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31 August 2004

Ms. Sybil Kolon
Michigan Department of Environmental Quality
Remediation and Redevelopment Division
301 East Louis Glick Highway
Jackson, MI 49201

RE: Response to Feasibility Study Review Comments
Gelman Sciences Site
Ann Arbor, Michigan

W.O. 20083.054.001

Dear Ms. Kolon:

Weston Solutions of Michigan, Inc. (WESTON) conducted a review of the Feasibility Study (FS) prepared by Pall Life Sciences (PLS) for their facility known as the Gelman Sciences Site in Ann Arbor, Michigan. WESTON conducted this work under State of Michigan Level of Effort (LOE) Contract No. 2002. Due to the long history and vast amount of data generated for the site and short time frame, WESTON's review focused only on the information provided in the FS. The review was conducted for the Michigan Department of Environmental Quality (MDEQ) and included a cost estimate for the MDEQ preferred remedial alternative. The review and cost estimate was submitted by letter on 14 July 2004.

PLS responded to the WESTON work on 17 August 2004. This response consisted of four emails and also addressed the July 2004 MDEQ Fact Sheet. Specifically, the emails contained:

- Summary Comments.
- Appendix A – Comments on MDEQ's review of the FS.
- Appendix B – Comments on WESTON's review of the FS and the cost estimate for the MDEQ alternative.
- Isoconcentration maps.
- Groundwater model.

The MDEQ and WESTON discussed these comments on 20 August 2004. Based on these discussions, WESTON has reviewed Sections II B, V, and Appendix B of the Summary Comments. The review and supporting documentation for Sections II B and V are provided in Attachment A. WESTON also responded to some of the PLS comments on the WESTON FS review (Appendix B of the PLS Summary Comments), when appropriate. These responses are provided in Attachment B.

WESTON appreciates the opportunity to provide continued professional services to the MDEQ for the Gelman Sciences Site. Should you have any questions or require additional information regarding this submittal, please feel free to call me at 517-381-5955.

Very truly yours,

WESTON SOLUTIONS OF MICHIGAN, INC

Michael A. Pozniak, C.P.G
Project Manager

For Robert C. Hunt
Program Manager

Attachments

ATTACHMENT A

RESPONSE TO SUMMARY COMMENTS
GELMAN SCIENCES SITE
ANN ARBOR, MICHIGAN

1 PIPELINES

MDEQ's proposed alternative includes the construction of the following pipeline system components:

- Gathering pipeline system to transport recovered groundwater from the Wagner Road to the existing treatment system located at the PLS facility.
- Gathering pipeline system to transport recovered groundwater from the Maple Road and leading edge areas to the proposed treatment system located at the Maple Road commercial area.
- A discharge pipeline component to transport the treated water from the Maple Road area treatment system to the Huron River.

PLS comments that MDEQ does not consider the degree of disruption to the surrounding community that would occur, and the significant right-of-way/access issues that would be encountered during the construction of the pipeline network included in their proposed alternative.

Based on review of the data provided by PLS in the FS, MDEQ concluded that groundwater extraction at the leading edge would not be as protective of human health, safety and welfare, and the environment as it would be in combination with interim responses that include groundwater extraction at the Wagner Road and Maple Road areas. The overall clean-up time would be reduced, and the potential for human exposure and other impacts resulting from uncertainties associated with subsurface conditions would be additionally limited by the recovery of impacted groundwater in these upgradient areas.

MDEQ recognizes that the difficulties associated with the construction of the proposed pipeline systems are significant, and acknowledges the potential issues associated with the

remedial alternatives that also include pipeline systems as detailed by PLS in the FS. However, at this time construction of the pipelines most likely provides the most effective method of achieving the remedial objectives, if not the only feasible method of those proposed by PLS. As indicated by MDEQ, the pathways for the proposed pipelines are preliminary at this time. The full extent of the difficulties that will be encountered during the construction of the pipelines along the final pathway can only be determined as the design of the proposed alternative is refined.

MDEQ estimates that while pipeline construction activities would likely be disruptive to the community, this most likely would be a relatively short term inconvenience especially when compared to the 10 to 20 year period of operation of the system and the benefits associated with its operation. As pointed out by MDEQ, the PLS preferred alternative will also result in disruption to the surrounding community with the installation of additional monitoring wells to monitor the plume status and the installation and operation of extraction and injection wells for the interim recovery operations in the Maple Village area.

In addition, it is anticipated that the required construction activities for installation of the proposed pipeline systems could include standard engineering and construction practices that have been developed to attempt to minimize disruptions. For example, MDEQ indicates that horizontal boring of pipelines is an available method that might be appropriate for areas where the minimization of disruption to the surrounding area is more critical. Further development of the MDEQ proposed alternative would be required to specify those areas and determine if this or any other pipeline construction method is technically appropriate for the site conditions in those areas.

PLS's comments that the proposed pipeline construction activities are not feasible or legally enforceable are somewhat premature at this time considering that the MDEQ proposed pathway is preliminary and the affected properties are not specified. In addition, because the design of MDEQ's proposed alternative is only conceptual, a time frame for the pipeline construction phase of the project can not be estimated. The scope of the proposed project suggests that the construction period might be significant. However, even if the construction

period is "years" as PLS suggests, this time frame may be reasonable relative to the total period of operation of the system, the benefits incurred with its operation, and estimated impacts, or lack of effectiveness, of other proposed alternatives.

2 TREATMENT SYSTEM

PLS comments that the installation and operation of an ozone/hydrogen peroxide (O_3/H_2O_2) treatment system proposed by MDEQ at the Maple Road location "is infeasible primarily because of two factors: a) the significant health and safety issues associated with liquid oxygen; and b) simply the physical size of the system." In support of their comment, PLS provides information detailing the existing ultraviolet/hydrogen peroxide (UV/H_2O_2) treatment system currently operating at the PLS facility. This information includes the dimensions of the building that houses the system, the approximate volume requirements of chemicals required for system operation, the approximate electrical requirements, and the fact that two equalization ponds are required to ensure continuous operation and compliance with discharge requirements.

As stated in the most recent MDEQ Fact Sheet, the proposed remedial alternative includes the installation and operation of an O_3/H_2O_2 treatment system at Maple Road to treat groundwater recovered from two areas: Maple Road and the leading edge of the affected groundwater plume. Groundwater will be recovered at approximately 500 gallons per minute (gpm) from wells installed in the Maple Road area and 650 gpm from the leading edge wells. An estimated concentration of 1,200 micrograms per liter (ug/L) of 1,4-dioxane was assumed for groundwater recovered from the Maple Road area wells. This concentration was based on the estimated 1,4-dioxane plume map provided by PLS in the FS. An estimated concentration of 85 ug/L of 1,4-dioxane was assumed for groundwater recovered from the leading edge wells. The proposed alternative assumed that the recovered groundwater from the two areas would be combined along the pipelines that transport the groundwater to the treatment system. Based on these assumptions, WESTON obtained preliminary, conceptual information from Applied Process Technologies, Inc. (APT) regarding their O_3/H_2O_2 treatment system products to treat a combined groundwater stream with an approximate 1,4-dioxane concentration of 570 ug/L at an approximate rate of 1,150 gpm.

In their comments, PLS compares the UV/H_2O_2 system currently in operation at their facility with the O_3/H_2O_2 system included as part of MDEQ's proposed alternative. This information was not provided in the FS with regards to PLS' proposed remedial alternatives that included installation and operation of a treatment systems (both O_3/H_2O_2 and UV/H_2O_2) at the Maple Road area. This comparison may not be as direct as PLS suggests for several reasons including:

- The two systems utilize different treatment processes with different treatment system operational requirements.
- WESTON understands PLS constructed this single UV/H_2O_2 system for use at their Ann Arbor, Michigan facility only. APT manufactures many O_3/H_2O_2 packaged systems for installation and operation at a variety of sites and clients.
- The O_3/H_2O_2 system currently in operation at the PLS facility treats groundwater recovered from closer to the plume source area. The groundwater currently treated by PLS' O_3/H_2O_2 system may contain a higher concentration of 1,4-dioxane than that estimated for the proposed combined groundwater stream from the Maple Road and leading edge areas.

Health and Safety Issues

Potential health and safety issues are associated with the use, storage and transportation of liquid oxygen which would be required by the O_3/H_2O_2 system included in MDEQ's proposed alternative. However, these concerns can be sufficiently and successfully managed and controlled by securing the site and following proper liquid oxygen handling procedures. Measures to secure the site include, but are not limited to, securing the units that house the treatment unit components, fencing of the entire treatment unit area, and posting of guard at the facility.

An alternative to use of liquid oxygen is the on-site generation of ozone. This would eliminate the potential hazards associated with the handling, use and storage of liquid oxygen. PLS comments that it would not be technically feasible to generate enough oxygen with an on-site oxygen generator to reliably treat 1,150 gpm. However, APT indicates that the on-site generation of oxygen is technically feasible, but should only be considered if there are barriers to the use of liquid oxygen, including use, handling, or storage issues or

abnormally high liquid oxygen prices. Both the capital and operation costs of on-site oxygen generation are most likely significantly greater than those associated with utilizing liquid oxygen stored on-site as the oxygen source.

PLS estimates that the MDEQ proposed treatment system would require 40,000 cubic feet per day (cfd) of liquid oxygen per day; however, APT estimates the actual oxygen flow requirements for the proposed O_3/H_2O_2 at about 30,000 cfd of oxygen gas. APT further calculated that approximately 250 gallons of liquid oxygen would be needed for the oxygen gas generation. This rate of liquid oxygen use would indicate that one delivery every three to four weeks would be required, depending on the actual size of the on-site the liquid oxygen storage tank.

Chemical Supply Requirements

PLS also indicated that they receive shipments of sulfuric acid, sodium bisulfate, caustic and hydrogen peroxide via truck every three to four days in 20-ton lots for use by the existing UV/H_2O_2 treatment system. APT indicates that their O_3/H_2O_2 system has only two additional consumables besides oxygen: hydrogen peroxide and electric power. The hydrogen peroxide use rate for the proposed system is estimated to be about 35 gallons per day (assuming 35% hydrogen peroxide solution). In addition, the on-site hydrogen peroxide storage tank for the estimated system could be sized for the same three to four week delivery rate as the liquid oxygen.

The sulfuric acid required by PLS's existing UV/H_2O_2 unit is most likely used to lower pH of the influent water to the system to help their overall economics, and the sodium bi-sulfate is used to neutralize residual hydrogen peroxide. APT indicates that the O_3/H_2O_2 system does not require pH adjustment. In addition, APT estimates that effluent from their O_3/H_2O_2 system has a much lower residual hydrogen peroxide than that from a comparable UV/H_2O_2 system. APT suggests that the low level of hydrogen peroxide residual in the O_3/H_2O_2 system can be handled if necessary with a granulated activated carbon (GAC) bed following the O_3/H_2O_2 system to act as a catalyst for hydrogen peroxide decomposition. The GAC is not consumed in this process so there is no operating cost to consider. However, the capital

costs for a carbon bed were not included in the capital cost estimates for the O_3/H_2O_2 system included in MDEQ's proposed alternative.

System Size

As PLS points out in their comments, the FS significantly understated issues associated with the installation and operation of a system at this location that would be large enough to treat the volume of groundwater needed to capture the leading edge of the plume. However, the MDEQ proposed alternative was in part based on details of PLS's proposed alternatives including the fact that PLS assumed that a treatment system located at the Maple Road location was feasible. MDEQ's proposal assumed that the large scale retail space located on Maple Road was a feasible location for the treatment system.

Based on additional information provided by APT, more specific space requirements for a conceptual O_3/H_2O_2 treatment system that would meet the needs of MDEQ's proposed alternative include:

- One 40 feet (ft) x 8 ft x 9 ft modified shipping container unit to house hydraulic components of the packaged system,
- A second 40 ft x 8 ft x 9 ft modified shipping container unit to house the supply equipment (hydrogen peroxide tank and pump, control panel, etc.).
- One large liquid oxygen storage tank (estimated size: 5 ft diameter by 15 ft high) with accompany vaporizers.
- Sufficient ground space for trucks to deliver liquid oxygen to on-site liquid oxygen storage tank.
- Additional ground space to secure system (fencing, guard shack).

Additional space may be required to provide capacity to accommodate variations in the system operation. However, based on information detailed below these additional space requirements most likely would not include equalization ponds as suggested by PLS.

3 PONDS

PLS comments that a treatment system sized to accomplish MDEQ's proposed remedial objectives would required the construction of influent and effluent equalization ponds at the Maple Road area, and that these ponds would be a size comparable to or at least half the capacity of the influent and effluent equalization ponds (each 1,000,000 gallon capacity) required for the UV/H_2O_2 treatment system PLS currently operates. These ponds significantly increase the area needed for the treatment system. Based on experience with their existing UV/H_2O_2 system, PLS indicates these ponds are also necessary to meet the technical challenges associated with operating the system proposed by MDEQ for the following reasons:

- The influent and effluent equalization ponds are necessary so that the iron can be precipitated from the recovered groundwater prior to and following treatment. This prevents the build-up in piping of iron which readily precipitates from groundwater treated by PLS UV/H_2O_2 system.
- The ponds are necessary to maintain the steady rate of water through the system needed to avoid constantly readjusting the calibration of the PLS UV/H_2O_2 system and to ensure that discharge requirements are met prior to discharge.
- An influent pond would be necessary with MDEQ's proposed system so that composition of groundwater that is recovered from multiple locations with potentially varying concentrations and water chemistry could equalize.
- If the performance objective is to capture the entire width of the plume, the additional storage capacity provided by the ponds is necessary to allow for continuous recovery during maintenance of the treatment system.

Based on the limited data on the quality of the influent groundwater (data related to iron content, or other characteristics, of area groundwater was not provided in the FS), it is not likely that an equalization influent pond for the precipitation of iron prior to treatment is necessary for the proposed O_3/H_2O_2 treatment system. Although APT has not treated groundwater with extremely high iron content, they have successfully treated groundwater with iron contents in the range of 15 to 20 milligram per liter (mg/L) utilizing their O_3/H_2O_2 treatment system without problems with the iron precipitation. APT believes that UV/H_2O_2 treatment processes are more susceptible to performance problems related to iron

precipitation since they depend on the optical quality of the water, where their O_3/H_2O_2 treatment system process is an aqueous phase chemical reaction not dependent on water clarity.

From the information provided by APT, it is the UV/H_2O_2 treatment process that causes the iron to precipitate. Iron precipitation should not occur with O_3/H_2O_2 treatment, provided that the concentrations of iron are not extremely high. Also, PLS comments indicate that they currently precipitate iron in both the influent and effluent equalization ponds to ensure iron removal. PLS suggested that for the MDEQ system, in the absence of iron precipitation, pigging of the **discharge** lines to the river **only** would be required (not influent lines from the wells to the treatment system). PLS does not indicate that precipitation of iron or calcium in the current PLS gathering system components is a problem. WESTON does not have supporting water chemistry data or information from PLS stating that iron or calcium scaling is a potential problem, except for water that is treated by their system.

The influent groundwater for MDEQ's proposed system will be derived from two source areas. Based on the information provided in the FS, the conceptual design of the proposed treatment system assumed 1,4-dioxane concentrations of 1,200 ug/L and 85 ug/L for groundwater recovered from the Maple Road and leading edge areas, respectively. No other data related to the water chemistry of the groundwater in these areas were provided in the FS. The conceptual design of MDEQ's proposed alternative assumes the groundwater from the two areas will be combined in the gathering pipelines upstream of the treatment system. While some mixing of the two streams will likely occur in this process, it may not be complete. In addition, while the MDEQ's proposed alternative also assumes continuous contribution from both streams, variations in the influent concentration and flow rate may occur.

MDEQ's conceptual design did not include the level of detail to consider variations in either the composition or flow rate of the influent stream to the O_3/H_2O_2 treatment system. However, as a more refined system design is developed prior to implementation of MDEQ's

alternative, the following system components and requirements might be considered to handle variations in the influent stream:

- Supply the O_3/H_2O_2 treatment system with a small influent equalization tank (with a residence time on the scale of a few to several minutes) that would allow the streams to mix. This tank may add to the treatment system space requirements.

- Operate the O_3/H_2O_2 treatment system to treat the entire stream as if it were the highest concentration stream (in this case, 1200 ug/L). This provides a simple and safe solution, but increases the operating cost.

- Add interlocks so that if the low concentration stream is not flowing, the system shuts down so that the more highly contaminated stream is not under-treated. The system can be restarted when the less contaminated stream is brought back on line, or the system can be re-tuned to treat highly contaminated water.

While the discharge requirements/restrictions for the system will likely be significant, they were also not considered in development of MDEQ's conceptual system design. However, at this stage of the design process, it does not seem likely that the discharge requirements necessitate the need for equalization ponds. APT's estimated downtime associated with normal operation and maintenance issues of the proposed system is very limited (approximately 2 to 5% over a period of continuous operation) based on past experience with operation of their O_3/H_2O_2 treatment systems. Therefore, it does not seem likely that either influent or effluent equalization ponds would be required to account for variations in effluent conditions resulting from the limited predicted downtime associated with normal system operation and maintenance issues. APT did indicate that the predicted downtime applied to operation of the system after its start-up period and did not account for potential system failures (i.e., equipment component failure, power outages). However, in the event of such a failure, groundwater recovery operations could be discontinued until the treatment system is on-line without significant consequence because of the relatively slow rate of contaminant migration along with groundwater flow.

If it is necessary to provide additional assurance that the treatment system is operated on a continuous basis, additional system components might be considered. For example, a component of the O_3/H_2O_2 treatment system with a long lead time is the ozone generator. One option to provide additional assurance of continuous operation is to incorporate

redundant ozone generators in the system. If the system includes three 50% sized ozone generators, the system could still run at 100% capacity while a unit that has failed is being repaired. These potential system design details and variations were not considered in MDEQ's proposed alternative. However, the space requirements are much less than those for the equalization ponds that PLS suggests are necessary.

4 FOOTPRINT

PLS comments that the treatment system for MDEQ's proposed alternative would be far too large to place on the suggested commercial property which is located in the vicinity of Maple Road. However, PLS estimates of the space requirements for the O_3/H_2O_2 system were based upon the space required for operation of their UV/H_2O_2 system. As indicated above, the preliminary design of MDEQ's proposed system does not indicate the need for either influent or effluent equalization ponds which significantly decreases the space requirements. Therefore, the Maple Road commercial property remains a location option for the MDEQ's proposed system.

V. Weston Cost Analysis

The cost estimate WESTON generated for the MDEQ alternative was completed on an expedited schedule, resulting on a reliance on information provided in the FS prepared by PLS, analysis of the costs used by PLS in the FS, and vendors (when possible). This reliance on outside sources is not an indication that "WESTON did not have sufficient time to learn the first thing about this site or the treatment technologies being contemplated". In fact, it appears that it is PLS that has confused the resources needed for their on-site UV/H_2O_2 treatment system with those needed for the O_3/H_2O_2 system proposed by MDEQ (see discussion above and supporting documentation from APT). Note that PLS has stated that they have consulted with APT concerning their O_3/H_2O_2 technology (see page 1 of PLS' Summary Comments).

WESTON learned during a 13 August 2004 conference call with PLS and the MDEQ that proposed wells would be located off the PLS property. WESTON will correct this. Note that

WESTON rounded the final costs to the nearest million dollars because of the uncertainties associated with the cost estimate.

Comment 1: "No capital or O & M costs were included by Weston for Wagner Road portion of DEQ's proposal. According to Weston, this was excluded intentionally."

The MDEQ asked WESTON to assume that pumping from Aquifer E would not increase the total capacity above the discharge permit level of 1,300 gpm. This could be accomplished since the system is not currently being used at capacity. Since this was within the design parameters of the current treatment system, MDEQ indicates that O&M costs would be absorbed by operation of the current shallow system. WESTON did add in O&M costs associated with the new wells and piping to be installed (see Table 4 of WESTON's review letter).

WESTON disagrees with the comment that no capital costs were included for the Wagner Road portion of the MDEQ's proposal. A total of $289,900.00 was included for the installation of extraction wells, piping, electrical service, pumping systems, etc. (see Infrastructure in Table 4 of WESTON's review letter). Note that the MDEQ's alternative includes well TW-11, which is already being used, in its configuration of three extraction wells.

During the 13 August 2004 conference call, PLS stated that the assumption to include the O&M costs in the current operations was wrong. The primary objection to including the O&M costs was that the treatment of the shallower aquifers would be completed before aquifer E. WESTON understood this concern and asked PLS to provide an estimation of when the shallower systems will be completed. At this time, WESTON has not been provided this information. To address PLS' concerns, the MDEQ provided an estimation that the shallow treatment will continue for <to be provided> years so the cost estimate could be revised.

Comment 2: "No costs for pipelines were proposed by WESTON for Wagner Road."

WESTON disagrees with this comment as pipeline installation is included in the infrastructure cost (see response to Comment 1). The cost assumes that the two newly-installed wells will be tied into the existing piping used for well TW-11, located furthest from the treatment plant. Concerns regarding the lack of costing for off-site access implicit in this comment have been addressed above.

Comment 3: The PLS comments questions the treatment cost per gallon, general costs for a treatment system which they believe has a larger footprint, and lack of system maintenance costs.

WESTON has attached email correspondence from APT which documents the treatment cost used in the WESTON proposal. With respect to the general costs for the treatment system, WESTON has addressed many of these issues in responses to Section II B of the Summary Comments. The response disputes assumptions that PLS has made for the MDEQ's proposed O_3/H_2O_2 based on their current operation of UV/H_2O_2 unit. Information obtained from APT documenting the O_3/H_2O_2 treatment system requirements is attached.

WESTON has discussed system maintenance with APT. According to APT, minor (if any) maintenance would be needed on the system. Thus, WESTON figured that the contingency for the O&M of the Maple Road and Leading edge cost estimates would be sufficient for system maintenance.

Comment 4: "WESTON inadvertently dropped 10 years of treatment costs at Maple Village"

This comment is correct and will be addressed in the revised cost estimate.

Comment 5: "No staff costs were included by WESTON."

This comment is correct and will be addressed in the revised cost.

Comment 6: "The estimate for Maple Village includes nothing for property access for the treatment system. The cost estimates assume that the access for the 25,500 feet of pipeline would be free (no cost provided)."

WESTON disputes these comments, as access fees for both the treatment system and the pipeline are provided in the Access Fees Sections of Tables 5 and 6 of the 14 July 2004 letter.

CONCLUSIONS:

PLS discounts the MDEQ alternative because they believe it is not feasible to continuously operate an oxygen generator-based system of the required size. They have projected the size and material usage of the MDEQ's proposed O_3/H_2O_2 system based on their operation of the Wagner Road UV/H_2O_2 unit. Information obtained from APT concerning operation of a O_3/H_2O_2 system and discussed throughout this document disputes the assumptions that PLS has extrapolated from their UV/H_2O_2 system

PLS stated that the use of a 7% discount factor "is not based on any MDEQ or United States Environmental Protection Agency (U.S. EPA) guidance, applies an inordinately high discount factor, and, incredibly, fails to account for inflation at all". WESTON disputes this comment in that the following U.S. EPA guidance was used:

- OSWER Directive No. 9355.3.20 – June 25, 1993. This memorandum explains that EPA policy has been changed to 7% in order to be consistent with the 1992 revisions to Circular A-94, issued by the Office of Management and Budget. From 1972 to 1992, a discount rate of 10% was used.

Further, the U.S. EPA considers the 7% discount rate a "real" discount rate. As such, it "approximates the marginal pretax rate of return on an average investment in the private sector in recent years and has been adjusted to eliminate the effect of inflation. Therefore,

this rate should be used with "constant" or "real" dollars that have not been adjusted for inflation" (Section 4.4, U.S. EPA, July 2000). Thus, the inflation factor used to determine the present worth for the PLS alternative will be removed.

PLS commented that its actual costs for liquid oxygen have increased over time from $0.91 to $1.43 per 1000 gallons. As a result, PLS suggests that this increase is due to inflation and that the MDEQ costs should be adjusted to account for inflation. However, it is important to note that in the FS, PLS only presents current costs and that the tables contain the caveat that "Costs are based on current (2004) U.S. Dollars. No adjustments have been made to account for inflation.".

WESTON has modified the cost estimate for the MDEQ alternative to reflect information arising from discussions in the conference call with PLS and MDEQ and PLS' written comments. The new costs reflect corrections based on changes in some of the assumptions (i.e., no access fee for Wagner Road, omissions (i.e., system O&M) and inclusion or deletion of various line items(i.e., combining treatment costs for Maple Road). As a result, some costs increase and others decrease. WESTON will submit the modified cost estimates to the MDEQ.

REFERENCES:

U.S. EPA. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002, OSWER 9355.0-75. July 2000

ATTACHMENT B

RESPONSE TO PLS COMMENTS
WESTON "REVIEW OF FEASIBILITY STUDY"
GELMAN SCIENCES SITE
ANN ARBOR, WASHTENAW COUNTY, MICHIGAN

INTRODUCTION

Weston Solutions of Michigan, Inc. (WESTON) provides the Michigan Department of Environmental Quality (MDEQ) with the following responses to comments that were submitted by Pall Life Sciences (PLS) on 17 August 2004. WESTON had provided MDEQ with the first set of comments on 14 July 2004 to the *Feasibility Study and Proposed Interim Response Plan for the Unit E Plume* (FS, dated 2 June 2004), which had been prepared by PLS for the Gelman Sciences Site in Ann Arbor, Washtenaw County, Michigan. WESTON has responded to the most relevant comments raised by PLS. Because of the necessarily complex train of comment and response incorporated herein, WESTON has briefly summarized the relevant PLS comments (in *italics*) and for clarity, has inserted references [e.g., to the previous WESTON comment] into the PLS comment.

PLS Comment in response to WESTON comment on Executive Summary of FS

WESTON provided very little explanation for [not concurring with the] conclusion [that the plume does not present an imminent, current threat to public health, or to the environment]. Accordingly, there does not appear to be a basis for WESTON's lack of concurrence.

WESTON comment was based on the fact that the aquifer that had supplied drinking water to a public water supply well has been contaminated. WESTON notes that the public water supply well had been voluntarily removed from service by the city, but the flow path and rate of migration for that contamination are not defined sufficiently to preclude the possibility that other drinking water wells could be contaminated.

PLS Comment in response to WESTON comments on Chapter 2 of FS

[Weston stated that higher concentrations of 1,4-dioxane have been detected on the PLS property, and that the FS does not provide information to document that these higher concentrations could not migrate away from the source containment system.]

PLS commented that PLS provides comprehensive data on its groundwater monitoring wells to DEQ on a quarterly basis. This data shows that there is only one monitoring well on site where concentrations have been detected above 2300 ppb of 1,4-dioxane, and that well is indisputably within the capture zone of an operating purge well. The only other wells on-site with concentrations higher than 2300 ppb are purge wells. This contamination is being extracted and will not be available for future migration at those elevated levels. Under PLS's plan, an additional purge well may also be installed to further halt migration of contaminated groundwater. PLS, therefore, believes that WESTON's statement is not justified.

WESTON notes that this comment from PLS provides the information that was requested in the original comment and that PLS could have provided summary data and maps from the quarterly reports to support these conclusions in the FS. However, the FS and conversations with the MDEQ seem to dispute the comment, indicating that more information is needed in this area. The FS indicates "PLS will undertake an investigation of groundwater quality within the plume in the area bounded by Wagner Road, Dolph Park, and the PLS property to determine if 1,4-dioxane concentrations in this area are high enough to prevent the Maple Road response measures discussed below from effectively protecting potential receptors." This is supported by data generated during recent PLS work. According to the MDEQ, as communicated to WESTON in telephone conversations on 20 and 30 August 2004, groundwater samples collected from location TW-17 contained 7,800 ug/L of 1,4-dioxane at a depth of 150 feet below ground surface (bgs) and 4,800 ug/L of 1,4-dioxane at 160 feet bgs. An extraction well has since been installed at this location to capture this contamination.

PLS Comments to WESTON comments on Chapter 3 – Identification and Screening of Remedial Technologies (Process Options)

[WESTON commented that the FS did not indicate whether the data on in-situ treatment had been provided to DEQ, or whether the results have been reviewed and approved. WESTON commented that because all six in-situ options have been screened out, the language on pages 20 and 21 should be revised.]

PLS agreed that that all six [in-situ] options had been screened out. The data had just come in at the time the FS was being finalized, which explains the discrepancy with page 20. The discussion of the remedial option in 3.3.6 makes it clear that the technology was not found effective at the present time. The FS does not require revision. PLS does not understand the comment about the FS not indicating the manner in which data were provided to DEQ or whether the results have been reviewed or approved. This information was provided electronically to DEQ as requested by them. The results of the study were not offered for approval by DEQ because it was only a study, and not a successful one that did not require approval of data. PLS assumes DEQ has reviewed the information and WESTON could have cleared this up with them if it was a significant concern. In any event, PLS has agreed to submit a narrative report on this subject by September 1, 2004.

WESTON notes that the PLS comment clarifies the text of the FS and that the information that should have been included in the FS for clarity and completeness will be available in the near future.

PLS Comment

[WESTON commented that additional investigation was needed downgradient of the currently known limits of the plume to provide information to all the alternatives.]

PLS asked why the downgradient investigation needed to be completed for options that involve capturing the plume. The downgradient characteristics become only marginally relevant, and in any event would be covered by performance monitoring wells for the other options. In the

abstract it is always easy to say that more information is better than a little, but in the case of other alternatives, there is no need for the detailed investigation downgradient called for with the non-capture alternatives reviewed in the FS.

WESTON does not believe that the downgradient characteristics are only marginally relevant to capturing the plume because those characteristics must be understood in order to show that the downgradient edges of the plume are in fact captured. WESTON does not believe that the rate and direction of groundwater flow or the hydrogeologic characteristics of the aquifer have been described adequately to ensure that any capture system is effective.

PLS Comment

[WESTON agreed that constructing a transmission pipeline back to the Wagner Road facility under I-94 would be a significant physical obstacle and commented that the FS should evaluate alternative routes for the discharge of water to the river that would avoid crossing the Interstate.]

PLS commented that lengthy pipelines, no matter what the routes, present similar extensive challenges and obstacles that do not differ in significant degree in terms of feasibility. This is primarily a function of access, road closures, in-road utilities, and timing. These are the factors that make pipelines as a whole less attractive. The added difficulty to cross I-94 to bring water back to PLS's Wagner Road facility is not a disqualifying factor. Moreover, given the benefits of housing the treatment system at an industrial site that already has industrial power feeds, limited access, and isolation from other uses, it would not have been prudent to eliminate a pipeline in that direction. The choice of pipeline to the river along M-14 was selected at the suggestion of the City of Ann Arbor. Other routes are available from the PLS facility, but a detailed evaluation would not have lead to a different conclusion. PLS does not understand the last statement in the quote. I-94 and M-14 lie between the plume and the river until the M-14 bridge, which is in the very heart of Ann Arbor. The only way to avoid crossing the highways would be to build significantly longer pipelines or to go directly through the downtown area. PLS asked what is the basis for the conclusion that the obstacles associated with these options are less significant.

WESTON was commenting that the FS presented only one pipeline route and did not provide justification for that route over any alternatives. The FS describes the obstacles to installing that pipeline, and PLS states that an evaluation of alternate routes would not have lead to a different conclusion. WESTON understands that the purpose of the FS is to consider alternatives and provide justification for the selection of a particular alternative, or set of alternatives. The FS does not provide that information, and the response to the comment appears to indicate that alternate routes were not evaluated.

PLS Comment

[WESTON commented that constructing a pipeline to transmit contaminated groundwater back to the Wagner Road facility is less practical than constructing a similar pipeline along rights-of-way to a treatment unit near Maple Road.]

PLS concluded in its FS that the practicality of construction of lengthy pipelines to handle Unit E water is uncertain. WESTON offers no opinion as to whether any pipeline is a practical solution for remediating the identified problem. As explained in the FS, PLS believes that due to the length of the pipelines involved there will be implementation and access problems and disruption to the community. The Huron River is, however, over 8,000 feet from the Maple Village area if a direct route could be found. All other routes to the river will be longer. That some other unidentified route may in an unspecified way reduce the delays or length of pipeline is not only speculative, but also misleading. Is any scenario that requires installation of nearly miles of pipe appropriate or justifiable when balancing costs and benefits?

WESTON concludes from this comment that PLS has decided that the practicality of construction of lengthy pipelines is not uncertain (as stated in the first sentence), but inappropriate and unjustifiable (as appears to be the point of the last sentence). WESTON understands the purpose of the FS to consider alternatives and provide justification for the selection of a particular alternative, or set of alternatives. The FS does not provide sufficient information on cost and implementability to support the conclusions that are drawn.

PLS Comment

[WESTON noted concerns about transportation, handling, storage and use of chemical oxidants in congested commercial areas would be associated with the IR options that are proposed in Chapter 4of the FS. These challenges appear manageable for the IR and should be equally manageable for Alternative 4.]

PLS commented that WESTON's inference is not justified. The IR consists of using a mobile, 200 gpm capacity system that can fit within the footprint of approximately two semi-trailers. Alternative 4 would require a system approximately several times that size (including adequate areas for spill prevention, materials off loading, etc) and with 3 times the capacity. The larger system would require more raw materials, more frequent product deliveries, more maintenance, and more power than a 200 gpm system. WESTON erroneously concluded that the scale of the systems for the various alternatives would not be relevant.

WESTON notes that the description of the system provided in the comment is more detailed than the one provided for Alternative 4 in the FS.

PLS Comment

[WESTON commented that PLS' experience with the treatment system operation will minimize risks to human health and safety, regardless of the location of the treatment system.]

PLS commented that their competence [in health and safety], however, does not address the issue of whether it is appropriate to locate a large-scale industrial process in the Maple Road area. There is still a question of zoning and public acceptance, particularly where larger systems than PLS's 200 gpm system would require liquid oxygen. And the larger the system, the more raw materials shipments are required and the higher the risks generally with respect to matters outside of PLS's control, such as transportation and delivery. PLS does not understand how this consideration can be disregarded.

WESTON would never disregard an issue that involves health and safety. Rather, WESTON is confident that a competent, experienced company such as PLS can take appropriate measures to protect health and safety when placing a treatment system in a commercial setting. In addition, see WESTON's comments pertaining to the treatment system in Attachment A.

PLS Comment

[In WESTON's opinion, the proposed investigation to determine the fate of the Unit E plume and the potential receptors should be conducted regardless of the selected alternative, so that the fate and transport of 1,4-dioxane can be getter defined and protection of human health and the environment assured.]

PLS disagrees. If the plume were captured at the leading edge and at two other places, as proposed by DEQ, there would be no need to conduct detailed investigations downstream of the leading edge. A performance monitoring system would be in place to assure long-term protection of the public health, safety, welfare and the environment.

The FS did not provide enough information to reliably predict the direction and rate of migration of the plume and, therefore, to assure the protection of human health and the environment. WESTON believes this information is needed to properly locate the extraction wells to capture the leading edge of the plume.

PLS Comment

[WESTON commented that reinjection of treated water downgradient into the plume would require additional investigation and modeling of the effects before WESTON could consider it a viable option.]

PLS commented that WESTON's need for additional information is selective (and biased against PLS's proposed response) and outside of the scope of a FS. While there are technical demonstrations that would be needed for groundwater injection, enough is known about the aquifer so that tentative conclusions can be drawn by PLS and others that reinjection of

approximately 200 gpm of treated groundwater can be considered viable in the Maple Village area. In addition, PLS is submitting a modeling report with these comments that should alleviate WESTON's alleged concerns.

WESTON does not question that injection of treated water is a viable technology. Had PLS provided the modeling report as an appendix to the FS or by reference, WESTON would have been able to evaluate the feasibility of injection in the area of interest.

PLS Comment

[Assuming that the IR action will be operated for 20 years or more, WESTON believes that the costs for this alternative are underestimated.]
PLS provided one year of O&M costs so that different cleanup horizons could be evaluated. At the present time, the cleanup horizons are not known until there is agreement on the level of remediation needed to protect downstream receptors. One year of costs was provided as an example, so reviewers could determine roughly how much it would cost to continue the IR into subsequent years. This was explained in email to DEQ. The costs were not intended to presume that the system would be operated for only one year, as suggested by WESTON.

One of the major deficiencies of the FS was the lack of direct comparison of costs for the different alternatives. WESTON attempted to provide this comparison, but could not find reliable information for the cost assumptions behind each alternative. Therefore, a simplifying assumption was made to facilitate the comparison.

PLS Comments to Section 6.2.2.2 Alternatives 3a, 3c, and 3e – Groundwater Pumping – Pipeline to and Treatment at Wagner Road

[WESTON agrees that constructing a transmission pipeline back to the Wagner Road facility under I-94 would be a significant physical obstacle. This situation provides justification for construction of a treatment unit at Maple Road, described under Alternative 4, where the I-94 would not be an obstacle.]

For the reasons discussed earlier, this observation by WESTON is not of value. Not only does WESTON not account for the difficulty of any pipeline that must extend for miles, the fact is that in order to avoid a pipeline through the heart of Ann Arbor it may well be necessary to cross I-94 or M-14 because that obstacle, formidable as it may be, is less than construction through downtown Ann Arbor. It appears that the real reason WESTON continues to raise I-94 as an obstacle, but not other highway crossings, is purely political. It seems that WESTON is trying to push the location of the treatment system away from the PLS site where it would discharge to the Honey Creek tributary.

WESTON does not have a political agenda as alleged in the PLS comment, but simply believes that an evaluation of alternate routes for pipelines seems appropriate in a FS before dismissing the technology entirely.

PLS Comment

[While Alternative 3e would be technically feasible, the FS did not provide information to indicate whether the receiving stream could accept the increased discharge volume of treated water. The FS notes (page 63) that NPDES permit issues could create implementation problems. In the absence of information related to the capacity of the receiving stream, WESTON cannot evaluate this alternative further.]

WESTON again evades reviewing another discharge alternative due to "lack of information." Similar objections could be raised with respect to ***every*** *discharge option that requires a state permit. Ordinarily a feasibility study it is not the appropriate document to cover all of the technical areas involved in a discharge permit. There is far more information available on the capacity of Honey Creek (as well as other objections) than there is on any of the other discharge options. Most of the potential issues, including capacity, have been raised and litigated in contested cases. WESTON could have reviewed that information. Because there is no existing permit, there is less information and more potential uncertainty regarding a discharge to the Huron River than to either the Honey Creek tributary or via reinjection. To the extent, then, that this is an issue, it disfavors constructing miles of pipeline without knowing if a permit will be issued.*

WESTON's review was limited to the information provided in the FS. The FS should have included the information relevant to the evaluation of an alternative. In addition, WESTON is not aware that the issue of permitting a discharge to the Huron River was raised in the FS.

PLS Comments on Section 6.2.2.5 Alternative 6 – Groundwater Pumping with Active Remediation and Treatment Proximate to the Huron River

[If the proposed investigation, monitoring, and modeling of the groundwater plume support the assumption that the potential receptors will be protected, then the contingency for extraction of contaminated groundwater near the Huron River would not be necessary. In that event, Alternative 6 would be comparable to Alternative 2, but without the institutional controls. However, the plume of contaminated groundwater would still be migrating under those properties. In WESTON's opinion, some institutional controls would be prudent to ensure that the contaminated groundwater is not consumed.]

PLS commented that this comment appears to concede that if the proposed investigation confirm PLS's observation that potential receptors will be protective, then capturing the plume at the leading edge would not be necessary. WESTON adds that in its "opinion," some institutional controls would be prudent to ensure that the contaminated groundwater is not consumed. As detailed in the FS, institutional controls are already in place that would prohibit installation of drinking water wells in the plume. WESTON did not review the adequacy of these controls, thus its analysis of the Alternatives proposed by PLS is not complete.

WESTON agrees that the additional investigation may provide sufficient information to demonstrate that natural attenuation would be protective and therefore, capturing the leading edge would not be necessary. WESTON consistently commented that the current information was not sufficient to reach that conclusion. It is WESTON's understanding that the MDEQ is addressing the controls referenced in the FS. It should be noted that no mention is made of residential wells 2 Ridgemor and 5 Ridgemor, which are located near the Montgomery Well (Figure 3 in FS). If these wells are screened in aquifer E, they may pull contamination already present at the Montgomery well towards them.

PLS Comments on Chapter 7—Overall Response Plan and Waiver Request

[As the Final Response Plan, the FS proposes to combine the IR Actions described in Chapter 4 with Alternative 6 to aggressively remove mass from near the most contaminated portions of the plume while it continues to migrate toward the river.]

PLS commented that WESTON, not PLS, coined the term "Final Response Plan". PLS is not certain what this term means. PLS explained its approach and rationale in the FS (Section 7.0, p. 71). Also, PLS notes that every remedial option, including those that capture at the leading edge, remove mass while allowing some water contaminated with 1,4-dioxane to migrate toward the river. The only difference between the options is how much groundwater is removed and from what locations, and the infrastructure involved with each. PLS does not concur with the inference that only PLS's proposed overall response plan (and waiver request) allows mass to continue toward the river.

In order to compare the relative costs of the alternatives precipitating out (which was not done in the FS), WESTON was forced to combine the IR and Alternative 6. This combination was called the Final Response Plan for lack of a comparable label in the FS, but in keeping with the recommended approach. WESTON does not believe there is any dispute that the IR is not designed to remove all the mass within the plume.

PLS Comment

[The discussion of determents to the environment beginning on page 75 provides new information not previously discussed in the FS, including groundwater level and surface water level declines that could result from aggressively extracting groundwater from the Unit E plume. The FS does not provide any data or other information to support these statements. As a result, WESTON cannot provide technical evaluation of their validity.]

PLS commented that whenever PLS has made a technical argument in support of its position, WESTON evades review by claiming PLS did not provide any (or inadequate) information. As

with other such statements, it this one is not accurate. The FS at page 75, PLS explained what has been observed in the other two aquifers that are being actively remediated. Water levels have declined by approximately 12 feet. The water level information for all of PLS's wells are communicated regularly to DEQ in quarterly report and other project related documents.

WESTON was contracted to review and comment on the FS. If technical information was available to support a conclusion, then that information should have been referenced at a minimum or provided as an appendix.

ESTIMATED COST OF DEQ-PROPOSED REMEDIAL ALTERNATIVE

In this section, WESTON provides an estimated cost of DEQ's proposed remedial alternative. PLS questions why WESTON did not provide a technical analysis of DEQ's response. PLS notes that according to WESTON, DEQ's response calls for construction of approximately 25,500 linear feet of pipeline. However, the pipeline routes are ill defined or not defined at all in the case of pipeline to the river. This very issue was flagged by WESTON as a criticism of PLS's review of the pipeline alternatives in the FS. PLS also notes that the cost estimates for the pipeline assume open cut, with directional drilling only at street crossings. (See Tables 5 and 6). Not only is this technique highly disruptive of neighborhoods, it is also inconsistent with public representations made by DEQ that open cut would be minimized. It may also indicates that, contrary to these representations, directional drilling may not be feasible.

PLS has reviewed WESTON's cost estimates. The following appear to be major oversights or omissions from WESTON's costs.[1] *These errors are discussed further in PLS's Summary Comments.*

The MDEQ requested that WESTON provide a cost estimate for their alternative using PLS' costs (reviewed by WESTON) and vender costs, when possible. This approach was used because the time duration limited the amount of research of alternatives and vender contacts that could be made. WESTON used the piping routes proposed by PLS in Alternative 4a. The 14 July 2004 letter does reference that the pipeline route to the river follows the route proposed in

Alternative 4a (page 23 Maple Road subsection). The length of piping is larger in the MDEQ proposed alternative because WESTON proposes two pipelines to transmit the water to the river.

The use of open trenching used for cost estimates is not an indictment that "directional drilling may not be feasible". Issues concerning use of directional drilling in the neighborhoods were not conveyed to WESTON. WESTON costed open cut trenching for installation of the pipeline to the Huron River as the most cost effective method. Directional boring was only costed for road crossings (including those in the neighborhoods and under the interstate). Open cut construction was selected due to the ease of construction and speed of installation, which translates to less expensive pipe placement. Unit prices for both open cut and directional drilling are available and upon further discussion the assumptions could be changed for construction in the neighborhoods.

TABLE 1

Alternative Cost Comparison
Gelman Sciences Site
Ann Arbor, Michigan

Alternative		PLS Cost Estimate				WESTON Estimate	PLS FS Reference	Notes
		Capital	O & M	Post Closure	Total			
2	Monitored Natural Attenuation with Institutional Controls	$1,362,800	$5,173,850	**$42,000**	$6,578,650	$4,000,000	Table 4 - changes discussed below	
3a-1	Groundwater Pumping, Pipeline to Wagner Rd Facility, Treatment at Wagner Rd with Ozone/Hydrogen Peroxide Followed by Transmission through a New Pipeline to the Huron River for Disposal Under a NPDES permit	$9,014,314	$19,419,508	$147,420	$28,581,242		Table 5	3 leading edge extraction wells. Transport untreated water to PLS. Treat with O3/H2O2 system. Transport treated water to Huron River to discharge.
3a-2	Groundwater Pumping, Pipeline to Wagner Rd Facility, Treatment at Wagner Rd with Hydrogen Peroxide/UV Followed by Transmission through a New Pipeline to the Huron River for Disposal Under a NPDES permit	$8,973,050	$34,178,356	$147,420	$43,298,826		Table 6	3 leading edge extraction wells. Transport untreated water to PLS. Treat with UV/H2O2 system. Transport treated water to Huron River to discharge.
3c-1	Groundwater Pumping, Pipeline to Wagner Rd Facility, Treatment at Wagner Rd with Ozone/Hydrogen Peroxide 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 ppb under a Part 22 Permit	$7,616,753	$20,088,890	$130,312	$27,835,955		Table 7	3 leading edge extraction wells. Transport untreated water to PLS. Treat with UV/H2O2 system. Inject treated water into Unit E where <85 ppb and >1 ppb.
3c-2	Groundwater Pumping, Pipeline to Wagner Rd Facility, Treatment at Wagner Rd with Hydrogen Peroxide/UV Followed by Injection into Unit E Through Mutliple New Wells at Locations Where 1,4-Dioxane Levels are less than 85 ppb, but exceed 1 ppb under a Part 22 Permit	$7,588,129	$34,847,738	$130,312	$42,566,179		Table 8	3 leading edge extraction wells. Transport untreated water to PLS. Treat with O3/H2O2 system. Inject treated water into Unit E where <85 ppb and >1 ppb.
3e-1	Groundwater Pumping, Pipeline to Wagner Rd Facility, Treatment at Wagner Rd with Ozone/Hydrogen Peroxide, Discharge into Honey Creek (Tributary)	$7,028,664	$17,475,370	$111,540	$24,615,574		Table 9	3 leading edge extraction wells. Transport untreated water to PLS. Treat with O3/H2O2 system. Discharge into Honey Creek.
3e-2	Groundwater Pumping, Pipeline to Wagner Rd Facility, Treatment at Wagner Rd with Hydrogen Peroxide/UV , Discharge into Honey Creek (Tributary)	$7,028,664	$32,234,218	$111,540	$39,374,422		Table 10	3 leading edge extraction wells. Transport untreated water to PLS. Treat with UV/H2O2 system. Discharge into Honey Creek.
4a	Groundwater Pumping, Treatment Near Maple Rd with Ozone/Hydrogen Peroxide Treatment Followed by Transmission through a New Pipeline to the Huron River for Disposal Under and NPDES Permit	$6,989,529	$17,880,950	$140,400	$25,010,879		Table 11	3 leading edge extraction wells. Transport untreated water to Maple Rd and treat with O3/H2O2 system. Transport treated water to Huron River to discharge.

TABLE 1

Alternative Cost Comparison
Gelman Sciences Site
Ann Arbor, Michigan

Alternative		PLS Cost Estimate Capital	O & M	Post Closure	Total	WESTON Estimate	PLS FS Reference	Notes
4c	Groundwater Pumping, Treatment at Site Near Maple Rd with Ozone/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 ppb under a Part 22 Permit	$9,982,329	$20,418,469	$95,160	$30,495,958		Table 12	3 leading edge extraction wells. Transport untreated water to Maple Rd and treat with O3/H2O2 system. Inject into Unit E where <85 ppb and >1 ppb.
5	Groundwater Pumping, Pipeline to Wagner Road Facility, No Treatment, Injection into Deep Geological Unit	$8,380,165	$10,785,219	$168,168	$19,333,552		Table 13	3 leading edge extraction wells. Transport untreated water to PLS and dispose into deep injection well.
6	Groundwater Pumping with Active Remediation Proximate to the Huron River, if necessary	**$5,663,456**	**$31,981,191**	$72,332	$37,716,979	$25,000,000	Table 14 with changes discussed below	Costs assume active remediation at Huron River necessary (30 years)
6a (PLS Preferred Alternative)	Groundwater Pumping with Active Remediation Proximate to the Huron River, if necessary, AND interim response measures that include mass removal at both PLS property and in the vicinity of Maple Rd.	***$5,663,456*** *$225,150* *$752,832* $6,641,438	***$31,981,191*** ***$540,958*** *$471,672* $32,993,821	*$72,332* *$7,020* *$23,993* $103,345	*$37,716,979* *$773,128* *$1,248,497* $39,738,604	$27,000,000	Table 14 (Alternative 6) App G (On-site Extraction) App G (Maple Rd Ext/Trtmt/Inj) - changes discussed below Total	•Costs assume active remediation at Huron River necessary (see costs for Alternative 6, 30 years) . •On-site groundwater extraction (one additional extraction well): O&M costs for ONE year operation only. •Extraction/treatment/injection at Maple Rd. (one extraction well, O3/H202 treatment/ one injection well): O&M costs for ONE year operation only. Capital costs for treatment system NOT included. Access costs at Maple Rd NOT included.

Alternative		WESTON Cost Estimate Capital	O & M	Post Closure		WESTON Total	Reference	Notes
MDEQ	Two additional recovery wells at PLS with treatment/discharge of recovered groundwater with current on-site system, AND 3 recovery wells at Maple Rd. and 3 recovery wells at leading edge, with recovered water treatment by O3/H202 system at Maple Rd. and discharge to Huron River.	$545,500 $3,384,400 $8,963,100 $12,900,000	$7,023,000 $6,498,000 $2,222,000 $15,700,000	Included in Capital Costs		$7,600,000 $9,900,000 $11,200,000 $29,000,000	uses both WESTON and PLS costs Total	NOTES: •Total on-site extraction rate is unaffected by additional extraction well. •Estimated 500 gpm extracted at Maple Rd. and 650 gpm extracted at leading edge requires treatment system rate and capacity for pipeline to Huron River of 1,150 gpm. Unit costs for various elements of FS alternatives must be adjusted when applied to MDEQ alternative to account for increase in rates of water recovered, treated, transported and disposed.

Present Worth:	
Alternative 6a - PLS costs	$8,318,263
Alternative 6a - WESTON costs	$6,250,670
MDEQ Alternative	$23,000,000

Notes: WESTON costs are a combination of PL-S and WESTON- generated costs, while PLS costs are based on on their unit rates, except the following:
- **Alternative 2**; $10,000 was added because Post Closure Costs for reporting was not included.
- **Alternative 6** equals $33,061,388 according to PLS Table 14
$600,000 for hydrogeologic is in Table 14 but not added into a subtotal. WESTON added this amount
Supporting Calcualtion B, Appendix E does not include $28,600 for manholes, with 12% contingency. WESTON added $32,032.
$9,610 added to 30% contingency for infrastructure
$700,000 for access legal fees and treatment system was not included in subtotal, WESTON added this amount
$3,313,949 was added to the 30% O&M contingency because PLS did not apply the contingency to the O&M subtotal
- **Alternative 6a**; $1,350 was added to the Wagner Road O&M 15% contingency to correct value

TABLE 3

Summary of MDEQ Alternative Costs
Gelman Sciences Site
Ann Arbor, Michigan

Present Worth Calculation

	Wagner Road	Maple Road	Leading Edge	Total
Mobilization	$ 25,000	$ 25,000	$ 25,000	$ 75,000
Groundwater Modeling	$ 132,000	$ -	$ 355,200	$ 487,200
Infrastructure	$ 289,900	$ 2,869,900	$ 7,586,200	$ 10,746,000
Access Fees	$ 19,500	$ 110,500	$ 201,500	$ 331,500
Consulting Engineering Fees	$ 32,300	$ 332,700	$ 738,100	$ 1,103,100
Post Closure	$ 46,800	$ 46,300	$ 57,100	$ 150,200
Subtotal Capital Costs	**$ 545,500**	**$ 3,384,400**	**$ 8,963,100**	**$ 12,893,000**
O&M Annual	$ 702,300	$ 324,900	$ 222,200	$ 1,249,400
Total Job with 1 year O&M	**$ 1,247,800**	**$ 3,709,300**	**$ 9,185,300**	**$ 14,142,400**
20 Yr O&M Present Worth		$ 3,442,000		$ 3,442,000
10 Yr O&M Present Worth	$ 4,227,700		$ 1,560,600	$ 5,788,300
Total Job with 10/20 year O&M	**$ 5,000,000**	**$ 7,000,000**	**$ 11,000,000**	**$ 23,000,000**

Current Cost Calculation

	Wagner Road	Maple Road	Leading Edge	Total
Mobilization	$ 25,000	$ 25,000	$ 25,000	$ 75,000
Groundwater Modeling	$ 132,000	$ -	$ 355,200	$ 487,200
Infrastructure	$ 289,900	$ 2,869,900	$ 7,586,200	$ 10,746,000
Access Fees	$ 19,500	$ 110,500	$ 201,500	$ 331,500
Consulting Engineering Fees	$ 32,300	$ 332,700	$ 738,100	$ 1,103,100
Post Closure	$ 46,800	$ 46,300	$ 57,100	$ 150,200
Subtotal Capital Costs	**$ 545,500**	**$ 3,384,400**	**$ 8,963,100**	**$ 12,893,000**
O&M Annual	$ 702,300	$ 324,900	$ 222,200	$ 1,249,400
Total Job with 1 year O&M	**$ 1,247,800**	**$ 3,709,300**	**$ 9,185,300**	**$ 14,142,400**
20 Yr O&M Present Worth		$ 6,498,000		$ 6,498,000
10 Yr O&M Present Worth	$ 7,023,000		$ 2,222,000	$ 9,245,000
Total Job with 10/20 year O&M	**$ 8,000,000**	**$ 10,000,000**	**$ 11,000,000**	**$ 29,000,000**

TABLE 4

MDEQ Combined Alternative
Wagner Road Cost Estimate with 10 and 1 Year O&M
Groundwater Pumping and Treatement
Discharge to Honey Creek
Gelman Sciences Site

COMPONENT	ENGINEER'S ESTIMATE Quantity	Unit	Unit Price	Cost	Subtotal	COMMENTS
MOBILIZATION/DEMOBILIZATION	1	Estimate	$25,000	$25,000		Includes all labor, materials, equipment, administrative costs.
Subtotal					$25,000	
GROUNDWATER MODELING						
Install Monitoring Wells	4	each	$20,000	$ 80,000		
Sample Wells	4	wells	$135	$ 500		
Analytical	4	samples	$385	$ 1,500		
Modeling	1	LS	$50,000	$ 50,000		
Subtotal					$ 132,000	
INFRASTRUCTURE						
Extraction Wells	2	each	$ 50,000	$ 100,000		
Connection piping to Extraction Wells	200	LF	$ 70	$ 14,000		Assume 100 feet per well connection to existing piping
Electrical Service	3	each	$ 10,000	$ 30,000		Supply service and connect
Pumping Systems	3	each	$ 3,000	$ 9,000		
Process Control	3	each	$ 10,000	$ 30,000		
Monitoring Wells	2	each	$ 20,000	$ 40,000		
Contingencies	1	LS	30%	$ 66,900		
Subtotal					$289,900	
Access Fees						
Extraction Wells	1	each	$ 10,000	$ 10,000		Assume single property owner
Pipelines	1	each	$ 5,000	$ 5,000		Assume single property owner
Contingency	1	each	30%	$ 4,500		
Subtotal					$ 19,500	
Consulting/Engineering Fees						
Extraction Wells	1	LS	12%	$ 12,000		
Pipeline Construction	1	LS	12%	$ 1,680		
Connection Piping	1	LS	12%	$ 1,680		
Pumping System/Process Contros	1	LS	12%	$ 4,680		
Monitoring Wells	1	LS	12%	$ 4,800		
Contingencies	1	LS	30%	$ 7,452		
Subtotal					$ 32,300	
Post Closure						
Plug Extraction Wells	3	each	$2,000	$ 6,000		
Plug Monitoring Wells	3	each	$2,000	$ 6,000		
Plug Pipeline to Treatment system	5	section	$ 1,800.00	$ 9,000		Cut and cap
Plug Pipeline to Honey Creek	5	section	$ 1,800.00	$ 9,000		Cut and cap
Technical/Professional Services	1	LS	20%	$ 6,000		
Contingencies	1	LS	30%	$ 10,800		
Subtotal					$46,800	
DIRECT COST SUBTOTAL					$545,500	
ANNUAL OPERATION AND MAINTENANCE COSTS - WELLS AND LINES						
Pipeline Maintenance	1	year	$ 10,000	$ 10,000		O&M only included for the new facilities
Well Maintenance	3	year	$ 2,000	$ 6,000		O&M only included for the new facilities
Analytical - Extraction Wells	48	samples	$ 185	$ 8,880		Four deep wells sampled quarterly
Contingencies	1	LS	30%	$ 7,464		
ANNUAL O & M SUBTOTAL - WELLS AND LINES					$ 32,300	
ANNUAL OPERATION AND MAINTENANCE COSTS - TREATMENT SYSTEM						
System Staffing	2	year	$ 56,000	$ 112,000		Assume unit cost of Pall staff remains constant
System O&M	131400	1000 gal	$ 3.07	$ 403,398		Assume cost of Pall O&M remains constant
Contingencies	1	LS	30%	$ 154,619		
ANNUAL O&M SUBTOTAL -TREATMENT SYSTEM					$ 670,000	
TOTAL CAPITAL COST (INDIRECT AND DIRECT COSTS)					$545,500	
PRESENT WORTH OF ANNUAL O & M OVER 10 YEAR PERIOD (WELLS AND LINES)					$226,900	Assumes a discount rate of 7 percent over a 10 year period.
PRESENT WORTH OF ANNUAL O&M OVER 8 YEAR PERIOD (TREATMENT SYSTEM)					$4,000,800	Assumes a discount rate of 7 percent over an 8 year period.
TOTAL PRESENT WORTH (10 YEAR O&M)					**$4,773,200**	Capital cost plus O&M (10 yrs facilities/8 yrs treatment)
PRESENT WORTH OF ANNUAL O&M OVER 1 YEAR PERIOD					$702,300	
TOTAL PRESENT WORTH (1 YEAR O&M)					**$1,247,800**	Capital cost plus 1 year O&M

TABLE 5

MDEQ Combined Alternative
Maple Road Cost Estimate with 20 and 1 Year O&M
Groundwater Pumping and Treatement
Discharge to Huron River
Gelman Sciences Site

COMPONENT	ENGINEER'S ESTIMATE Quantity	Unit	Unit Price	Cost	Subtotal	COMMENTS
MOBILIZATION/DEMOBILIZATION	1	Estimate	$25,000	$25,000		Includes all labor, materials, equipment, administrative costs.
Subtotal					$25,000	
INFRASTRUCTURE						
Extraction Wells	3	each	$ 50,000	$ 150,000		
Connection piping to Extraction Wells	300	LF	$ 91	$ 27,300		Assume 100 feet per well connection
Pipeline to Maple Road						
8 inch HDPE	7500	LF	$ 225	$ 1,687,500		Assume open cut
Steel casing under roads all roads	675	LF	$ 290	$ 195,800		Assume directional drill 9 crossings at 75 LF each
Manholes	14	each	$ 4,500	$ 63,000		
Electrical Service	3	each	$ 25,000	$ 75,000		Supply service and connect
Pumping Systems	3	each	$ 3,000	$ 9,000		Per Pall FS
Process Control	0	LS	$ 10,501	$ -		
Treatment System	0	LS	$ 775,000	$ -		
Contingencies	1	LS	30%	$ 662,280		
Subtotal					$ 2,869,900	
Access Fees						
Extraction Wells	1	LS	$ 10,000	$ 10,000		
Pipeline to K Mart	1	LS	$ 50,000	$ 50,000		
Well Pipelines	1	LS	$ 25,000	$ 25,000		
Contingencies	1	LS	30%	$ 25,500		
Subtotal					$110,500	
Consulting/Engineering Fees						
Extraction Wells	1	LS	12%	$ 18,000		
Pipeline Construction	1	LS	12%	$ 233,556		
Connection Piping	1	LS	12%	$ 3,276		
Pumping System/Process Contros	1	LS	12%	$ 1,080		
Contingencies	1	LS	30%	$ 76,774		
Subtotal					$ 332,700	
Post Closure						
Plug Extraction Wells	3		$ 1,500	$ 4,500		
Plug Pipeline To Maple Road	14	section	$1,800.00	$ 25,200		
Technical/Professional Services	1	LS	20%	$ 5,940		
Contingencies	1	LS	30%	$ 10,692		
Subtotal					$ 46,300	
DIRECT COST SUBTOTAL					$3,384,400	
ANNUAL OPERATION AND MAINTENANCE COSTS						
Treatment system operation	262800	1000 gal	$ 0.27	$ 70,956		500 GPM - 24 hr per day - 365 days per year
Pipeline Maintenance	1	year	$ 20,000	$ 20,000		
NPDES monitoring, reporting, fees	1	year	$ 30,150	$ 30,150		
Well Maintenance	3	year	$ 2,000	$ 6,000		
Groundwater Sampling	144	samples	$ 135	$ 19,440		Sample 36 wells Quarterly
Analytical - Monitoring Wells	144	samples	$ 385	$ 55,440		Sample 36 wells Quarterly
Analytical - Extraction Wells	36	samples	$ 185	$ 6,660		Assume 3 wells sampled monthly
Electrical for Pumping	1	Year	$ 38,956	$ 38,956		
Electrical for Discharge	1	Month	$ 3,012	$ 3,012		Per Pall FS
Contingencies	1	LS	30%	$ 74,281		
ANNUAL O & M SUBTOTAL					$ 324,900	
TOTAL CAPITAL COST (INDIRECT AND DIRECT COSTS)					$3,384,400	
PRESENT WORTH OF ANNUAL O & M OVER 20 YEAR PERIOD					$3,442,000	Assumes a discount rate of 7 percent over a 20 year period.
TOTAL PRESENT WORTH (20 YEAR O&M)					**$6,826,400**	Capital cost plus 20 O&M
SINGLE YEAR OF OPERATION O&M					$324,900	
TOTAL PRESENT WORTH (1 YEAR O&M)					**$3,709,300**	Capital cost plus 1 year O&M

TABLE 6

MDEQ Combined Alternative
Leading Edge Cost Estimate with 10 and 1 Year O&M
Groundwater Pumping and Treatement
Discharge to Huron River
Gelman Sciences Site

COMPONENT	ENGINEER'S ESTIMATE Quantity	Unit	Unit Price	Cost	Subtotal	COMMENTS
MOBILIZATION/DEMOBILIZATION	1	Estimate	$25,000	$25,000		Includes all labor, materials, equipment, administrative costs.
Subtotal					$25,000	
GROUNDWATER MODELING						
Install Monitoring Wells	10	each	$20,000	$200,000		
Sample Wells	10	wells	$135	$1,350		
Analytical	10	samples	$385	$3,850		
Modeling	1	LS	$150,000	$150,000		
Subtotal					$355,200	
INFRASTRUCTURE						
Extraction Wells	3	each	$ 50,000	$ 150,000		
Connection piping to Extraction Wells	300	LF	$ 91	$ 27,300		Assume 100 feet per well connection
Pipeline to Maple Road						
12 inch HDPE	2500	LF	$ 240	$ 600,000		Assume directional drilling at $90/LF
Steel casing under roads all roads	750	LF	$ 290	$ 217,500		Assume 10 roads at 75 feet each
Manholes	5	each	$ 4,500	$ 22,500		
Pipeline to Huron River						
8 inch HDPE	35250	LF	$ 90	$ 3,172,500		Assume open cut with doubled 8 inch lines ($90/LF for single line, $50/LF for double line)
Steel casing under roads all roads	1950	LF	$ 240	$ 468,000		Assume directional drill 13 crossings at 75 LF each
Manholes	12	each	$ 4,500	$ 54,000		
Electrical Service	3	each	$ 50,000	$ 150,000		Supply service and connect
Pumping Systems	3	each	$ 3,000	$ 9,000		
Process Control	1	each	$ 10,304	$ 10,300		
Treatment System	1	LS	$ 775,000	$ 775,000		
Security Fence	600	LF	$ 34.93	$ 21,000		10 foot security fence with 3 strands barbed wire
Rolling Gate	2	each	$ 1,500	$ 3,000		
Building (Sprung Structure)	1	each	$ 139,318	$ 139,300		Insulated structure, 1 10X10 service door, 1 man door include deliver and installation
Liquid Oxygen Tank	1	each	$ 50,000	$ 50,000		150 psi pressure vessel (5000 gal) include foundation and install
Mixing Tank (5000 Gallon Baker)	1	each	$ 20,000	$ 20,000		
Contingencies	1	LS	30%	$ 1,696,830		
Subtotal					$ 7,586,200	
Access Fees						
Extraction Wells	1	LS	$ 10,000	$ 10,000		
Pipeline to Maple Road	1	LS	$ 50,000	$ 50,000		
Pipeline to Huron River	1	LS	$ 50,000	$ 50,000		
Treatment System	1	LS	$ 20,000	$ 20,000		
Well Pipelines	1	LS	$ 25,000	$ 25,000		
Contingencies	1	LS	30%	$ 46,500		
Subtotal					$201,500	
Consulting/Engineering Fees						
Extraction Wells	1	LS	12%	$ 18,000		
Pipeline Construction	1	LS	12%	$ 544,140		
Connection Piping	1	LS	12%	$ 3,276		
Pumping System/Process Contros	1	LS	12%	$ 2,316		
Contingencies	1	LS	30%	$ 170,320		
Subtotal					$ 738,100	
Post Closure						
Plug Extraction Wells	3		$ 2,000	$ 6,000		
Plug Monitoring Wells	0		$ 2,000	$ -		
Plug Pipeline To Maple Road	5	section	$ 1,800	$ 9,000		
Plug Pipeline to Huron River	12	section	$ 1,800	$ 21,600		
Technical/Professional Services	1	LS	20%	$ 7,320		
Contingencies	1	LS	30%	$ 13,176		
Subtotal					$ 57,100	
DIRECT COST SUBTOTAL					$8,963,100	
ANNUAL OPERATION AND MAINTENANCE COSTS						
Treatment system operation	341640	1000 gal	$ 0.26	$ 88,826		650 GPM - 24 hr per day - 365 days per year
Pipeline Maintenance	1	year	$ 20,000	$ 20,000		
Well Maintenance	3	year	$ 2,000	$ 6,000		
Analytical - Extraction Wells	36	samples	$ 185	$ 6,660		Assume 3 wells sampled monthly
Electrical for Pumping	1	year	$ 49,448	$ 49,448		
Contingencies	1	LS	30%	$ 51,280		
ANNUAL O & M SUBTOTAL					$ 222,200	
TOTAL CAPITAL COST (INDIRECT AND DIRECT COSTS)					$8,963,100	
PRESENT WORTH OF ANNUAL O & M OVER 10 YEAR PERIOD					$1,560,600	Assumes a discount rate of 7 percent over a 10 year period.
TOTAL PRESENT WORTH (10 YEAR O&M)					**$10,523,700**	Capital cost plus 10 year O&M
SINGLE YEAR OF OPERATION O&M					$222,200	
TOTAL PRESENT WORTH (1 YEAR O&M)					**$9,185,300**	Capital cost plus 1 year O&M