that would track the model ordinance described by the MDEQ guidance documents. But in light of the City's recent decision to file a lawsuit against PLS, that option is not currently being actively pursued.

A combination of existing ordinances and other institutional controls, such as court order, can, however, be implemented to accomplish the statutorily mandated objective for institutional controls that prevent unacceptable exposure. The following ordinances are already in place that control drinking water exposure in the zone that needs to be protected:

Washtenaw County Rules and Regulations for the Protection of Groundwater, adopted February 4, 2004, Res. No. 04-0029 (Appendix F), reliably restricts the installation of new water supply wells in the zone of protection. Under those rules and regulations: (1) no one can construct or drill any well (including a drinking water well) without first obtaining a permit from the County Health Office (Sec. 2:1); (2) no municipality within the county may issue a building permit where a well is necessary or allow construction to commence on any land where an approved public or private water supply is not available until issuance of a permit by the Health Officer (Sec. 2:4); (3) no permit can be issued by the Health Officer if it is not in compliance with the Rules or if it would create a dangerous or unsafe condition (Sec. 2:5); (4) it is unlawful for any person to occupy or permit to be occupied any premise in Washtenaw County not equipped with an adequate supply of potable water as determined by the Health Officer (Sec. 6:1); (5) the rules apply to all non-community and private groundwater supplies within Washtenaw County (Sec. 6:2); (6) water supplies intended for human consumption that are not "potable" must either be abandoned, identified at the outlet as unfit for human consumption, or treated by methods approved by MDEQ or the County Health Officer so as to make the water potable; (7) newly drilled wells cannot be used for human consumption until approved by the Health Officer and after it has been tested for bacteriological or chemical contaminants (Sec. 6:6); and (8) no well can be located within at least 100 feet from a source of contamination, or at such increased distance as determined necessary by the Health Officer (Sec. 6:7). "Potable" water is defined, as water that is free of contaminants in concentrations that may cause disease or harmful physiological effects, is safe for human consumption and meets the State drinking water standards set forth in the Michigan Safe Drinking Water Act.

Under the existing County ordinance, unacceptable exposures would be prohibited within the zone subject to the waiver, and indeed throughout the rest of the County. Wells could not be installed within the zone because it would be a "new well" that would require a permit and no permit could be issued because the water would not meet the definition of potable, the isolation requirements could not be met, and the wells could not be used until tested. Any additional statutory requirements that are not addressed by the ordinance can be addressed by appropriate stipulated order of the court. For example, PLS would stipulate to an order requiring PLS to carefully monitor the existing County ordinance and to notify the MDEQ of any amendments, in order to meet the notice requirement of MCL 324.20120(5).

CHAPTER 8 – CONCLUSIONS

This Feasibility Study has systematically evaluated all identified alternatives for a comprehensive response to the Unit E contamination. Eight remedial alternatives survived initial screening and were evaluated in detail. Twelve primary and secondary Rule 530 (5) criteria were considered in the detailed evaluation of each alternative. Each alternative was evaluated with respect to these criteria.

PLS has weighed the advantages and disadvantages of the remedial alternatives and interim response options detailed in Chapters 5 and 6 and has selected Alternative 6 "Groundwater Pumping – Active Remediation and Treatment Proximate to Huron River" coupled with interim response at Maple Village and near the PLS facility as the preferred remedial alternative.

All seven of the surviving alternatives were judged to be equally protective of the public health and the environment. All assure that receptors are not exposed to 1,4-dioxane levels in excess of allowable criteria. The only differences between alternatives from this standpoint do not appear to be material. The five "leading edge" alternatives (all but 2 and 6) would by design prevent expansion of areas of contamination above drinking water criterion. Alternative 2 would not, by design, contain the plume at all, while Alternative 6 would contain the plume as necessary prior to any potential impact on downgradient receptors. These distinctions make little or no practical difference in terms of protection of public health and the environment. Under any alternative, no one would actually be consuming groundwater contaminated with 1,4-dioxane. Over time roughly the same area of Unit E would contain detectable levels of 1,4-dioxane (no matter which alternative is selected) because, by design, even the "leading edge" alternatives do not capture all of the 1,4-dioxane. Finally, it is not possible to quantify the difference in area inside a "leading edge" containment alternative versus alternatives 2 and 6. This is because all of the leading edge alternatives are subject to significant uncertainty (in timeliness) because of access and other practical implementation issues.

All of the alternatives are extremely expensive. The least expensive alternative is monitored attenuation (Alternative 2). PLS has not selected that alternative because it does not have sufficient indication that the alternative would enjoy any public support, much less the public support necessary for successful adoption of institutional controls. PLS does not believe it is appropriate to recommend Alternative 2 at this time, although if public support develops for this alternative, it may become viable at a later time. With respect to the remaining alternatives, deep well injection is the second least costly alternative. This alternative, however, also involves construction of a lengthy pipeline and there is also some uncertainty as to whether adequate injection capacity exists in the Mt. Simon formation. The remaining alternatives are all extremely expensive, but otherwise comparable in overall costs.

The five "leading edge" alternatives all face significant timing, construction and implementation issues. Because of the current location of the leading edge of the plume, each of these alternatives would necessarily include the installation of lengthy transmission pipelines. The equally lengthy construction horizon for these alternatives (after obtaining necessary access) and the continued migration of the plume calls into question the practical feasibility of these alternatives. At a minimum, the goal of capturing the leading edge of the plume would be compromised because the recovery wells would have to be placed well downgradient of the current leading edge to ensure that capture could be still achieved when the infrastructure became available. Otherwise, the continued expansion of the plume would require PLS to reconfigure and relocate the groundwater recovery infrastructure to respond to the new shape of the plume.

The Unit E reinjection options (3c and 4b) suffer from significant technical challenges. Injection of the volumes needed to contain the plume near Maple Road may not be possible if the objective is to control the plume. Injection back at the PLS facility will create significant uncertainty in terms of containment and may also force contaminated water back into shallower aquifers that are covered under the Washtenaw County Circuit Court's 5 year plan. Also, any Unit E reinjection option will require pretreatment. Although ozone-hydrogen peroxide is a strong candidate for ex-situ treatment generally, it is a weaker option for injection strategies because there will be the need to control the formation of bromate. UV-hydrogen peroxide does not have this drawback, but reliance on that technology greatly increases remediation costs (see Appendices).

Although a deep injection well is a possibility, the former deep well at PLS had far less capacity than what would be needed for capturing the leading edge of unit E and additional study will be needed to ascertain whether the deep formations can actually accept the required volumes.

Finally, alternatives 3a, 3c, 3d, 4a, 4c and 5 all have the same drawback. Each would cause a significant disruption to neighborhoods, streets and parks. Each would also involve using property in a way inconsistent with current and surrounding zoning. Alternatives 4a and 4c would require a significant treatment system to be constructed in an area that is otherwise inconsistent with such land use. The residents in neighborhoods where monitoring and purge wells have already been installed have legitimately questioned those intrusions in light of the apparent lack of environmental benefit. All of the "leading edge" alternatives multiply this concern by orders of magnitude. PLS views this is an important public welfare consideration.

Alternative 6 avoids the drawbacks of the other alternatives. It is superior to alternatives 3c, 4c and 5 because it avoids the problems associated with reinjection. It is superior to alternatives 3a, 3c and 4a because it would involve less pipeline. It is superior to all of the "leading edge" alternatives because it does not have a drastic impact on public welfare, residential or recreational uses. When coupled with an interim response such as that suggested by PLS in the FS, this alternative actively remediates groundwater, provides an added level of safety and reduced risk to exposure of potential receptors, and reduces the mass of 1,4-dioxane migrating toward the Huron River. For these reasons, PLS recommends this alternative.

CHAPTER 9 - REFERENCES

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