

3.0 Analysis of Alternatives

3.1 Identification of Potential Alternatives

Two areas of improvements have been identified to address the wastewater needs within the study area:

- **WWTP Sludge Utilization:** These alternatives address the need to effectively dispose wastewater treatment plant sludge, find an alternative beneficial use for the sludge, and relieve water quality problems posed by current sludge disposal practices.
- **Gas Utilization:** These alternatives address the need at the existing WWTP for a reliable source of green, renewable energy to power operations and maximize the beneficial use of the gas resource created by the landfill and sludge disposal practices.

3.1.1 WWTP Sludge Disposal Alternatives

Table 3-1 summarizes the alternatives analyzed. The table also includes a summary of each alternative's cost, advantages, and disadvantages with respect to initial cost, environmental impact, technical feasibility, and sustainability.

In general, implementation of a sludge bioreactor Research, Development, and Demonstration Project (RDDP) at the CML offers significant economic and environmental advantages over the other alternatives. Key environmental benefits include green energy production from sludge and a contained end use. The economic benefits, including increased green energy recovery potential, are explored in the monetary evaluation below.

Table 3-1. WWTP Sludge Utilization Alternatives

Alternative	Approximate Cost	Advantages	Disadvantages
NO ACTION			
no action	n/a	<ul style="list-style-type: none"> • Maintain short-term compliance • Least capital investment 	<ul style="list-style-type: none"> • Does not improve local surface water quality • Create potential for future runoff problems from transportation and application • Increase capital costs for future operations
OPTIMUM PERFORMANCE OF EXISTING FACILITIES			
upgrade sludge press	\$690,000	<ul style="list-style-type: none"> • Utilize some existing infrastructure 	<ul style="list-style-type: none"> • End disposal is the same (land apply or landfill), but treatment operation and maintenance costs are higher, including energy cost for presses
install sludge dryer using gas-to-energy heat	\$1,400,000	<ul style="list-style-type: none"> • Improve utilization of green energy source, gas-to-energy facility • Reduce potential environmental impacts from handling and transportation of sludge 	<ul style="list-style-type: none"> • End disposal is the same (land apply or landfill), but treatment operation and maintenance costs are higher
REGIONAL ALTERNATIVES			
truck sludge to neighboring communities for spraying	n/a	<ul style="list-style-type: none"> • Remove pollution problem from Midland 	<ul style="list-style-type: none"> • Create pollution problem in neighboring community • Increase in truck traffic and handling and transportation of sludge with potential for fugitive sludge releases
PROPOSED SLUDGE TREATMENT AT LANDFILL (RESEARCH AND DEVELOPMENT)			
truck sludge to landfill, perform Research, Development, and Demonstration Project (RDDP)	\$800,000	<ul style="list-style-type: none"> • Improve landfill gas generation – alternative green energy resource • Reduce sludge treatment cost • Reduce pollution impacts on local surface waters 	<ul style="list-style-type: none"> • Actual incremental cost to City is low due to transfer of existing resources to project • Nominal increase in truck traffic (6 trucks/day)
pump sludge to landfill via pipeline, perform Research, Development, and Demonstration Project (RDDP)	\$2,360,000	<ul style="list-style-type: none"> • Improve landfill gas generation – alternative green energy resource • Reduce sludge treatment cost • Reduce pollution impacts on local surface waters 	<ul style="list-style-type: none"> • Actual incremental cost (of RDDP) to City is low due to transfer of existing resources to project • Pipeline capital, operations, and maintenance costs are relatively high • Sludge has poor flow characteristics, can clog pipeline

Alternative	Approximate Cost	Advantages	Disadvantages
install sludge dryer using gas-to-energy heat, truck sludge to landfill, perform Research, Development, and Demonstration Project (RDDP)	\$2,200,000	<ul style="list-style-type: none"> • Improve landfill gas generation – alternative green energy resource • Improve utilization of green energy source, gas-to-energy facility • Reduce potential environmental impacts from transporting wet sludge • Reduce pollution impacts on local surface waters 	<ul style="list-style-type: none"> • Actual incremental cost (of RDDP) to City is low due to transfer of existing resources to project • Nominal increase in truck traffic (2 trucks/day) • Nominal increase in operations costs
install sludge press upgrade, truck sludge to landfill, perform Research, Development, and Demonstration Project (RDDP)	\$1,490,000	<ul style="list-style-type: none"> • Improve landfill gas generation – alternative green energy resource • Improve utilization of green energy source, gas-to-energy facility • Reduce potential environmental impacts from transporting wet sludge • Reduce pollution impacts on local surface waters 	<ul style="list-style-type: none"> • Actual incremental cost (of RDDP) to City is low due to transfer of existing resources to project • Nominal increase in truck traffic (2 trucks/day)

3.1.2 Gas Treatment/Utilization Alternatives

These alternatives involve the end use of gas generated by the landfill and by the anaerobic digester at the WWTP. Table 3-2 summarizes the alternatives analyzed. The table also includes a summary of each alternative's cost, advantages, and disadvantages with respect to initial cost, environmental impact, technical feasibility, and sustainability.

In general, the most effective alternatives for the use of the landfill and digester gas are direct piping to a local industrial user and electricity generation at the WWTP.

Table 3-2. Gas Treatment/Utilization Alternatives

Alternative	Approximate Cost	Advantages	Disadvantages
NO ACTION			
no action	n/a	<ul style="list-style-type: none"> • Least capital investment 	<ul style="list-style-type: none"> • Incur fines, order to install gas system • Loose benefit of valuable resource (landfill gas) • Increase in odor nuisance with time • Does not address backup power concern for WWTP
OPTIMUM PERFORMANCE OF EXISTING FACILITIES			
n/a			<ul style="list-style-type: none"> • No gas reclamation apparatus currently exists
REGIONAL ALTERNATIVES			
install gas collection system and pipe gas to regional end user	>\$7,364,662	<ul style="list-style-type: none"> • Reduce gas emissions • Potential beneficial end use for landfill gas 	<ul style="list-style-type: none"> • Large capital cost • Does not address backup power concern for WWTP
ON-SITE GAS DISPOSAL			
install gas collection system and flare gas	\$1,467,212	<ul style="list-style-type: none"> • Reduce gas emissions 	<ul style="list-style-type: none"> • Loose benefit of valuable resource (landfill gas) • Does not address backup power concern for WWTP
ON-SITE ENERGY DEVELOPMENT			
install gas collection system, pipe gas to local industrial user	>\$3,667,067	<ul style="list-style-type: none"> • Reduce gas emissions • Beneficial end use for landfill gas • Generate revenue from gas sales 	<ul style="list-style-type: none"> • Long-term viability depends on industrial user • Requires pipeline construction • Does not address backup power concern for WWTP
install gas collection system, generate electricity at landfill, sell to electric utility	\$7,327,877	<ul style="list-style-type: none"> • Reduce gas emissions • Beneficial end use for landfill gas • Generate revenue from electricity sales 	<ul style="list-style-type: none"> • Does not address backup power concern for WWTP
install gas collection system, generate electricity at landfill, wheel power to WWTP	\$7,327,877	<ul style="list-style-type: none"> • Reduce gas emissions • Beneficial end use for landfill gas • Reduce operations costs at WWTP and WTP 	<ul style="list-style-type: none"> • Does not address backup power concern for WWTP
install gas collection system, compress and purify gas, sell to gas utility	\$9,713,882	<ul style="list-style-type: none"> • Reduce gas emissions • Beneficial end use for landfill gas • Generate revenue from gas sales 	<ul style="list-style-type: none"> • Capital, operations, and maintenance costs are relatively high • Technical problems with gas purification • Does not address backup power concern for WWTP

Alternative	Approximate Cost	Advantages	Disadvantages
install gas collection system, compress and purify gas, sell as vehicle fuel	\$10,471,982	<ul style="list-style-type: none"> • Reduce gas emissions • Beneficial end use for landfill gas • Generate revenue from gas sales 	<ul style="list-style-type: none"> • Capital, operations, and maintenance costs are relatively high • Technical problems with gas purification • Does not address backup power concern for WWTP
install gas collection system, pipe to WWTP for electricity/heat cogeneration	\$8,853,582	<ul style="list-style-type: none"> • Reduce gas emissions • Beneficial end use for landfill gas and WWTP digester gas • Reduce operations costs • Provides backup power capability to WWTP 	<ul style="list-style-type: none"> • Requires pipeline construction

3.2 Analysis of Principal Alternatives

The principal alternatives considered are

- No action on sludge utilization (to provide a comparable cost for comparisons)
- Sludge use in an RDDP
- Sludge use in an RDDP including sludge press upgrades
- Piping gas to a local industrial user
- Electricity generation from gas at the WWTP

The following subsections discuss the analysis of these alternatives.

3.2.1 Monetary Evaluation

The key differences between the sludge utilization alternatives involve the RDDP permitting, engineering, construction, monitoring, sludge disposal operations, and green energy development potential. The key differences between gas utilization alternatives involve construction and equipment costs, operating costs (supplies, energy, and outside maintenance support), and energy cost offsets (from green energy development).

The present worth of costs each year throughout the project period of 20 years is determined by the using the formula provided below:

$$\text{Present Worth} = \frac{A}{(1+i)^n}$$

where A = annual expenditure (or cost offset/salvage value)

n = number of years
 i = EPA discount rate (0.045)

The salvage value of any buildings or forcemains has been calculated based on straight line depreciation over 50 years, per the SRF guidance document. The salvage value of any electric generators or similar mechanical equipment is taken as 10% of their installation cost at the end of their 20 year life. A discount rate of 4.5% is applied in the present worth analysis, per FY 2009 guidelines.

Tables 3-3 through 3-5 summarize the present worth calculations for the sludge disposal alternatives. Note that the salvage value of the constructed solid waste disposal facility is not included in these comparisons because nearly identical salvage values can be expected for all alternatives. Also, the annual escalation rate is due both to energy prices and projected gas generation rate increases during the project period. Based on these calculations, the RDDP alternative, including the upgraded sludge press, is more cost-effective than the other alternatives, including the no action alternative.

Table 3-3. Summary of Present Worth Calculations for No Action Sludge Disposal (Sludge Disposal Area)

Item	Initial Cost	salvage	Annual Cost	Annual Escalation	Present Worth
Sludge Disposal		\$ -	\$ 157,216	0.0%	\$ 2,202,272
TOTAL PRESENT WORTH					\$ 2,202,272

Table 3-4. Summary of Present Worth Calculations for RDDP Construction and Management of Sludge and Degradable Waste (Sludge Disposal Area)

Item	Initial Cost	salvage	Annual Cost	Annual Escalation	Present Worth
Sludge Disposal			\$ 157,216	0.0%	\$ 2,202,272
RDDP Bioreactor Permit/ Construction - Year 1	\$ 300,000			0.0%	\$ 300,000
RDDP Bioreactor Construction and Monitoring - Year 2 - 5	\$ 500,000			0.0%	\$ 500,000
+25% Gas Production Green Energy Cost Offset			\$ (87,500)	3.0%	\$ (1,596,246)
TOTAL PRESENT WORTH					\$ 1,406,026

Table 3-5. Summary of Present Worth Calculations for RDDP Construction and Management of Dewatered Sludge and Degradable Waste (Sludge Disposal Area)

Item	Initial Cost	salvage	Annual Cost	Annual Escalation	Present Worth
Sludge Disposal			\$ 78,608	0.0%	\$ 1,101,136
RDDP Bioreactor Permit/ Construction - Year 1	\$ 300,000				\$ 300,000
RDDP Bioreactor Construction and Monitoring - Year 2 - 5	\$ 500,000				\$ 500,000
+25% Gas Production Green Energy Cost Offset			\$ (87,500)	3.0%	\$ (1,596,246)
Sludge Press Upgrades	\$ 690,000	\$ (69,000)			\$ 661,390
TOTAL PRESENT WORTH					\$ 966,280

Tables 3-6 and 3-7 summarize the present worth calculations for the gas utilization alternatives. Based on these calculations, the electric generation alternative is clearly the most cost-effective, largely due to the electricity cost offset. Note that the annual escalation rate is due both to energy prices and projected gas generation rate increases during the project period.

Table 3-6. Summary of Present Worth Calculations for Gas System Installation and Pipeline to Local Industrial User (Gas Utilization Area)

Item	Initial Cost	salvage	Annual Cost	Annual Escalation	Present Worth
Gas Collection System	\$ 1,467,212	\$ (146,721)	\$ 43,500	0.0%	\$ 2,015,721
Gas Compressor, Dryer and siloxane removal	\$ 1,596,450	\$ (159,645)	\$ 81,346	3.0%	\$ 3,014,230
LFG Pipeline	\$ 603,405	\$ (362,043)	\$ -	0.0%	\$ 453,286
Gas Revenue			\$ (406,729)	3.0%	\$ (7,419,878)
TOTAL PRESENT WORTH					\$ (1,936,641)

Table 3-7. Summary of Present Worth Calculations for Gas System Installation and Electric Generation Alternative (Gas Utilization Area)

Item	Initial Cost	salvage	Annual Cost	Annual Escalation	Present Worth
Gas Collection System	\$ 1,467,212	\$ (146,721)	\$ 43,500	0.0%	\$ 2,015,721
Building	\$ 743,475	\$ (446,085)	\$ 10,000	0.0%	\$ 698,588
Electric Generators, Gas Compressors, and Associated Equipment	\$ 5,201,140	\$ (520,114)	\$ 153,884	3.0%	\$ 7,792,757
Dryer and siloxane removal	\$ 838,350	\$ (83,835)	\$ 81,346	3.0%	\$ 2,287,564
LFG Pipeline	\$ 603,405	\$ (362,043)	\$ -	0.0%	\$ 453,286
Electricity Cost Offset			\$ (894,804)	3.0%	\$(16,323,731)
TOTAL PRESENT WORTH					\$ (3,075,815)

3.2.2 Environmental Evaluation

The CML is currently a Michigan DEQ permitted and licensed solid waste disposal facility. As such, it is subject to regular inspections and monitoring to ensure compliance with air, water, construction, and operation rules. The facility will continue to operate according to these rules regardless of the alternative selected. Therefore, the differences in the environmental impacts due to each alternative considered are limited in scope to issues related to construction and operation above and beyond the scope of current operations.

For the principal alternative for WWTP sludge utilization, the RDDP, the primary environmental impacts are positive. A gradual improvement in local surface water quality is expected due to improved sludge utilization practices. The accelerated decomposition of solid waste due to the sludge application is expected to reduce the growth rate of landfill operations, preserving precious land area. Finally, the RDDP improves the recovery of green energy in the form of accelerated landfill gas generation and collection.

For the principal alternatives for gas utilization, the long-term impact on air quality is positive since greater amounts of the gas generated by sludge and solid waste decomposition are captured by the proposed gas collection system. For the energy recovery options, including the electricity alternative, construction activities cause a short-term increase in noise and stormwater impacts. However, these impacts are planned to be mitigated through construction management practices. In the long-term, the electricity option will result in increased noise in the immediate vicinity of the

generators (an area restricted to the WWTP site). Also, the regional air and water quality will be improved due to use of this renewable energy resource in lieu of fossil-fuel burning power generation capacity offset by this plan.

3.2.3 Implementability

The key challenges to the implementation of the sludge treatment RDDP include permitting with the MDEQ and the limitations of sludge injection technologies. The City proposes to overcome these challenges by working with the MDEQ through its part 117 framework to plan and permit the RDDP. The City proposes to overcome the sludge injection technology challenge through a pilot scale test to be implemented in coordination with the MDEQ part solid waste regulators. These proposals represent a conservative approach and have been successfully implemented elsewhere.

The key challenges to the implementation of the electricity alternative for gas utilization include successful construction and startup of a gas-to-energy facility and negotiation of an economically viable green energy development agreement with the electric utility. Both of these challenges are being addressed by the City in its negotiations with the electric utility.

The financial capability to implement each of these alternatives has been demonstrated in the monetary evaluation. Since each alternative results in a decrease in the cost of operations, money currently budgeted to the City of Midland Utilities will be sufficient to support the proposed plan.

3.2.4 Technical Considerations

The proposed gas system for currently active landfill areas will need to be expanded during the 20-year project period due to the current and projected rate of incoming solid waste to the facility. Therefore, several construction events are expected during this time. However, this regular cycle of solid waste construction events is not within the scope of this project plan.

The gas-to-energy systems are appropriately sized to meet the projected demands for the next 20 years. These systems are attached to a landfill and a WWTP which have been sized in anticipation of the community's solid waste and sewage treatment and disposal needs. The service area served by the landfill and WWTP is not changed by these improvements.

Three landfill gas pipeline routes were considered in the development of the gas pipeline design. The current route represents the most logical routing since it disturbs the least amount of land and maximizes the utilization of existing infrastructure, rights-of-way, and easements.