January 25, 2012

Vermillion Solid Waste
Attn: Mr. Bob Iverson
25 Center Street
Vermillion, SD 57069

Re: Phase I Strategic Planning Study
Vermillion/Yankton Joint Integrated Solid Waste Management System
Summary and Recommendations

Dear Mr. Iverson:

HDR is please to provide the attached technical memorandums related to Phase I of the Solid Waste Strategic Master Plan for the Joint Powers. The technical memorandums cover the following solid waste management topics:

- Solid Waste Disposal Alternatives
- Recycling in Vermillion and Yankton
- Vermillion Landfill Assessment
- Yankton Transfer Station Assessment
- "In-Town" Multi-Purpose Solid Waste Facility Assessment
- Yard Waste Handling and Processing
- Cost of Service

Summary of Recommended Operational Strategy

As part of the Study, HDR looked at the technical memorandums as a whole. From that, an overarching solid waste operational strategy was developed. The following is a bulleted summary of the key elements of the strategy. The items are listed in order of recommended priority.

1. Continue to operate a Landfill. Waste-to-energy technologies are either too expensive or not commercially proven. Long haul disposal of the waste to another landfill will likely cost more and will result in the Joint Powers losing partial control of their waste disposal.
2. Maximize the existing Landfill's capacity by re-permitting it to allow for higher waste placement and steeper sideslopes.
3. Re-permit the landfill's liner design requirements to allow for an insitu liner construction. This will reduce the cost of future cell constructions.
4. Complete a detailed rate design study.

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5. Consider privatization of recycling programs in Vermillion and Yankton. This could lower cost and help manage uncertainties inherent to the recyclable market.
6. Modify the Vermillion Recycling Center to improve efficiency and safety. Modifications need to be done in consideration with potential expansion of recycling programs.
7. Consider franchise solid waste collection in Vermillion. This should lower the cost of collection, reduce the number of haul trucks going down residential street, and save on the wear and tear of City streets.

The following is a more detailed summary of the recommended strategy for the Joint Powers going forward.

Recycling

Both the City of Vermillion and the City of Yankton have curbside recycling collection programs for their residents. Both programs utilize the Vermillion Recycling Center for processing recyclables, which is in need of improvements. Ventilation and lighting, as well as the overall building layout need to be upgraded to improve the efficiency and safety of the building. In addition, some of the equipment in the Recycling Center is old and needs to be replaced.

Both communities have also expressed an interest in expanding their curbside recycling programs. Expanding recycling collection in both communities would likely require additional modifications to the Recycling Center due to the increase in the quantity of recyclables being processed there. Therefore, expansion of the recycling programs should be done with consideration to the operations of the Recycling Center and potential improvements that may be needed.

The cost of service review completed as part of this study found that the two communities spend a combined total of approximately $450,000 on processing recyclables. The communities received approximately $240,000 in combined revenue from the sale of recyclables in 2010, which results in a net processing cost of approximately $210,000. The community's service approximately 6,500 households, resulting in a $2.69 per household per month cost to process recyclables. It is important to note that this does not include the cost of collecting recyclables or recognize the value of diversion.

As an alternative improving and possibly expanding the Recycling Center operation, the City of Vermillion and the City of Yankton could privatize recycling collection and processing. This can be done in a number of ways that fit the needs of the communities. For example, it could be for both collection and processing, or just one or the other. In Mitchell, South Dakota, the entire recycling process is contracted out to a private

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company that charges less than $4 per household per month. It is also possible to include diversion requirements, or incentives to encourage the private contractor to divert more waste, in the recycling contract.

To summarize the recycling recommendations, the Joint Powers appears to have the following three recycling options. Further study of these options should be completed before finalizing the direction of the recycling programs in the Joint Powers region.

1. Continue with the recycling program as is and make necessary improvements to the Recycling Center facility. Approximate Cost: $200,000 to $400,000
2. Expand recycling collection and make necessary improvements to the Recycling Center. Approximate Cost: $300,000 to $500,000 to improve the Recycling Center. Plus the cost to collect from expanded customer base.
3. Privatize collection and processing of recyclables.

Landfill

To increase the life of the Vermillion Landfill, it is recommended that the City of Vermillion apply for a permit modification to allow for higher fill placement and steeper sideslopes. Currently the Landfill is permitted with shallow sideslopes (10:1, horizontal to vertical) which limit the overall height of the landfill and subsequently the overall capacity of the Landfill. As discussed in the Landfill technical memorandum, there are several factors in determining the allowable height increase, including slope stability, impacts to leachate collection, stormwater control, and erosion control, as well as impacts to surrounding lines of sight and other aesthetic considerations.

As currently permitted, the landfill has approximately 40+ years of capacity remaining. Depending on the ultimate final height of a vertical expansion, the landfill could gain an additional 20 to 35 years of life with a vertical expansion, resulting in a remaining landfill life of approximately 60 to 75years. Also, in the short term, an increase in the maximum height of the landfill could extend the life of existing Trenches 1 through 4 and subsequently delay the construction of Cell 5 by 1 to 6 years.

The cost to permit the higher elevations would be approximately $40,000. In addition, it is also recommended to include in the application a request to construct future cells with an alternative, in-situ clay liner system which will reduce the construction cost of upcoming cells. The request for an alternative liner permit modification would cost approximately $20,000. Making the total permit application cost approximately $60,000.

It is also recommended that the City of Vermillion continue to pursue purchasing adjacent property to the Landfill. As described in the Landfill technical memorandum, there are many benefits to owning more property at the Landfill site.

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Rate Study

It is recommended that a rate study be completed. The rate study should take into account the costs identified in the cost of service study, the probable costs of future projects (as determined by the results of the Phase 1 Strategic Planning Study), the variability in the recycling market, and the projected growth in waste from the communities. The rate study should also develop a plan that has a strategy going forward that covers costs and limits loans. The cost of a rate study for this type of project would likely range from $15,000 to $20,000.

Franchise Waste Collection in Vermillion

The City of Vermillion currently has garbage collection performed by private haulers that are individually contracted by citizens of the City. As an alternative, the City of Vermillion could franchise solid waste collection. Rather, the City could organize the collection of waste into different regions that could be competitively bid to hauling companies. Each region would then have one hauler. This should lower the cost of collection, reduce the number of trucks going down a street each week, and save on wear and tear of City roads.

The cost to institute franchise waste collection would depend on the amount of outside consulting the City needs. Outside consulting could assist with writing of new ordinances, as well as facilitating public meetings and city council meetings, writing request for proposals, managing the proposal process, and reviewing the proposals.

Sincerely,

HDR ENGINEERING, INC.

Matthew J. Evans, P.E.
Project Manager

J. Mike Coleman, P.E.
Vice President

cc: John Prescott, City of Vermillion
Mike Carlson, City of Vermillion
Doug Russell, City of Yankton
Al Viereck, City of Yankton

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Technical Memorandum

To:			
From:	HDR. Engineering, Inc.	Project:	Vermillion Landfill Master Plan
CC:			
Date:	November 17, 2011	Job No:	HDR - 164381
Attachments:			

RE: Technical Memorandum: Solid Waste Disposal Alternatives for the Joint Powers

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As part of the Vermillion Landfill Master Plan, several alternatives to landfill disposal were reviewed and are summarized in this memo. The following alternatives are described:

- Waste-to-energy (mass burn)
- Refuse derived fuel (RDF)
- Plasma arc
- Gasification
- MSW composting
- Long-hauling to a landfill outside the region

I. Waste-to-Energy

Traditional waste-to-energy technology, also known as mass burn combustion, can be divided into two main types: (a) grate based, waterwall boiler installations; and (b) modular, shop erected combustion units with shop fabricated waste heat recovery boilers. The modular units are typically limited to less than 200 tons per day (tpd) and are historically used in facilities where the total throughput is under 500 tpd. The larger Mass Burn Combustion process with waterwall boilers feed MSW directly into a boiler system with no preprocessing other than the removal of large bulky items such as furniture and white goods. The MSW is typically pushed onto a grate by a ram connected to hydraulic cylinders. Air is admitted under the grates, into the bed of material, and additional air is supplied above the grates. The resulting flue gases pass through the boiler and the sensible heat energy is recovered in the boiler tubes to generate steam. This creates three streams of material: Steam, Flue Gases and Ash. The steam is sent to a turbine generator and converted into electrical power. In the smaller modular mass burn systems, MSW is fed into a refractory lined combustor where the waste is combusted on refractory lined hearths, or within a refractory lined oscillating combustor (e.g. Laurent Bouillet). Typically there is no heat recovery in the refractory combustors, but rather, the flue gases exit the combustors and enter a heat recovery steam generator, or waste heat boiler, where steam is generated by the sensible heat in the flue gas, resulting in the same three streams, steam, flue gas and ash. The steam is either sent to a steam turbine to generate electricity or it can be piped directly to an end user as process steam, or a combination of these uses. The bottom ash from mass burn combustion may also be used as a construction base material, which is a common end-use for this by-product in Europe. The fly ash from the boiler and flue gas treatment equipment is collected separately and can be disposed of in a landfill or in some cases reused (e.g. in making concrete).

Mass burn technologies utilize an extensive set of air pollution control (APC) devices for flue gas clean-up. The typical APC equipment used include either selective catalytic reduction (SCR) or non-catalytic reduction (SNCR) for NOx emissions reduction, spray dryer absorbers (SDA) or scrubbers for acid gas reduction, activated carbon injection (CI) for mercury and dioxins reduction, and a fabric filter baghouse (FF) for particulate and heavy metals removal.

Large-scale and modular mass-burn combustion technology is used in commercial operations at more than 80 facilities in the U.S., two in Canada, and more than 500 in Europe, as well as a number in Asia.

Examples of larger-scale grate system technology vendors (some offer more than one design) include: Martin GmbH, Von Roll Inova, Keppel Seghers, Steinmuller, Fisia Babcock, Volund, Takuma, and Detroit Stoker. Some examples of smaller-scale and modular mass burn combustion vendors include: Enercon, Laurent Bouillet, Consutech, and Pioneer Plus.

Refuse Derived Fuel

There are two types of refuse derived fuel (RDF) technologies, RDF with stoker firing and RDF with fluidized bed combustion. These technologies are described below.

II. RDF with Stoker Firing

This technology uses spreader stocker type boiler to combust RDF. A front-end processing system is required to produce a consistently sized feedstock. The RDF is typically blown or mechanically injected into a boiler for semi-suspension firing. Combustion is completed on a traveling grate. Thermal recovery occurs in an integral waterwall boiler. Air-pollution control equipment (APC) on existing units includes good combustion practices, dry scrubbers for acid gas neutralization, carbon injection for control of mercury and complex organics (e.g., dioxins), and fabric filters for particulate removal. These facilities are capable of meeting stringent air emission requirements. New units would likely require additional NOx control such as selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR) or flue gas recirculation.

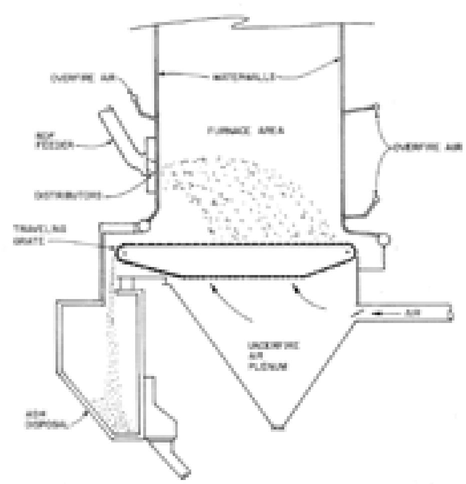

Figure 1 - Spreader Stoker Unit

This technology is used at the following facilities: Southeastern Public Service Authority, VA; Mid-Connecticut; Honolulu, HI; and West Palm Beach, FL.

Boiler Vendors: Alstom; Babcock and Wilcox; Babcock Power.

RDF with Fluidized Bed Combustion

This technology uses a bubbling or circulating fluidized bed of sand to combust RDF. A front-end processing system is required to produce a consistently sized feedstock. Heat is recovered in the form of steam from waterwalls of the fluidized bed unit as well as in downstream boiler convection sections. The required APC equipment is generally similar to that described above for spreader stocker units. Lime can be added directly to the fluidized bed to help control acid gases such as sulfur dioxide (SO_2). RDF may be co-fired with coal, wood (as in the case of the French Island facility shown), or other materials.

Figure 2 - Fluidized Bed RDF Combustion, Wisconsin

This technology is in limited commercial use in North America for waste applications with one operating facility at French Island, WI. Fluidized bed combustion is more commonly used today for combustion of certain other biomass materials and coal than it was at the time most of the existing RDF facilities were developed. This technology would be suitable for combustion of RDF alone or together with biomass and other combustible materials that are either suitably sized (nominally 8 cm) or can be processed to a suitable size.

Fluidized Bed Boiler Vendors: EPI, Von Roll Inova, Foster Wheeler, and Ebara

III. Plasma Arc

Plasma arc technology uses carbon electrodes to produce a very-high-temperature arc ranging between 3,000 to 7,000 degrees Celsius that “vaporizes” the feedstock. The high-energy electric arc that is struck between the two carbon electrodes creates a high temperature ionized gas (or “plasma”). The intense heat of the plasma breaks the MSW and the other organic materials fed to the reaction chamber into basic elemental compounds. The inorganic fractions (glass, metals, etc.) of the MSW stream are melted to form a liquid slag material which when cooled and hardened encapsulates toxic metals. The ash material forms an inert glass-like slag material that may be marketable as a construction aggregate. Metals can be recovered from both feedstock pre-processing and from the post-processing slag material.

Similar to gasification and pyrolysis processes, the MSW feedstock is pre-processed to remove bulky waste and other undesirable materials, as well as for size reduction. Plasma technology also produces a syngas; this fuel can be combusted and the heat recovered in a Heat Recovery Stem Generator, or the syngas can be cleaned and combusted directly in an internal combustion engine or gas turbine. Electricity and/or thermal energy (i.e. steam, hot water) can be produced by this technology. Vendors of this technology claim efficiencies that are comparable to conventional mass burn technologies. These higher efficiencies may be feasible if a combined cycle power system is proposed. However, the electricity required to generate the plasma arc, as well as the other auxiliary systems required, brings into question whether more electrical power or other energy products can be produced than what is consumed in the process.

This technology claims to achieve lower harmful emissions than more conventional technologies, like mass burn and RDF processes. However, air pollution control equipment similar to other technologies would still be required for the clean-up of the syngas or other off-gases.

Plasma technology has received considerable attention recently, and there are several large-scale projects being planned in North America (e.g. Saint Lucie County, Florida; Atlantic County, New Jersey). In addition, there are a number of commercial-scale demonstration facilities in North America, including the Alter NRG demonstration facility in Madison, Pennsylvania, and the Plasco Energy Facility in Ottawa, Ontario in Canada. PyroGenesis Canada, Inc., based out of Montreal, Quebec, also has a demonstration unit (approximately 10 tpd) located on Hulburt Air Force Base in Florida that has been in various stages of start-up since 2010.

There are a number of Plasma Arc technology vendors, including Startech, Geoplasma, PyroGenesis Canada, Inc., Westinghouse, Alter NRG, Plasco Energy, and Coronal.

IV. Gasification

Gasification converts carbonaceous material into a synthesis gas or "syngas" composed primarily of carbon monoxide and hydrogen. This syngas can be used as a fuel to generate electricity directly in a combustion turbine, or fired in a heat recovery steam generator to create steam that can be used to generate electricity via steam condensing turbine. The syngas generated can also be used as a chemical building block in the synthesis of gasoline or diesel fuel. The feedstock for most gasification technologies must be prepared into RDF developed from the incoming MSW, or the technology may only process a specific subset of waste materials such as wood waste, tires, carpet, scrap plastic, or other waste streams. Similar to Fluidized Bed Combustion, these processes typically require more front end separation and more size reduction, and result in lower fuel yields (less fuel per ton of MSW input). There exists one technology, Thermoselect®, which does not require preprocessing of the incoming MSW similar to a mass burn combustion system.

The feedstock reacts in the gasifier with steam and sometimes air or oxygen at high temperatures and pressures in a reducing (oxygen-starved) environment. In addition to carbon monoxide and hydrogen, the syngas consists of water, smaller quantities of CO2, and some methane. Processing of the syngas can be completed in an oxygen-deficient environment, or the gas generated can be partially or fully combusted in the same chamber. The low- to mid-Megajoule syngas can be combusted in a boiler, gas turbine, or engine or used in chemical refining. Of these alternatives, boiler combustion is the most common, but the cycle efficiency can be improved if the gas can be processed in an engine or gas turbine, particularly if the waste heat is then used to generate steam and additional electricity in a combined cycle facility.

Air pollution control equipment similar to that of a mass burn unit will be required if the syngas is used directly in a boiler. If the syngas is conditioned for use elsewhere, the conditioning equipment will need to address acid gases, mercury, tars and particulates.

Gasification has been proven to work on select waste streams, particularly wood wastes. However, the technology does not have a lot of commercial-scale success using mixed MSW when attempted in the U.S. and Europe. Japan has several operating commercial-scale gasification facilities that claim to process at least some MSW. In Japan, one goal of the process is to generate a vitrified ash product to limit the amount of material having to be diverted to scarce landfills. In addition, many university-size research and development units have been built and operated on an experimental basis in North America and abroad. .

Examples of a number of potential gasification vendors include: Thermoselect, Ebara, Primenergy, Brightstar Environmental, Erergos, Taylor Biomass Energy, SilvaGas, Technip, Compact Power, PKA, and New Planet Energy.

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V. MSW Composting

MSW composting is a process that is used as a way to divert organic materials from landfills while producing a beneficial product. The process involves separating the organic materials (paper, food waste, yard trimmings) from the rest of the MSW and processing it to create compost. The non-organic fraction is typically recycled or disposed of in a landfill.

One process is in use in Rapid City, South Dakota and is described in *BioCycle*, a national journal on composting and organics recycling. Rapid City processes their MSW stream and removes items that are not organic. The non-organic materials are removed by adding water to the waste and moving it through a series of drums and screens, causing the organic items to fall through the screens. The non-organics are then deposited into roll-off containers to be transported to be recycled or to the landfill. The organic material from the process is stored in piles which are rotated using a screw auger that allows for aeration of the material. This process takes place indoors in a building designated for composting, and typically takes 30 days for the initial stage of the process. After the initial phase, the material is then transported to another area where additional aeration, referred to as curing, takes place for an additional 30 days. After the curing process is complete, the material is finished by screening the material to remove particles larger than 3/8", and is then processed additionally to remove heavier items such as rocks and glass particles that should not be in the final compost product.

The initial capital cost to construct the Rapid City facility was approximately $6 million. The facility also has relatively high O&M costs because it is operating both a landfill and an MSW composting facility.

VI. Long-Hauling to a Landfill Outside the Region

One alternative to disposing of waste at the Vermillion Landfill is to long haul the waste out of the Joint Powers region. In this scenario, the Landfill would be closed and waste would likely be hauled from the Yankton transfer station and a new transfer station in Vermillion. Currently, the LP Gill Landfill in Jackson, Nebraska (near Sioux City, Iowa) would be the likely landfill that would receive the waste. It is relatively close to the two cities and has a low tipping fee compared to other landfills in the area (posted tipping fee is $30 per ton for MSW).

Operating a transfer station typically costs around $20 per ton. The hauling costs to Jackson would depend on fuel prices; however it would likely cost another $3 to $5 per ton. Therefore, the total tipping fee would be approximately $53 to $55 per ton, assuming a disposal fee at LP Gill of $30 per ton. It should be noted that LP Gill could negotiate a lower tipping fee with Vermillion and Yankton.

In addition to potential additional cost, another disadvantage of hauling waste out of the region is the loss of control of the ultimate disposal of the waste. The Joint Powers would not have long term control of the tipping fee at the facility or first hand knowledge of the landfill's operations. The following figure shows the location of the LP Gill landfill relative to Vermillion and Yankton.

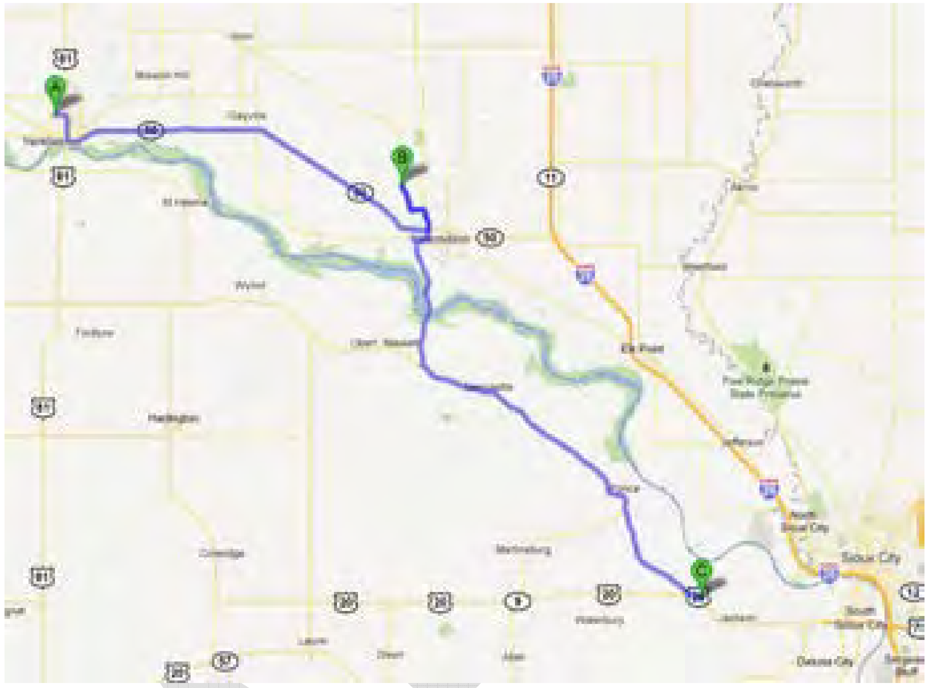

Figure 3 - Long-Haul Routes to LP Gill Landfill in Jackson, Nebraska
Reference: Google Maps

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<u>Recommendation</u>

HDR recommends that the City of Vermillion continue to operate a Landfill. Waste-to-energy technologies are either too expensive or not commercially proven. Long haul disposal of the waste to another landfill will likely cost more and will result in the Joint Powers losing control of their waste disposal.

Technical Memorandum

To:	Vermillion/Yankton Joint Integrated Solid Waste Management System		
From:	HDR Engineering, Inc.	Project:	Phase I Strategic Planning Study
CC:			
Date:	November 17, 2011	Job No:	HDR – 00000164381

Re: Recycling

The purpose of this technical memorandum is to discuss current recycling practices in Vermillion and Yankton, identify efficiency improvements to the recycling programs, show alternate recycling building layouts, and discuss the pros and cons of various recycling collection options (i.e. single stream, source separated, and drop-off box locations), ways to increase recycling participation, and methods for effective marketing of recyclable materials.

Recycling turns materials that would otherwise become waste into valuable resources. Recycling includes: 1) collecting materials that would otherwise be considered waste; 2) processing recyclables into raw materials that can be used to produce new products; and, 3) using the collected material, in whole or in part, in new products used by consumers, which completes the "recycling" cycle.

U.S. Environmental Protection Agency (USEPA) recommends an "integrated, three-tier hierarchical approach to municipal solid waste (MSW) management… The hierarchy favors source reduction to reduce the volume and toxicity of waste and to increase the useful life of manufactured products. Recycling, which includes composting, is the next preferred waste management approach to divert waste from landfills and combustors. The third tier of the hierarchy consists of combustion and landfilling. The goal of this approach is to use a combination of all of these methods to safely and effectively handle the MSW stream with the least adverse impact on human health and the environment. USEPA believes that each community should choose a mix of alternatives that most effectively meets its needs, looking first to source reduction and second to recycling as preferences to combustion and landfilling (Source: USEPA, *Wastes – Ask a Question*, "What is the municipal solid waste (MSW) hierarchy?," http://waste.custhelp.com/cgi-bin/waste.cfg/php/enduser/std_adp.php?p_faqid=1040, retrieved on 07/01/2009). A separate technical memorandum addresses composting (yard waste handling and processing).

I. Current Recycling Programs and Facilities

Vermillion and Yankton are involved in the initial steps of the recycling process by collecting and processing materials for use in a secondary market, thus diverting them from disposal. Each operates their own recycling programs with some materials from Yankton transferred to Vermillion for processing and marketing. Vermillion operates a curbside collection program, drop-off centers, a recycling center and recycling management at the Vermillion Landfill. Yankton operates a curbside collection program, drop-off centers, and recycling management at the Yankton Transfer Station. The following discusses the existing programs and facilities for each community.

A. Vermillion

Vermillion currently provides residential curbside collection and drop-off centers as recycling options for its citizens. The curbside collection program began in 2010. The process is typically referred to as a “curbside sort” recycling program in which materials are separated into three categories by the owner and further separated at the curb by the City worker collecting recyclables. Residents are provided two recycling bins for their recyclables.

- A green 18-gallon bin for plastics, aluminum and tin containers
- A blue 14-gallon bin for newspaper, office/mixed paper and magazines
- Cardboard placed underneath bins or between

The City worker collecting and sorting the materials places the collected materials into segregated compartments on the City’s recycling trailer.

Drop-off centers are available for public use at several locations throughout the City. There are a total of six drop-off center locations offered by the City. Four are located throughout town at schools and businesses. The other two are located at the Landfill and the Recycling Center. Recyclable materials accepted at the drop-offs include: plastics 1 and 2, aluminum, tin, other metals, newspaper, office mix, white ledger, magazines, hard back books, cardboard, clothing, shoes, and empty plastic chemical jugs.

The Recycling Center located at 840 Crawford Road serves as a drop-of center for the public and a processing facility for collected recyclables. Facility features include a truck scale, residential drop-off area, processing equipment, storage area, and roll-off boxes for residential drop-off of wood waste and yard waste. Recyclable materials are sorted and processed for sale and shipment through private recycling brokers.

Private hauler collection of old corrugated cardboard (OCC) is collected from the HyVee grocery store in Vermillion, as well as the Polaris factory and delivered to the Recycling Center for processing. The City of Vermillion pays a freight charge to private haulers and retains revenues from sale of the OCC.

In addition to the plastic, aluminum, tin, paper and cardboard that can be dropped off at the Landfill, electronic wastes, white goods (appliances) and tires can be dropped-off at a fee to the customer. Scrap metal can also be dropped off at the Landfill for a charge.

In addition to the drop-off centers described above, recyclable materials are also collected at the City’s Service Center. This is a location that is not open to the public. It is for City generated materials at the Service Center. Materials collected at the Service Center include plastic, scrap wire and scrap metal.

B. Yankton

Yankton provides a “curbside sort” recycling program to its citizens. Residents use their own covered containers that are labeled with a City provided tag that citizens can pick-up at City Hall or the Transfer Station. Residents can also drop-off plastics, aluminum cans and foil, tin cans, newspaper, mixed papers, magazines, cardboard, computer/white paper, and shredded office paper free of charge at the Transfer Station.

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Other materials that are accepted for future recycling at the Transfer Station include waste oil, white goods (must be free of electric motors and capacitors), refrigeration appliances (must be drained of Freon and free of compressors, capacitors and electric motors, aerosol cans (visible hole and free of fluids), and 55-gallon and other size metal barrels (one end must be cutout and barrel must be free of materials). These materials are accepted at no charge.

At the Yankton Transfer Station the following processing is completed. OCC and newspaper are baled throughout the day at the Transfer Station to keep up with the space limitations within the facility. Aluminum, tin cans, mixed paper, office paper and magazines are collected in gaylord boxes and shipped to the Vermillion recycling center for processing. Plastics are placed in a rear loaded compactor truck and shipped to the Vermillion Recycling Center for processing.

II. Facilities Evaluation

Visual observations of the Vermillion Recycling Center (at 840 Crawford Road, Vermillion) and the Yankton Transfer Station (at 1200 West 23rd Street, Yankton) were conducted during a site visit on June 27, 2011. The discussions below describe the facilities, site, equipment and operations that affect the recycling programs.

A. Vermillion Recycling Center

The Recycling Center was generally evaluated for operating capacity and physical conditions relevant to the City's short- and long-term recycling goals and diversion. Please reference the Attachment A drawings, including an aerial map and building map.

a. Structure and Site Observations

The Recycling Center is operated in a building that was not designed for material recovery operations and has been modified several times. It is possible that some features of the building may not be in compliance with building and safety code requirements. Key observations from HDR's review of the facility are described below.

- The processing area is insulated and heated during the winter months with radiant heat. The Center's baler, sort line, and associated recycling equipment is located in this area.
- There is a fire wall located between the storage area and the heated processing area.
- There are electrical service lines located along this fire wall and walls of the processing area, which will make building modifications in this area more complex.
- Water line runs along the walls of the heated processing area. Any building modifications need to keep water lines within heated area.
- Ventilation within the building is poor.
- Lighting within the building is poor.
- Loose storage space is limited.
- The building is relatively compartmentalized with several walls, storage areas, and processing areas breaking up the building. This makes moving materials in the facility relatively difficult and could be a potential safety issue.
- Curbside collection trailers and packer trucks drive through (south to north) the middle of building between processing area and material storage area (loose & baled) to unload their collected materials.

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b. Fixed and Mobile Equipment

The Recycling Center equipment includes processing equipment and mobile equipment. The equipment varies in age. The following are key observations related to the Recycling Center equipment.

- The sort line is old but still works well with two sorting positions. The belt magnet at the beginning of the sort line is old and limits the speed of processing mixed aluminum and tin cans.
- There needs to be a better way to feed the sort line. Currently, materials are lifted and loaded into a hopper.
    - Current hopper is small; thus greater time is needed to load materials
    - Infeed can not be in-floor due to high groundwater table
    - Consider a raised conveyor sort line with bins underneath
- City plans to get new baler in 2012.
    - This should provide heavier density on bales, including aluminum (600 lbs/bale)
    - New baler speed is anticipated to be about 30% faster

c. Operations

Observations of the structure, equipment, and site related directly to operational conditions are described below.

- If curbside collection is expanded, facility will need a new magnet and may need new sort line in order to handle increased quantities of recyclables. It should also be noted that there are only two sort positions on existing sort line which may not be enough if curbside collection is expanded.
- Aluminum cans were previously blown loose into a truck. The City is currently baling aluminum but broker must break bales apart and re-bale to meet market specs, resulting in lower revenues to the City. The City would prefer to bale aluminum and meet market bale specs.

B. Yankton Transfer Station

The recycling operations at the Yankton Transfer Station was generally evaluated for operating capacity and physical conditions relevant to the Yankton's recycling program.

a. Structure and Site Observations

The recycling operations are conducted within two buildings at the Transfer Station site. The Transfer Station building has the baler, two loading docks, and serves as the drop-off center for residential recyclables. The second smaller building is where the curbside recycling trailer unloads materials into gaylords for storage. Gaylord boxes with papers, aluminum and tin cans are transferred to a semi-trailer at the outdoor loading dock. The key building structure observations are described below.

- Transfer Station building
    - The configuration of the docks and bale storage space impact operations as described below.

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- The outdoor dock area has space available to park a second trailer. A second trailer could provide storage for loose or baled recyclables.

- Curbside recycling building
  - The curbside recycling building is small and appeared old. Direct condition of the building structure was not evaluated.
  - This building has limited storage space.
    - One half of the building is for backing the curbside recycling trailer and unloading the trailer bins directly into gaylord boxes.
    - The second half of building has several boxes stacked one and two high prior to transfer for recycling processing.

b. Fixed and Mobile Equipment

The recycling equipment includes processing equipment and mobile equipment. The baler is a few years old and is utilized to bale only corrugated cardboard and newspaper. This baler may be capable of baling other recyclable materials. Other mobile equipment includes a forklift, trailers and rear loader (shared with other solid waste operations). There is no conveyor sort line and very limited space for sorting recyclables.

c. Operations

Observations of the structure, equipment, and site related directly to operational conditions are described below.

- Corrugated cardboard and newspapers are baled throughout the day to keep up with space limitations.
- Baled corrugated cardboard is stored within the Transfer Station building near the C&D unloading area, which requires the bales to be moved across the MSW unloading area when being stored. Baled newspaper is stored in a docked trailer.
- Because of the limited storage area for baled materials, Yankton is not able to hold onto materials and contract the best price (rather, recyclables must be picked up when there is a full load of recyclables ready for delivery).

III. Program Options

Recycling program options can take many forms and involve differing levels of participants, program/services, and materials. In terms of participants, the main categories are residential, multi-family, and commercial/industrial. Level of service refers to how recycling opportunities and programs are presented to potential users. The Cities of Vermillion and Yankton both provide curbside recycling service (source separated at the curb) to all their single family households within City limits (and up to four-plexes in Vermillion). Some may characterize this service as mandatory in the fact that households are provided the service whether they participate or not. However the program is voluntary since residents and businesses can (voluntarily) do as they chose (recycle or not) through the programs provided. Participation at the drop-off centers is also voluntary.

There are a wide array of options that can increase the quantity of material recycled or diverted from disposal; several recycling program options have been identified that could be applicable to the Cities in the future. These include the following residential and commercial materials recycling options:

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Residential

- Additional Drop-off (Convenience) Centers
- Evaluate and Expand Curbside Collection
    - o Curb-Sort (current system)
    - o Dual-Stream
    - o Single-Stream

Commercial

- Provide drop-off/Processing at the Recycling Center and Transfer Station
    - o Voluntary
    - o Buyback purchase
- Collection at Business or Industry

These options are conceptually evaluated in terms of potential tons of materials diverted per household set-out; infrastructure and operational requirements; and, general costs or typical costs for such programs. Under each option, the potential impact to the processing and operations at the Recycling Center is discussed.

A. Residential

The typical household generates a wide array of materials that can be recycled. These residential sources also present the greatest number of program options. Nationwide there are hundreds of different types or variations in program options for recycling materials generated at a household/residential level. This memorandum deals with the most common types and presents them in general concept. If additional interest develops in implementing such programs, then additional analysis and refinement of these concepts may be appropriate.

a. Drop-Off Centers

Convenience centers are as the name describes – a convenient location for residents to drop-off recyclable materials on a voluntary basis. The exact definition of how far one might conveniently travel to use such a facility varies by user. Convenience/drop-off facilities are the simplest example of voluntary recycling programs.

The drop-off centers in Vermillion and at the Yankton Transfer Station are examples of distributed and centralized residential (and commercial) convenience facility. Typically, distributed drop-off facilities are located at or with other convenient (household-use type) facilities such as grocery stores, schools, churches, or government buildings. Materials collected at the drop-off centers are hauled to a central processing facility (e.g. Recycling Center).

Drop-off centers have historically contributed only a small percent towards recycling quantities when compared to other more costly approaches. Table 1 further describes some of the advantages and disadvantages of distributed drop-off centers.

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Table 1
Distributed Drop-Off Centers

Advantages	Disadvantages
Easy to implement	Recovery rates are generally low (i.e. less than 3% of residential waste stream)
Low capital cost and operating costs	Potential higher contamination rates than a staffed receiving facility
Can target multiple materials and can achieve a certain level of pre-sorting by users	Potential for illegal waste dumping and vandalism
Minimal effort is required to change recycling program to add or remove a material (based upon markets or policy changes)	Quality of recyclables can be impacted by people scavenging high revenue materials, e.g. aluminum.
Can be open 24 hours per day	
Can be a supplement to other recycling efforts	

Conveniently located drop-off centers with service area of one- to two-mile radius and public education could average 50 to 70 pounds per capita per year of recovered materials from residents. When drop-offs supplement curbside recycling, this average would decrease to about 25 to 35 pounds per capita per year since participants will mostly be residents without the curbside service (i.e. multi-family units).

Costs of distributed drop-off centers vary widely; Table 2 presents the typical factors used in determining the cost of implementing such facilities.

Table 2
Drop-Off Center Costs and Considerations

Cost Component	Typical Range of Costs	Cost Considerations*
Site Improvement	$0 to $15,000	Co-location with existing businesses/service vs. new construction
Multi-Material Containers or Recycling Trailers	$7,000 - $9,000 each Trailers up to $15,000 each	30-cubic yard gable-top roll-off or mobile trailers
Dumpster-Style Containers	$400 to $650 each	1-CY to 4-CY

* Grant funding could help off-set the costs of developing recycling drop-off centers.

Infrastructure and operational considerations may include part-time efforts to inspect, clean up litter at the sites, and place recyclables in appropriate compartments. This may take place when the container(s) are collected. It may also be possible to do this with existing staff.

b. Curbside Collection

Curbside collection provides a relatively higher level of residential recyclables diversion, especially when compared with convenience drop-off centers. By contrast it is significantly more costly to implement and operate. Various program options can be tailored to specific community's goals and policies. The preferable method for any given community is a function of costs, diversion goals, public and institutional support. To optimize success, a curbside program also requires public relations, enforced regulations, educating households, and encouraging participation.

The following are the more common or historically tested programs:

- **Curbside Sort** – Hauler separates mixed/commingled or semi-commingled recyclables at the curb into compartmentalized recycling vehicle or trailer.
- **Dual-Stream** – The collection vehicle has split compartments, one compartment for papers and cardboard and one compartment for containers; alternatively, paper fibers are collected one week in a packer-type truck and commingled containers (glass, cans and plastics) are collected the following week.
- **Single Stream** – All recyclables are collected in one truck, usually a packer-type truck or automated collection system. Automated collection systems uses special trucks equipped with robotic arms to lift and unload carts. Single stream collection method typically excludes glass due to the potential for the broken glass to contaminate other recyclables.

Commingled (including single stream) recycling collection requires some level of processing and sorting at a material recycling facility. Curbside sorted materials can be kept separate and be directly processed at the existing Recycling Center.

i. Curbside Sort Collection Option

A curbside sort (multi-stream) collection option provides the greatest amount of source-separation of recyclables by the generators (households) themselves with additional sorting provided by the collection personnel at the curb. This option decreases the amount of sorting at the Recycling Center necessary to market individual material types, but increases both the collection costs and the amount of effort required by residents. Some considerations with the curbside sort are:

- Smaller specialized collection trucks with greater staff on the truck
- Collection routes average 450 to 500 stops/route; more time is consumed per stop as a result of the need to sort
- Produces quality products with minimal post-collection processing
- Estimated results with good education and mature program:
  - Average annual participation of households with a multi-bin approach of 50 percent
  - Estimate 25 - 30 lbs per household per set-out

This option typically diverts the lowest quantity of recyclables and will have a relatively high collection cost per ton. However, collection with curbside sorting provides the highest quality of recyclable materials and would have minimal processing requirements (i.e. lowest processing costs) at the Recycling Center. The general costs of curbside sort option compared to other collection options are:

- Low equipment capital and maintenance costs
- Higher labor costs (driver plus labor for manual collection, including curbside sorting of materials)
- Initial high bin purchase costs

ii. Dual-Stream Collection Option

A dual-stream collection option may be evaluated to consider an increase in collection efficiency and reduced effort by residents over curb-sort, multi-stream collection, while keeping paper and container recyclables separate (and maintaining market value). Dual stream collection could utilize a rear load packer truck with collection of containers one week and papers the next week, or evaluate use of a split-body packer truck. The number of households and stops served daily will be lower with split-body collection; this would increase the number of routes compared to traditional

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rear loader but could provide overall reduced collection costs over a two-week period. One of the issues with split-body truck collection, however, is that one side may fill-up quickly causing the truck to leave the route early in order to unload at the recycling facility. Considerations with the dual-stream collection option are:

- Large garbage packer trucks can be utilized (split compartment or single)
- Collection routes average 700 to 800 stops/route for manual collection (split-body truck collection would average lower number of stops)
- Requires greater processing for sorting of the commingled papers and commingled containers
- Estimated results with good education and mature program:
  - Average annual participation of households of 60 to 70 percent (Commingled home storage is believed to increase public participation)
  - Estimate 30 to 35 lbs per household per set-out

This option will divert a mid-range quantity of recyclables at a higher collection cost per ton. The dual-stream collection provides reasonably high quality recyclable materials as long as materials (especially containers) are further sorted and processed at the Recycling Center. The additional processing requirements would require some modifications to the existing Recycling Center and staffing. Without processing, materials marketed as commingled papers or containers will earn lower revenues than the source-separated materials in the curb-side sort option. The general costs of dual-stream collection option compared to other collection options are:

- Relatively high equipment capital and maintenance cost (purchase of new rear-load compaction trucks can be $185,000 or more)
- Higher labor costs (driver plus labor for manual collection similar to curbsort) – potential savings in the greater number of households served per route and consolidation of routes
- Initial high bin purchase costs

The dual-stream system could be easily implemented with Vermillion's current 2-bin system. Residents would not require new containers. Routing changes would need to be evaluated to maximize collection efficiency and minimize the number of routes. Additional public education would be required to re-educate the public.

The City of Yankton may also be able to implement a dual-stream system; routing impacts, recycling tag modifications or provision of bins, and public education would need to be evaluated.

The current Recycling Center layout, sorting equipment, and staff would not be adequate to handle the greater processing requirements required under a dual-stream system. The proposed Recycling Center modifications and costs would need to be evaluated in conjunction with implementation of any dual-stream system.

The potential increases in participation, quantities of recovered materials while still maintaining a level of quality, collection/route efficiencies, and potential for expansion of service within existing number of collection days could make the dual-stream system beneficial to the Joint Powers overall recycling programs.

iii. Single-Stream Collection Option

A single-stream collection option may be considered for the greatest level of collection efficiency and least effort by residents. The level of commingling in this option, however, requires significant sorting of collection materials at the Recycling Center or reduced market value. Considerations with the single-stream collection option are:

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- Large garbage packer trucks can be utilized or large specialized trucks (automated) for collection
- Collection routes average 700 to 800 stops/route for manual collection and 900 to 1000 stops/route for automated collection systems
- Requires the greatest processing for sorting of the commingled materials
- Higher contamination rates can lead to lower revenues for degraded recyclable commodities (glass is a primary culprit and is often excluded from single stream programs)
- Estimated results with good education and mature program:
  - Average annual participation of households of 70 to 80 percent
  - Estimate 40 to 50 lbs per household per set-out

Currently glass is not collected by the Cities in their curbside recycling programs; thus, the exclusion of glass would not be a change.

This option will divert a high quantity of recyclables and will have a lower cost per ton. However, single-stream collection provides the lowest quality of recyclable materials and would require a high level of processing (manually and mechanically). If the single stream processing was to be done in Vermillion at the Recycling Center, single stream sorting would require extensive building modifications (possibly expansion) and purchasing new sorting equipment in order to receive, handle, and process the anticipated quantities. Staffing requirements would also increase. As an alternative, single stream materials could be collected and hauled to a company in Sioux Falls that mechanically separates the materials for a cost.

The general costs of single-stream collection option compared to other collection options are:

- Relatively high equipment capital and maintenance cost (purchase of new rear-load compaction trucks can be about $185,000 or more; automated side-load compaction truck can be about $240,000)
- Lower labor costs with automated collection (1 driver, fewer routes, every other week collection)
- New 65-gallon collection carts would likely be needed in both Vermillion and Yankton, adding to the cost of implementing single stream recycling.

As previously mentioned, this collection option requires the greatest processing of materials which will significantly increase costs of providing recycling services. Any savings from collection and increases in recyclable quantities would need to be evaluated against the increased expenses for processing.

Pay "As-You-Throw" Collection

A variation in solid waste collection practice that has also lead to further increases in voluntary recycling is a program generically called "pay-as-you-throw". This involves charging household garbage collection rates based on the size of the container they use; the concept is to encourage recycling/diversion through a financial incentive of lowering the household garbage collection rate. These pay-as-you-throw garbage collection systems, in conjunction with curbside recycling, have shown increases in overall recycling rates of 5 to 6 percent of the total waste stream (Skumatz/SERA, PAYT In the US: 2006 Update and Analyses, December 2006).

Residential Recycling Collection Summary

Collecting and marketing recycled materials can represent a significant investment and expense for a community and its residents. The USEPA, Wastes – Resource Conservation – Tools (**www.epa.gov/waste/conserve/tools/localgov/economics/index.htm**) for Local Government

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Recycling Programs identifies the primary impacts to the “per ton” or “per household” costs of collecting recyclables as the following:

- **Costs increase with the number of separately segregated commodities collected.** Single-stream collection (all recyclables combined in a single bin/container) programs are the least costly to collect, followed by two-stream (2 containers/separations), etc.
- **Costs increase with the frequency of collection.** Collecting half as frequently as waste pick-up (e.g., every other week instead of weekly) can reduce collection costs by approximately 25 percent, assuming traditional two-stream set outs.
- **Costs decrease as more materials are collected by the program.** If few households participate in the program and the program does not collect many commodities, the per household cost soars, as it is costly to drive a recycling truck past household after household that has not set out recyclables.

B. Commercial

Focusing on the commercial waste stream for the collection of recyclables can dramatically increase the recycling rates. High quality, source separated papers (and in some instances select plastics or metals) can often be obtained from commercial businesses. Commercial recycling generally brings the largest amount of recyclable materials for least cost per ton; a lower cost per ton of recovered material than a residential recycling program. Because this can often be an easily captured material stream with potentially high resale value, private recyclers often/periodically target commercial material as a source of income. Effective commercial recycling programs often target corrugated cardboard and office paper as the two predominant waste streams.

The Cities of Vermillion and Yankton already accept clean loads of corrugated cardboard at the Recycling Center and Transfer Station, respectively. Businesses are not charged a fee and in some cases paid a nominal amount for freight charge to deliver corrugated cardboard loads to the Recycling Center. The City of Vermillion also has a pilot program of limited collection of corrugated cardboard on Mondays from some area businesses. Discussions of expanding this pilot program are included below under Section IV(A), Recycling Program Improvements.

Both Vermillion and Yankton can increase promotion and education to local businesses on the economic benefits of separating corrugated cardboard and delivering to the Recycling Center or Transfer Station for recycling.

IV. Recommended Recycling Program Improvements

From discussions with City staff in both communities and visual observations conducted during the site visit on June 27, 2011, HDR has identified recycling program improvements for the following areas of the programs.

- Recycling Collection Systems
- Vermillion Recycling Center
- Yankton Transfer Station
- Public Education and Recycling Participation

Recommended improvements in these areas are summarized in the sections below.

A. Recycling Collection System

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It is recommended that the following recycling collection system improvements be considered. These improvements need to be evaluated for cost and degree of operational modifications needed to implement.

- Expand recycling collection to assisted living centers and large multi-plex residential buildings;
- Evaluate dual-stream collection system option;
- Expand commercial cardboard collection program in Vermillion;
- Expand drop-off locations in Yankton;
- Evaluate privatizing recycling collection.

Expand Recycling Collection

Both the City of Vermillion and the City of Yankton residential recycling collection system include weekly curbside collection (curb-sort) and drop-off centers. Both cities have received inquiries to expand recycling to larger residential buildings. With the interest expressed to expand recycling, it is recommended that the Joint Powers and the Cities of Vermillion and Yankton evaluate expanding these recycling collection services to the trailer courts, assisted living centers and larger apartments (greater than 4-plexes). Items to consider in the evaluation include:

- Evaluate existing collection routes (number of households, route path, times, and quantities) to help identify how best to incorporate the expanded service area and revise the routes. Route revisions will need to consider which collection method (curb-sort, dual-stream or single stream) will be implemented under an expanded program.
- Under the existing 2-bin, curbside sort collection system, the evaluation should consider the following:
    - Location and number of collection points/stops for apartments and assisted living centers
    - Additional bin costs for expanded service area
    - Number of routes required to serve total number of households/units – revise daily routes for best collection efficiency
    - Monday collection route and/or addition of another recycling collection crew to cover expanded curbside recycling services
    - Identify how these residents will be charged for curbside recycling – some apartments and living facilities may include utilities as part of the monthly rent
    - Re-calculate the monthly recycling fee based on expanded services
- Evaluate the modifications and additional operational processing costs that would be needed at the Vermillion Recycling Center to accommodate an increase in recycling quantities. The cost to process additional recyclables should be considered when evaluating expansion of the recycling collection system.

Evaluate Dual Stream Collection

Since the City utilizes a 2-bin set-out for the curbside sort collection system, it is recommended that the City evaluate **dual-stream collection** (as described above) to increase collection efficiencies and potentially expand services while utilizing existing staff. Such evaluation should consider the following:

- Capital and annual maintenance costs of rear loader (or split-body) packer truck
- Location and number of collection points/stops for apartments and assisted living centers

- o Number of routes required with ability to handle greater number of stops – revise daily routes for best collection efficiency
- o Additional bin costs for only the expanded service area
- o Level of citizen resistance to change (i.e. single rear loader collection would likely require commingled containers one week and commingled papers the other week versus current weekly collection of both material streams now)
- o Additional costs of processing the commingled streams at the Recycling Center
- o Level of equipment modifications (i.e. sort line) and capital costs required at the Recycling Center to meet the processing needs
- o Calculate the monthly recycling fee based on both costs of collection and differential costs of processing

Single-stream collection would provide the greatest efficiencies in collection; however the processing requirements could exceed the savings in collection. In addition, the Recycling Center is not set-up for full recyclables sorting and may be difficult to modify sufficiently to allow single-stream sorting. As an alternative to processing at the Recycling Center, the collected single-stream recyclables could be hauled to a privately owned single stream recycling center in Sioux Falls. This method would have additional costs to load materials into a transfer trailer, haul it, and pay a fee to the processing company. Because of the additional costs associated with single-stream recycling, it is not recommended for further evaluation at this time.

See further discussion and descriptions of each curbside collection method under Section III, Program Options.

Expand Commercial Cardboard Collection Program in Vermillion

The City of Vermillion operates a pilot program to collect corrugated cardboard from a limited number of businesses on Mondays (day of week with no residential collection). Since commercial recycling provides greater quantities of clean materials, Vermillion should evaluate expanding the commercial OCC collection service. The current collection system is inefficient (materials are filled into a trailer and manually unloaded) and does not allow for increasing business customers. As such, a covered roll-off container or rear-load packer truck should be considered for corrugated cardboard collection.

- The roll-off container provides a lower capital cost option (i.e. $4,000 to $5,000 for new roll-off; $6,000 to $7,000 for covered roll-off). The roll-off container requires manual loading of cardboard into the container but would be more efficient with unloading than the current trailer system. A roll-off truck will also need to be made available from other operations to haul the container. Alternatively, the City could provide dedicated roll-offs to businesses with significant quantities of corrugated cardboard for scheduled or on-call pick-ups.
- The rear loader provides the greatest flexibility to increase business customers and corrugated cardboard quantities while reducing labor (i.e. faster collection). However, the initial capital cost of a rear loader may not be economically viable for the number of business collections available, operating one day a week. Under the evaluation of dual-stream collection for the expansion of the curbside recycling program, the benefit of using the rear loader (or split-body) for the commercial corrugated cardboard collection should be included in the evaluation.

Expand Drop-off Locations in Yankton

In addition to curbside recycling, the City of Yankton has one drop-off center located at the Transfer Station. As a low-cost option to expand recycling services to residents, the City should consider locating one or more additional drop-off center to provide convenient recycling to citizens located farther from the Transfer Station site.

Evaluate Privatizing Recycling Collection

As an alternative to City collection of recyclables, some communities solicit bids from private companies to collect and process recyclables. For example, the City of Mitchell has privately run recycling program. All of the equipment and personnel necessary to collect and process the materials (i.e. recycling bins, trucks, and drivers) are provided by the private company.

According to City of Mitchell staff, the cost of the program is less than $4 per month per household, including collection and processing. As shown in the Cost of Service technical memorandum, recycling processing costs for the City of Vermillion and the City of Yankton total approximately $450,000 annually (note that this does not include costs associated with recycling collection, which are not a Joint Powers expense). Revenues from the sale of the collected recyclables vary depending on the market prices; however, in 2010 the revenue generated from recyclables was approximately $240,000. Combined, the two Cities provide curbside recycling service to approximately 6,500 residences. Considering the cost of processing, revenues from the sale of recyclables, and the number of residences served, the cost of processing recyclables is approximately $2.70 per month per household (again, note that this does not include costs associated with recycling collection).

As discussed in the recommendation sections above, the expansion of recycling services and possible switch to a dual stream collection system needs to be done with consideration to cost. When considering the cost of these services it should be compared with the alternative of privatizing the recycling collection and processing system. The request for bids could include specific details that are unique to the Vermillion and Yankton communities (e.g. include collection of recyclables from apartment buildings, use the existing 2-bin system that is currently in place in Vermillion, etc.).

B. Vermillion Recycling Center

Several process and building improvements were evaluated for the Recycling Center located in Vermillion. Since this facility provides the processing not only for Vermillion's recyclables but also for plastics, aluminum, tin cans, and mixed papers from Yankton, modifications need to address quantities and potential collection programs from both communities.

General process and building improvements include:

- Modify building layout to store all loose materials closer to baler. Identify minimum areas needed for loose material storage and area by sort line.
- Provide greater area for a larger sort line, preferably raised with bunkers below.
- Add new cross belt magnet on existing sort line or as part of new/expanded sort line (cost of cross belt magnet estimated to be $10,000 to $20,000 depending upon manufacturer and size).
- Increase baled material storage, if possible, to allow flexibility in selling recyclables at better market rates.
- Consider moving offices and break room out of the current building footprint to create more room for recycling activities and storage.
  - Roll-offs for yard waste and wood waste could be relocated if office/break room added on to north side of building
  - Avoid electrical transformer located outside of building north of northeast corner

C. Yankton Transfer Station

Recycling related improvements are summarized in the Yankton Transfer Station Technical Memorandum.

D. Public Education and Recycling Participation

Public education about services, service changes, rules, regulations, guidelines, and desired behavior is a critical component of any recycling program. Without adequate education and the resulting compliance from those impacted, the cost to provide services would undoubtedly increase. Public education is essential to ensure success for the enhanced recycling programs.

Existing staff with the Cities of Vermillion and Yankton solid waste programs have been tasked with public education as one small component of their responsibilities. At the implementation of a service change (i.e. curbside recycling collection), extra time and effort for public education was expended at the start-up. However, sustained public education to increase participation has been more difficult. The City of Vermillion identified a few reasons why some people were not participating in the curbside recycling collection or drop-offs.

- People who previously took recyclables to the Recycling Center drop-off for free now have issues with paying for curbside recycling services.
- Assisted living apartment dwellers (elderly) would like to have curbside recycling at their building, since they are not able to take recyclables to the drop-off centers.
- Other apartment dwellers may not be participating through the drop-off program since it is not convenient; space constraints in apartments for storage of recyclables are another common reason for lack of participation.

Increasing participation includes expanding curbside collection (discussed in previous section) and implementing active public education strategies described below. A variety of educational efforts would support the program enhancements and options. Just as changes in programs may be phased, education programs would be designed in phases also. And, because education and outreach methods are constantly evolving with new technologies and changing media, this section provides a recommended approach based on current knowledge.

Education for recycling programs should make residents aware of the options available (source reduction, curbside and drop-off centers), days of collection and frequency, locations of drop-off centers, services, hours, and items acceptable. Common education strategies to support the recycling programs enhancements and increase participation would include:

- Increase communications/announcements via existing City's website and local cable channel;
  - Include calendars for service areas collection days
  - List all drop-off locations, hours, and items accepted
- Electronic announcements via website, e-mail and digital media (e.g. Facebook and Twitter);
- Direct mail one-page brochure;
- Flyers and posters;
- Local print advertising;
- Radio advertising;
- Other television/cable advertising; and
- Truck signs.

The Joint-Powers and/or each City should identify which education initiatives can be led by existing solid waste staff or other City personnel, and when necessary, seek outside assistance from other professionals such as graphic artists and advertising professionals. The timing for specific education programs varies depending on the service being implemented and the message goals. As a general rule of thumb, education planning and work should begin at least six months prior to a new or revised service launch.

For increasing commercial recycling of corrugated cardboard the preferred outreach method would most likely include direct mail to local businesses in Vermillion and Yankton. The outreach mailings/brochures should identify the drop-off center(s) information and contact for each City. Expanding the pilot corrugated cardboard collection program in Vermillion will most likely require a separate direct mailing and telephone communications to those businesses known to generate significant quantities of corrugated cardboard with no current diversion alternative.

V. Recycled Materials Markets

One of the greatest sources of uncertainty in recycling is the prices for commodities such as newspaper, cardboard, mixed paper, plastic, and metals. Prices for commodities vary daily and have varied tremendously over the past several years (near record highs and lows). Secondary materials markets experienced an extreme downturn since September 2008. Materials prices have rebounded somewhat but are still highly variable. This price variation can present a significant risk to the processing facility (or party responsible for brokering the recyclables), especially if there are minimum levels of revenue required to be profitable or sustain operations.

Each of the Cities and Joint-Powers, as a processor of source-separated recyclables, can generate significant revenues when recycling markets are high, but can lose money in times of down markets. A fundamental issue that the Joint-Powers will need to consider in defining the level of recycling that it would like to provide/implement is its commitment to this service as a long-term investment. One of the greatest risks to the success of a program, especially a program targeting residentially recycled materials, is reliability. If facilities open and close, services change frequently and reliability (availability) to the residents is uncertain, people will become disgruntled and the level of support and participation can drop off significantly. This can in turn affect future success and diversion rates.

The City of Vermillion and City of Yankton appear to be doing an effective job in marketing the recyclable products they currently accept and process. Vermillion checks material prices twice a month with the 3 to 4 recycling buyers and keeps track of which markets provide higher and more stable prices. Both Vermillion and Yankton should continue the strong relationships they have developed with their current buyers. With the possibility of increasing the quantities of materials to the Recycling Center through expanded curbside residential/commercial programs and education, it is recommended that Vermillion communicate with their buyers to review level of materials sorting (i.e. prices for mixed materials vs. greater sorting) and processing (i.e. baled vs. loose). Some items to note with general material markets are:

- Sorted paper is likely to generate higher revenues for most buyers (providing acceptable bale size and the density generated by high-penetration balers)
    - Some multi-material buyers may prefer directories and soft books (newsprint) to be collected with newspaper instead of with office mix

- Some buyers find that communities may not produce a high enough quality white ledger to market separately
- Baled materials may or may not generate higher revenues for some buyers (e.g., in some areas Green Fiber or other end users are set up to accept primarily loose fiber)
- Separating HDPE resins by color may increase revenues depending on buyers/end users
- The cost of recycling glass typically exceeds any revenues, which is why glass is not currently collected in the recycling programs. Joint-Powers could evaluate alternative local options for glass management such as crushing and using as aggregate at the solid waste facilities

The Joint-Powers might also consider exploring opportunities to establish partnerships with other organizations (i.e. Keep Yankton Beautiful, Inc., local waste haulers, etc.) and increase waste diversion - ideally for a stable and consistent quality and quantity of materials over time which could improve revenues.

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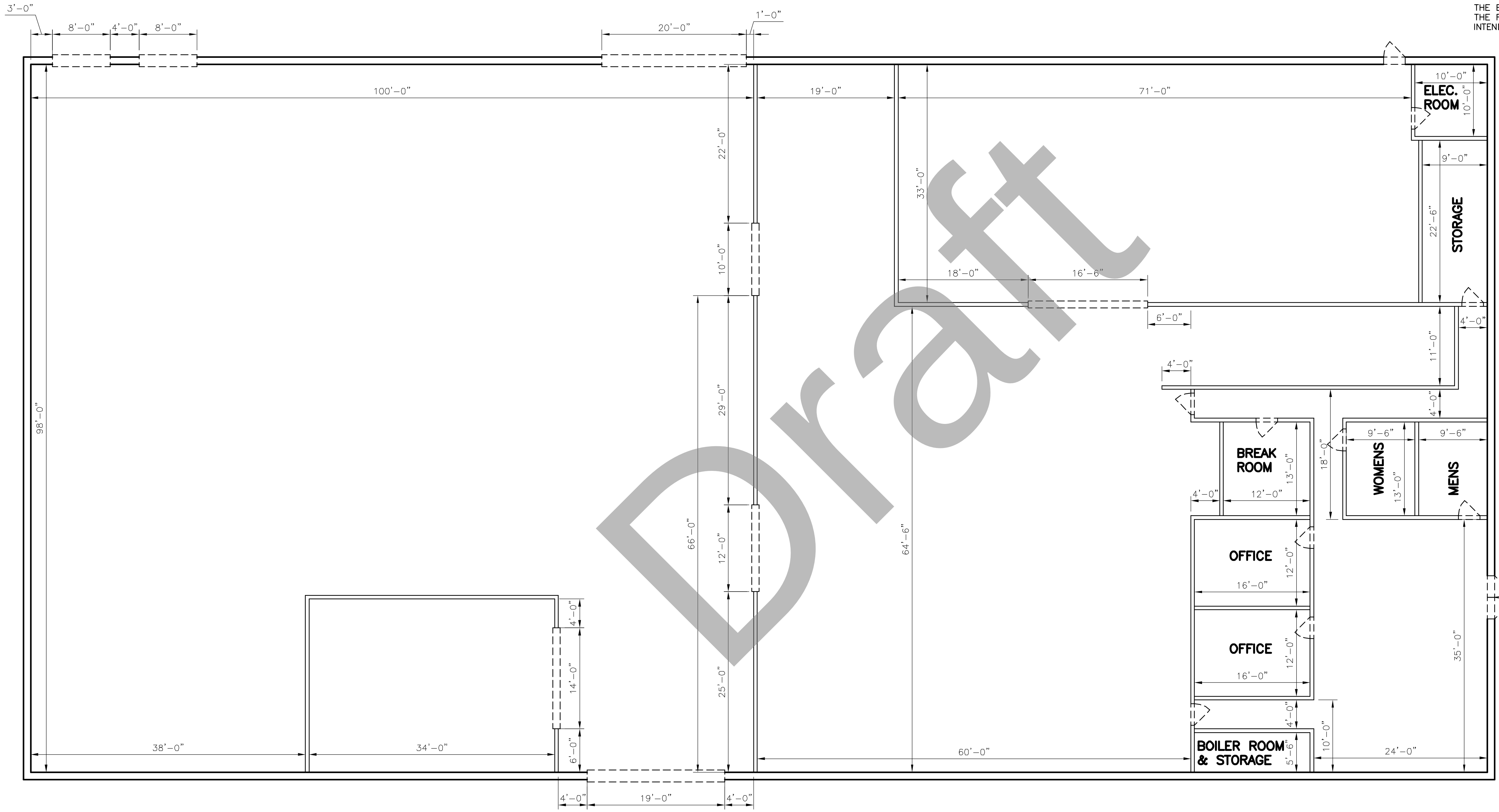
EXISTING RECYCLING BUILDING

SCALE: 1/16"=1'-0"

NOTES:

THE BUILDING DIMENSIONS SHOWN WERE MEASURED IN THE FIELD WITH A TAPE MEASURE. THEY ARE NOT INTENDED FOR CONSTRUCTION DESIGN.



Draft

VERMILLION

SOLID WASTE MASTER PLAN

EXISTING RECYCLING BUILDING

DESIGNED BY:MJE
DRAWN BY: RAC
CHECKED BY: TJY
REVISIONS:
ACAD FILE:H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011

CITY OF VERMILLION

SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.

2

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

RECYCLING BUILDING LOCATION

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION
SOLID WASTE MASTER PLAN

RECYCLING BUILDING LOCATION

DESIGNED BY:MJE
DRAWN BY: RAC
CHECKED BY:TJY
ACAD FILE:H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011
REVISIONS: BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
1

YANKTON TRANSFER STATION

YANKTON

YANKTON TRANSFER STATION

DESIGNED BY:MJE
DRAWN BY: RAC
CHECKED BY:TJY
ACAD FILE:H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011
REVISIONS: BY: DATE:
BY: DATE:

CITY OF YANKTON
SOLID WASTE COLLECTION
416 WALNUT STREET, YANKTON, SD
PHONE:(605)668-5251

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

FIGURE NO.
1

Technical Memorandum

To:	Vermillion/Yankton Joint Integrated Solid Waste Management System		
From:	HDR Engineering, Inc.	Project:	Phase I Strategic Planning Study
CC:			
Date:	November 17, 2011	Job No:	HDR – 00000164381

Re: Vermillion Landfill

As part of this technical memorandum, the following areas of the Vermillion Landfill operation were reviewed:

- Leachate management and future trench orientation
- Facility layout
- Landfill gas collection and reuse
- Leachate recirculation (Bioreactor)
- Final cover contours

These areas are summarized in separate sections below. A site map of the existing facility layout and topography is included as Attachment A.

I. Leachate Management and Future Trench Orientation

Leachate Management and Future Trench Orientation has been previously addressed by the following documents:

- Technical Memorandum dated April 18, 2011 regarding "Leachate Management Plan – Vermillion Landfill"
- Permit modification letter to South Dakota, Department of Environment and Natural Resources (DENR) dated April 29, 2011 regarding "Permit Modification, Vermillion Landfill Permit No. 10-04, Landfill Cell Excavation Depth Modification"

The following briefly describes each document.

A. April 18, 2011, Leachate Management Plan, Technical Memorandum

This technical memorandum was prepared to summarize specific design considerations related to modifying the existing leachate management system at the Vermillion Landfill. The memorandum was intended to provide design options and prepare design materials for use in the permit modification request. In general, options to lower the waste cell base grades were analyzed in conjunction with leachate management systems and future trench orientation. The memorandum covered the following topics:

- Geotechnical Evaluation
- Base Grade and Cell Orientation Options
- Liner System

- Hydrologic Evaluation of Landfill Performance (HELP) Modeling
- Leachate Collection Piping
- Leachate Collection Sump Pump
- Trench 4 Piping Modification
- Leachate Pond

B. Permit Modification Letter

After discussion of the technical memorandum with Vermillion staff, a permit modification letter was submitted to the DENR with the chosen future trench orientation alternative. The permit modification was requested to allow for deeper cell excavations. Information included in the letter included supporting information similar to the technical memorandum. This information included:

- Hydrogeologic evaluation of the underlying soils and ground water
- Updated base grade contours and cell orientation plan for the deeper cells
- Liner system summary and assessment
- Leachate generation and liner head estimates utilizing the HELP model
- Leachate collection pipe sizing and pipe strength calculations
- Leachate collection sump pump sizing
- Leachate management plan summary

A copy of this permit modification request letter has been included for reference as Attachment B.

As part of preparation of this technical memorandum, Leggette, Brashears & Graham, Inc. (LBG) reviewed and provided comments on the permit modification request letter based on their long-term familiarity with the site and the compatibility of the modifications with the development history and hydrogeology of the site. A copy of LBG's comment letter is included as Attachment C to this technical memorandum.

II. Facility Layout

The purpose of this Section is to review the following facility layout considerations:

- Relocation of the facility's scale, scalehouse and baler building;
- Need for acquiring adjacent property;
- Site entrance improvements and alternatives;
- Stormwater drainage.

A. Relocation of Infrastructure

As currently permitted, the landfill will eventually encroach upon the area where the existing baler building and scalehouse are located. These buildings, as well as any other infrastructure within the future waste footprint will have to be relocated prior to those cells being constructed. However, according to the currently permitted fill plan, this will not be required until the site starts work on future Cells 11 and 12. The following table summarizes the remaining volume and life of the landfill as currently permitted.

Volume and Life Estimates

Future Cells	Additional Fill Volume (cu. yds.)	Landfill Life (calendar year)	Average Cell Life (years)
Cells 5 - 14	3,808,000	2058	Approx. 4.6

Assumptions:
1. Landfill life assumes waste placement in Cell 5 starting in 2013
2. Annual waste tonnage in 2010 at 36,500 tons
3. Annual waste tonnage growth rate at 1%
4. Final cover simplified volume estimated by waste footprint area and 4.5' thickness
5. Airspace utilization factor (compaction) at 0.62 tons/cu.yd.
6. Additional fill volume is calculated based on the newly permitted lower base grade contours and the current permitted final contours

As shown on the table, an average useful life of a future waste cell is approximately 4.6 years. Using this average factor, and assuming that the buildings must be removed while filling Cell 10 and excavating Cell 11; it will be approximately 28 years before relocation of these buildings is required. This timeframe would be extended if the higher final cover contours (discussed in separate section of this technical memorandum) are permitted.

B. Additional Property Acquisition

Related to the relocation of these buildings, and the facility layout as a whole, the possible acquisition of the property directly adjacent to the southern boundary of the site has been reviewed. Attachment D shows the location of the two parcels. Note that it is HDR's understanding, based on discussion with City staff, that the current landowner is not interested in selling the property at this time. However, the following are some noted advantages to City ownership of the land:

- Additional buffer for odor and noise considerations are always advantageous for landfill operations, especially if City development extends away from the City and out toward the Landfill.
- As currently permitted, the existing scale house and baler building will eventually need to be relocated. There is very limited amount of area on the current Landfill property for these buildings to be relocated to. The buildings could be relocated to the new property.
- Currently, groundwater monitoring wells on the southern property boundary have detected limited landfill related groundwater impacts. Purchase of land to the south of the site would provide more down-gradient buffer for groundwater monitoring and/or remediation in the future. See letter from Leggette, Brashears & Graham, Inc. in Attachment C for further groundwater monitoring discussion and related property acquisition needs.
- Purchase of land to the south of the site could also provide space for an alternative entrance to the Landfill (from Highway 19 located to the east of the site).
- Although current discussion of landfill life and vertical expansion of the waste cells provides for over 40 years of waste capacity, the City may want to expand the waste footprint to allow for more waste capacity.

C. Site Entrance Improvements and Alternatives

Currently, there is only one entrance to the site, which is located on the west side of the property along Bluff Road. The topography in that area creates an entrance that runs at an angle up a steep slope on the landfill property (see Attachment A). The entrance road and Bluff Road intersect at a sharp angle that makes line-of-sight difficult as vehicles exit the landfill on to Bluff Road. Unfortunately, there are no entrance road alternatives along the west side of the property that would

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provide an alternate entrance road that has a slope similar to, or less than, the existing entrance road.

To improve the safety of the existing entrance, HDR recommends placing a stop sign at the entrance for trucks exiting the landfill and turning on to Bluff Road. Also, HDR recommends placing a "Trucks Crossing" sign for northbound traffic along Bluff Rd to alert oncoming vehicles of trucks entering the road (see W8-6 sign, 2009 MUTCD page 108, 128-129 for proper placement and usage of this sign). Another possible improvement would be to remove the trees on the right side of northbound Bluff Road between Bluff Road and the landfill driveway so trucks entering Bluff Road could have a better view of oncoming northbound Bluff Road traffic.

As an alternative to the existing entrance on the west side of the property, a new entrance to the east would be possible with the acquisition of adjacent property. This entrance alternative would connect with Hwy. 19 and could be used in lieu of the Bluff Road entrance. From discussions with City staff, it appears that there is more than one option for the location of this entrance, as well as more than one adjacent property that could be used for the road.

D. Stormwater Drainage

An important part of consideration when evaluating the usage of the existing property and general facility layout is the current and future stormwater drainage needs of the facility.

Currently, the majority of the stormwater on the west half of the site is collected in a detention pond located in the southwestern portion of the site (where future Cell 14 will be located). The pond discharges under a culvert and off-site into an existing drainage ditch on the property to the south of the Landfill. There is also stormwater that flows off of the western portion of the entrance road and sideslope of the bluff along the Bluff Road that drains into the ditch along the east side of Bluff Road. All stormwater that comes in contact with waste in the active working face of the landfill is contained within the footprint of the Landfill.

Topography on the east side of the site is generally flat. Stormwater in this area is collected in ditches and low areas before discharging offsite.

As part of the facility layout assessment, the location and area needed for future stormwater detention ponds were reviewed. In order to estimate the scale of runoff required to be managed on-site when the waste footprint is fully utilized, the Rational Method was used to calculate peak runoff flow for the 25-year and 100-year storm events. Variables used in the calculations were based on South Dakota Department of Transportation Drainage Design Manual (Chapter 11). The following table summarizes the results:

Preliminary Peak Runoff Estimates

Drainage Area	25-Year Event (cfs)	100-Year Event (cfs)
East ~ 71 acres	139	171
West ~ 37 acres	91	112

Assumptions: See Attachment E for calculations.

These peak runoff values provide conceptual runoff flows that must be managed by stormwater detention areas/ponds prior to discharge from the site. At a minimum, a detention pond would be required on the eastern and western portions of the site. There is an existing stormwater pond located on the west side of the property that can likely provide the needed stormwater capacity for that half of the property. It should be noted that the western pond is in the location of Cell 14, and would need to be relocated when Cell 14 is excavated (approximately 40 years from now). The eastern pond would need to be constructed as waste filling operations continued to the east, and

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runoff could not be effectively routed to the existing pond on the west side of the property. This could occur within five years, as Cell 5 is brought up to grade (depending on short-term landfill growth decisions). This is currently the only area available that would be outside of the future waste footprint, and still allow room for the proposed leachate pond in the northeast corner. Future design and placement of these ponds would require more detailed hydraulic calculations prior to construction.

III. Landfill Gas Collection and Reuse

A. Introduction to Landfill Gas to Energy

The beneficial utilization of landfill gas (LFG) for heat, electricity, or other fuel needs is generally referred to as a landfill gas to energy (LFGTE) project. LFGTE is not a new concept in the municipal solid waste industry. In fact, the first LFG collection and utilization projects began in the 1970s, and many well-known projects remain in service as the landfills continue to accept waste. Historically, LFGTE projects were financially and technically feasible mostly at larger landfills with higher LFG generation and collection rates or where significant tax incentives were available. However, with advances in gas processing technology and public awareness of LFG as a fuel source, LFGTE projects have steadily become more feasible for a wider range of landfill sizes and circumstances.

In developing a LFGTE project, not only is there an environmental benefit with the destruction of the landfill gas (methane is a potent greenhouse gas), there is also a potential economic benefit for the landfill. LFG is comprised mainly of methane (CH_4), carbon dioxide (CO_2), and several other constituents. On average, LFG is contains about 50 percent methane, which means that LFG has an average heat content of 500 British thermal units (Btu) per cubic foot or half the heat content of pipeline natural gas (almost entirely methane at approximately 1,000 Btu per cubic foot). This energy content allows the LFG to be utilized as a medium Btu fuel source in a variety of ways.

B. LFG Generation

The first necessary component of any LFGTE project is the generation of LFG that will fuel the project. This is typically done through mathematical modeling of LFG generation and collection (e.g., the EPA LandGEM model). This model estimates the rate of biological decomposition of the solid waste (and therefore LFG generation) dependent on specific independent variables. Important variables include past and future predicted waste receipts, as well as moisture content and MSW composition. A landfill's LFG generation rate will typically increase as it continues to accept waste, then begin a gradual decline after the last year of waste placement.

A LandGEM model has been created for the Vermillion Landfill to estimate current and future LFG generation. This model analyzes the "new" landfill (55 acres) and estimates the total amount of landfill gas that it is potentially creating. It is important to note that not all of the landfill gas created is collected. Industry-standard collection efficiency is approximately 75% (collected over generated). The following table summarizes average standard cubic feet per minute (scfm) of LFG expected in select years.

LFG Generation and Collection

YEAR	LFG GENERATION (scfm)	LFG COLLECTION (scfm)
2011	165	124
2031	348	261
2051	490	368

C. LFG Collection

A necessary component of any LFGTE project is a LFG collection and flare system. This system collects the LFG generated by the landfill and conveys it to a central location for utilization by the LFGTE project and/or combustion of the gas when the LFGTE project is unavailable.

While detailed design of a future collection system is outside the scope of this document, industry standard practices and recent experience provide that a typical LFG collection system with flare station will cost approximately $23,000 per acre of waste footprint (including engineering and permitting costs). Operations and maintenance of a collection system generally runs about $50/acre/month.

Based on these general costs, the following costs apply to the Vermillion Landfill with a current waste footprint of 55 acres:

Typical LFG Collection System Costs

ITEM DESCRIPTION	ESTIMATED COST
LFG Collection System with Flare	$1,265,000
INITIAL CAPITAL COST	**$1,265,000**
Annual Collection System O&M	$33,000
ANNUAL COST	**$33,000**

These costs do not include any costs associated with expansion of the LFG collection system as the landfill grows over time. In a more detailed pro-forma analyses, the cost of expansion would be taken into account, as well as the O&M cost increases as a result of the gas collection system covering greater and greater acreages.

D. Common LFGTE Project Types

There are many variations of LFGTE projects. However, most projects can be classified into one of three types:

1. On-site generation of electricity for sale to an electric utility.
2. Direct thermal utilization of the LFG as a medium Btu fuel by piping the gas to a nearby thermal energy-user (to offset natural gas or other fossil fuel usage).
3. Processing of LFG on-site (or nearby) to produce natural gas quality product for pipeline sale or other alternative fuel use (e.g., compressed natural gas for vehicle fuel).

Of these project types, the on-site generation of electricity is the most common.

E. On-Site Electricity Generation

Generation of electricity is quite common and can be adapted to both low (50 scfm) flow rates and higher (greater than 2,000 scfm) flow rates, depending on the conversion technology utilized. The most common electricity generation technology for LFG involves the installation of reciprocating engine generators, however the flow rates expected from the landfill would not support an engine until 2051. For the lower flow rates at Vermillion, microturbines are commonly used, with estimated costs on the order of $5,000 per kilowatt of generation capacity. For example, a 250 kW microturbine could operate on approximately 125 scfm of LFG, and would have an initial capital cost of approximately $1,250,000 (in addition to the LFG collection system costs), assuming no pretreatment of the LFG is required. Assuming a sales price of $0.04/kWh, this could provide electricity sales revenue of $88,000/year.

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F. Medium Btu Direct Use

The use of the LFG as a medium Btu fuel depends on the existence of a local end user (usually near the landfill). The end user typically utilizes the LFG in an industrial process, such as a boiler. The value of the medium Btu project is maximized if the end user operates on a continuous basis and can accept all of the LFG collected from the landfill. Most of the capital costs from this type of process reside in the construction of the pipeline to the end user. Further capital costs for this type of system can be attributed to compression and dehydration of the LFG for pipeline transport and retrofitting boilers or other units at the end locations.

For example, preliminary discussions have focused on possible utilization of the LFG from Vermillion Landfill at the nearby Lewis and Clark Water Plant (approximately one mile east of the landfill). Rather than an industrial process, initial ideas are to utilize the LFG to offset fossil fuel costs for a building heater system during the winter months. The Lewis and Clark Water Plant is being built with two natural gas fueled Wetback Scotch Boilers, each with 5,230 MBH (thousand Btu per hour) input demand at full capacity. The boilers will be used to heat the facility. This would equate to 174 standard cubic feet per minute (scfm) of natural gas, or 348 scfm of LFG at maximum capacity.

The fueling of this system by LFG is technically feasible; however, it is not an ideal LFGTE project because it will only utilize LFG during the winter months when the heater unit is running. Also, during the coldest parts of the winter months when the boilers are running at maximum capacity, LFG from the landfill will only be able to supply roughly half of the boiler's LFG demand.

In the event that LFG supply and demand scenarios change with the water plant, the following table summarizes expected costs associated with the piping the landfill gas to the water plan (not including the LFG collection system):

Estimated LFG Pipeline and Boiler Modification Costs

ITEM DESCRIPTION	ESTIMATED COST
New Heater Unit or Modification	$25,000
Dehydration/Compression and building	$300,000
Dedicated LFG Pipeline (assume 1 mile)	$250,000
LFG Monitoring and Safety Equipment	$10,000
INITIAL CAPITAL COST	**$585,000**

For similar medium BTU projects, LFG has been sold to the end user for prices ranging fromapproximately $1 to $4 per MMBtu, depending on costs incurred by the end user, natural gas prices, and other items negotiated between the seller and the buyer. For the Vermillion scenario, if it is assumed that the water plant has an average LFG annual demand of 90 scfm, and that the LFG is sold to the water plant at $3/MMBtu, the City of Vermillion would generate approximately $70,000 annually in revenue from the sale of LFG.

G. High Btu Direct Use

For landfills with higher projected LFG flow rates, usually more than 2,500 scfm, the processing of the LFG into a high Btu end product may be feasible. The product gas, which is approximately 99 percent methane and virtually equivalent to natural gas, is injected into existing natural gas pipelines, or used for other fueling projects. These flow rates are not feasible at the Vermillion Landfill.

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H. Conducting a Feasibility Study

Although the anticipated LFG generation estimates do not appear to support an economically viable LFGTE project, the following summarizes the purpose of a feasibility study, which is typically the next step in developing a LFGTE project.

Conducting a feasibility study will provide Vermillion much more information on which to base decisions and negotiate LFG contracts. A LFGTE feasibility study involves determining the technical, financial, and contractual feasibility of the project – similar to the above example, but at a greater level of detail. This involves determining potential LFG recovery from the landfill, understanding basic technology options, understanding funding sources and financial benefits, and finally, evaluating the operational and financial risks of each project type. Some of the variables (e.g., cost of capital, taxes) will vary depending on whether the project is developed by Vermillion as the landfill owner or by a private LFGTE developer.

I. LFGTE Project Development Process

Depending on the results of the feasibility study and the decision by Vermillion to go forward with a LFGTE project at this time, there are several options for implementing a LFGTE project. The three primary options are (1) the landfill owner acts as project developer, (2) the landfill owner hires a developer to provide a "turn-key" project, or (3) a combination of the first two.

When the landfill owner acts as the project developer, the landfill owner typically receives revenue directly from the sale of the LFG or electricity to the end user and any credits or other incentives that are applicable. The advantages of this ownership scenario include a greater degree of control over the project and the ability to retain more revenue from the project. The disadvantages include substantially more effort on the part of the landfill owner and a larger capital cost investment (and risk) in the LFGTE project.

When the landfill owner utilizes a developer, the landfill owner typically receives revenue in the form of royalties from the sale of the raw LFG to the developer as it is collected from the landfill and any credits or other incentives that are applicable. The advantages for the landfill owner of this ownership scenario includes "one stop shopping" for a developer to manage the project from start to finish and a decreased capital investment requirement for the landfill owner. The disadvantages include less control over the project, and potentially less revenue from the project.

J. Project Procurement

Regardless of the ownership scenario decided upon for the LFGTE project, the selection of a design/construction firm or private developer of a project should be a competitive procurement process. This will provide the landfill owner with multiple scenarios and options for LFGTE projects that can be formally evaluated. A properly developed RFP (based on information gathered in the feasibility study) will ensure the best value – taking into account financial gain, risk, and other factors. The procurement process, from the start of the feasibility study until the time the project is online, is typically 18-36 months. However, this can vary substantially depending on several factors including which project type is implemented and any regulatory/permitting hurdles that may be encountered.

IV. Leachate Recirculation (Bioreactor)

A. Introduction to Leachate Recirculation (Bioreactor)

The Solid Waste Association of North America (SWANA) has defined a bioreactor landfill as "any permitted Subtitle D landfill or landfill cell where liquid or air is injected in a controlled fashion into the waste mass in order to accelerate or enhance biostabilization of the waste." The United States Environmental Protection Agency (EPA) is currently collecting information on the advantages and disadvantages of bioreactor landfills through case studies of existing landfills and additional data so that EPA can identify specific bioreactor standards or recommend operating parameters. A bioreactor landfill operates to rapidly transform and degrade organic waste through the addition of liquid and/or air to enhance microbial processes. There are three general types of bioreactor landfill configurations: aerobic, anaerobic, and hybrid.

This memorandum focuses on leachate recirculation and provides information on anaerobic bioreactor features specific to the Vermillion Landfill. In an anaerobic bioreactor landfill, moisture is added to the waste mass in the form of recirculated leachate and other liquid sources to obtain optimal moisture levels. Biodegradation occurs in the absence of oxygen (anaerobically) and produces landfill gas, which can be captured to minimize greenhouse gas emissions and for energy projects.

Moisture content is the single most important factor that promotes the accelerated decomposition. A bioreactor relies on maintaining optimal moisture content near field capacity (approximately 35 to 65%) and the addition of liquids is usually necessary to maintain that percentage. The moisture content, combined with the biological action of naturally occurring microbes decomposes the waste. A side affect of an anaerobic bioreactor is that it produces landfill gas at an earlier stage in the landfill's life and at an overall higher rate of generation than traditional landfills.

At the Vermillion Landfil, collected leachate is sprayed on to the crown of the site's active cells and trickles down into the waste mass. This recirculation activity is the only permitted technique currently allowed under the City's solid waste permit. Leachate recirculation utilizing lateral pipes into the landfill or other direct leachate recirculation techniques have only been permitted in South Dakota if a Subtitle D composite liner with a geomembrane is installed. The City of Vermillion currently does not have this type of liner system. Furthermore, the cost to install a geomembrane liner on future cells will likely cost more than the leachate management value of recirculation. This cost should be further assessed if leachate disposal costs increase.

Bioreactors often need other liquids such as stormwater, wastewater, and wastewater treatment plant sludges to supplement leachate to enhance the microbiological process by control of the moisture content. This differs from a landfill (like Vermillion) that simply recirculates leachate for liquids management. In addition, the baling of the waste at Vermillion prior to landfilling serves to decrease the ability of the waste to absorb liquids to increase the overall moisture content (even if additional liquids were introduced).

B. Advantages/Disadvantages

As discussed, Vermillion is currently not permitted to supplement the leachate recirculation technique with other liquids in order to work towards operation as a bioreactor. Although unlikely, if Vermillion were to pursue a course of action to line the cells with a geomembrane and permit the site for operation as a bioreactor, the following are the associated advantages and disadvantages:

Advantages:

- Faster decomposition and biological stabilization;
- Lower waste toxicity and mobility (specifically noted in the leachate);
- A 15 to 30 percent gain in landfill space due to an increase in density of waste mass;
- Increased LFG generation rate (see *Landfill Gas Collection and Reuse* section); and,
- Reduced post-closure care

Disadvantages:

- Higher design, permitting and capital costs associated with geomembrane lining of waste cells;

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- Increased gas emissions and possible odors;
- Chance of physical instability of waste mass due to increased moisture and density;
- Increased design requirements to ensure stability of waste and liner systems;
- Possibility of surface leachate seeps; and,
- Possibility of landfill fires (subsurface combustion).

C. Status of the Technology

EPA is currently gathering data from bioreactor landfills for comparison with data from traditional dry landfills. This information will serve to identify the regulatory, environmental, and operating parameters of these landfills, and will identifying and evaluating best operating practices. The study will assist EPA in determining long-term monitoring needs for environmental compliance with groundwater standards, gas emissions, leachate quality, liner stability, physical stability, and other factors to address life-cycle integrity and economic viability concerns. In addition, this information should lay the groundwork for EPA to develop technical guidance and/or best practices for design, operation and permitting the bioreactor landfill.

D. Conclusion

Based on the currently permitted operation of the Vermillion Landfill, as well as the overall scale of the facility, it would be not be advantageous to modify the currently permitted design to allow for increase liquids recirculation in pursuit of a bioreactor operation. The possible advantages in landfill gas production would be hindered by the lack of collection and energy infrastructure discussed in the *Landfill Gas Collection and Reuse* section of this document. In addition, the capital cost and initial efforts of geomembrane liner installation, other design modifications, and permitting efforts could not be recouped with additional landfill gas production or waste mass settlement. In conclusion, the scale, operational, and permitting status of the Vermillion Landfill does not support a change in the status quo leachate disposal technique.

V. Final Cover Contours

A. Introduction

This section discusses the possibility of increasing the height and slope of the final cover contours at the Vermillion Landfill. These modification options are designed to maximize the Landfill's capacity within the existing landfill footprint. The following aspects were considered and analyzed as part of this assessment:

- Three conceptual final cover contour plans were designed using 4:1 sideslopes (horizontal:vertical) and increasing the overall maximum height of the landfill;
- Waste volume and landfill life projections were calculated for the three final cover contour options and compared to the current permitted landfill capacity;
- Short-term and long-term sequencing implications to the three alternative final cover options;
- Permitting implications.

B. Alternate Final Cover Contour Options

Currently, the Vermillion Landfill is permitted for a maximum final cover elevation of 1300. Three alternative cover contour options were created for three higher options. The options are shown in the drawing set included in Attachment F and have maximum elevations of 1318, 1340 and 1356. For each of the options a plan view, two section views, and a drawing showing the additional fill thicknesses are included. The plan view shows current topography overlain by the proposed final cover contours. The section views show the current topography, the currently permitted final contours, and the proposed final contours; as well as cross sectional airspace that is gained. The drawing showing the additional fill thickness presents how many vertical feet of additional waste can be placed above the current permitted final cover elevations for each option.

C. Waste Volumes and Fill Rates

As shown on the drawing set in Appendix A, each of the three final cover contour options results in significant increases in airspace volume for the Landfill. More airspace volume yields more landfill life, depending on annual waste acceptance rates and operational airspace utilization (compaction, soil usage, etc.). The follow table summarizes estimated airspace and landfill life that would be gained by increasing the maximum elevations.

Final Cover Contour Options

Option	Maximum Final Elevation	Additional Fill Volume (cu. yds.)	Approximate Additional Landfill Life Gained (years)	Approximate Total Landfill Life Remaining (years)
#1	1356	2,859,400	34	74
#2	1340	2,595,300	31	71
#3	1324	2,070,800	24	64

Assumptions:
- Additional life is years *in addition to* current estimates
- Annual waste tonnage in 2010 at 36,500 tons
- Annual waste tonnage growth rate at 1%
- Final cover simplified volume estimated by waste footprint and 4.5' thickness
- Airspace utilization factor (compaction) at 0.62 tons/cu.yd
- Currently, there is approximately 40+ years of landfill life remaining

The table shows that 24 to 34 additional years of landfill life can be achieved by going higher as shown on the attached drawings.

D. Fill Sequencing Considerations

In August, 2011, a letter requesting a grade modification to fill the north side of Trenches 1 through 4 at a 4:1 grade (horizontal:vertical) instead of the permitted 10:1 grade was submitted to the DENR. The ultimate height of the landfill would not change. The request was approved in September, 2011, and the life of Trenches 1 through 4 was extended by a year. A copy of the letter requesting the grade modification, and the DENR approval letter, are included in Attachment G.

Without a vertical expansion of the Landfill, it is estimated that existing Trenches 1-4 will reach capacity in 2014. Therefore the Landfill's next cell will need to be constructed in 2013 to ensure that the Landfill is ready to receive waste when Trenches 1-4 fill-up in 2014.

As an alternative to constructing in 2013, the City of Vermillion may want to pursue a permit modification in 2012 to go higher in Trenches 1-4 delay the next cell's construction. This would allow the City to complete more of the excavation work of the next cell on their own, saving the expense of hiring a contractor. The following table presents the estimated volume and life gained in existing Trenches 1 through 4. Drawings showing the contours of the Trench 1 through 4 alternatives are included in Attachment H.

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Final Cover Contour Options – Trenches 1-4

Option	Final Elevation (Nominal)	Additional Fill Volume (cu. yds.)	Additional Trench 1-4 Life (years)
#1	1350	628,000	~7
#2	1330	610,700	~6
#3	1310	517,300	~5

Assumptions:
Additional life is years on top of Trenches 1-4 *in addition to* current estimates
Annual waste tonnage in 2010 at 36,500 tons
Annual waste tonnage growth rate at 1%
Final cover simplified volume estimated by Trench 1-4 waste footprint and 4.5' thickness
Airspace utilization factor (compaction) at 0.62 tons/cu.yd.

E. Permitting Considerations

Any significant increase in the Landfill's volume will require a permit modification approved by the DENR. Factors that will need to be reviewed when considering going higher include: impacts to slope stability, leachate collection, stormwater management, erosion control, surrounding lines of sight, and other neighbor concerns related to aesthetics and view of the landfill.

From an engineering perspective, one of the biggest challenges with going higher is the weight of the additional garbage on the underlying leachate collection systems located at the bottom of the landfill. Leachate at the base of the landfill is collected in drainage pipes that could crush if too much weight is put on them, causing leachate to pool up at the base of the landfill instead of being collected and pumped to a treatment facility.

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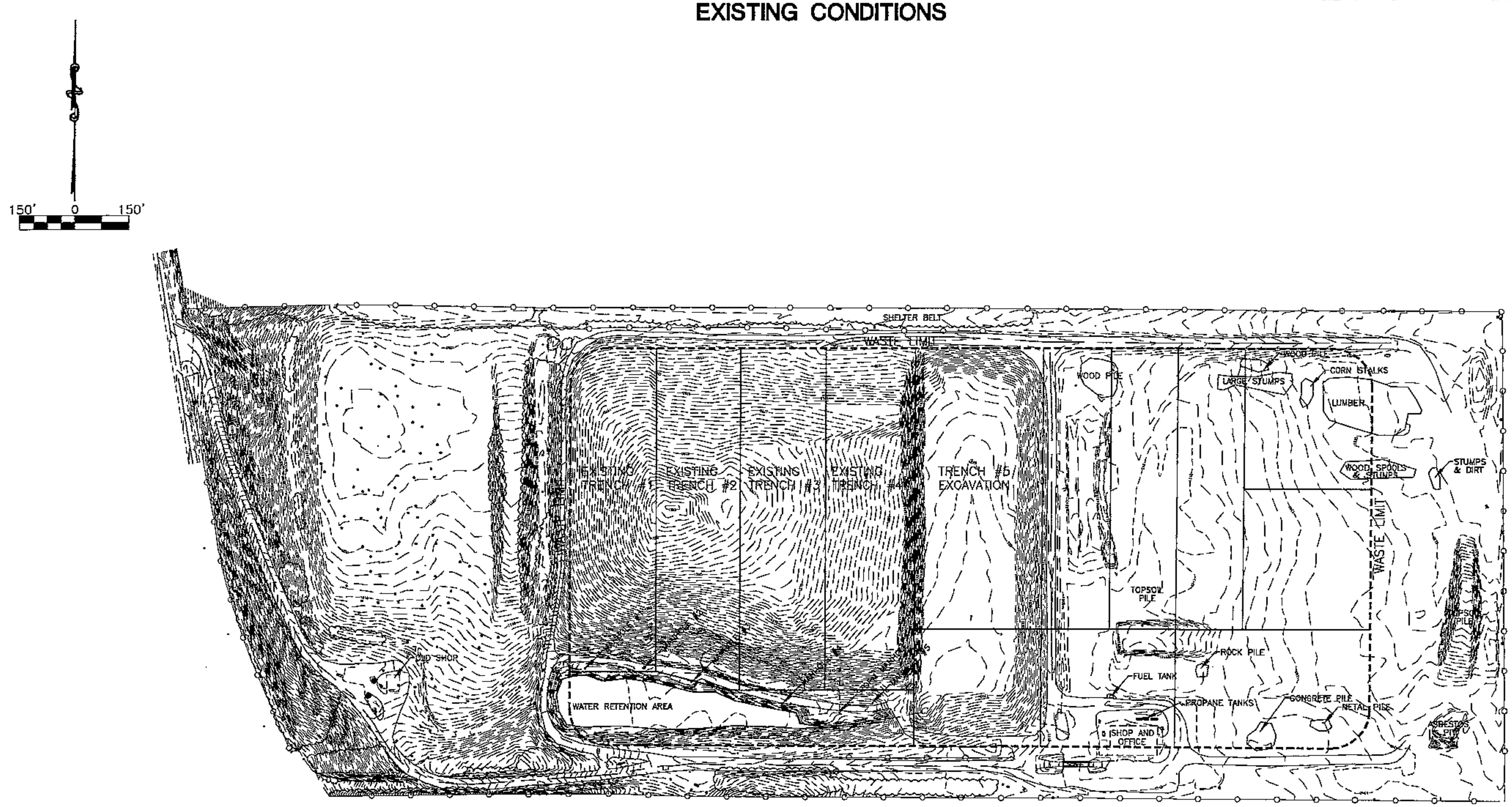
EXISTING CONDITIONS



LEGEND

- EDGE GRAVEL ROAD
- EDGE CONCRETE PAVEMENT
- EDGE ASPHALT PAVEMENT
- CENTERLINE
- FENCE
- DEBRIS FENCE
- STORM PIPE
- DECIDUOUS TREE
- CONIFEROUS TREE
- MANHOLE
- MONITORING WELL
- SURVEY CONTROL POINT
- SIGN
- SEWER CLEAN OUT

SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

HDR PLANS BY: HDR, INC. SIOUX FALLS, S.D.

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

EXISTING CONDITIONS

DESIGNED BY: DJS
DRAWN BY: BAC
CHECKED BY: MJE
ACAD FILE: J/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011
REVISIONS: BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.
3-1

April 29, 2011

Mr. Steven Kropp, P.E.
Department of Environment and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3182

Re: Permit Modification
Vermillion Landfill: Permit No. 10-04
Landfill Cell Excavation Depth Modification

Dear Mr. Kropp:

HDR Engineering, Inc. (HDR) has prepared this letter on behalf of the City of Vermillion (City) to request a permit modification to allow for deeper cell excavations at the Vermillion Landfill (Landfill). Information included in this letter that supports this request includes:

- Hydrogeologic evaluation of the underlying soils and ground water
- Updated base grade contours and cell orientation plan for the deeper cells
- Liner system summary and assessment
- Leachate generation and liner head estimates utilizing the Hydraulic Evaluation of Landfill Performance (HELP) model
- Leachate collection pipe sizing and pipe strength calculations
- Leachate collection sump pump sizing
- Leachate management plan summary

The required $500 permit modification application fee will be submitted by the City of Vermillion in a separate delivery to the Department of Environment and Natural Resources (DENR).

The City requests response to this permit modification application by May 31, 2011. A response by this time will help meet the City's goal of advertising the construction of Cell 5 in February 2012 with a deeper than currently permitted bottom elevation. The following is the City's anticipated schedule for this permit modification:

- April 30, 2011: Permit modification letter submitted to the DENR
- May 31, 2011: DENR response to permit modification letter
- June 10, 2011: City and HDR provide DENR with response to comments
- July 11, 2011: Complete 30-day public notice period
- July 15, 2011: DENR issues permit modification

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HDR Engineering, Inc.

6300 S Old Village Place
Suite 100
Sioux Falls, SD 57108-2102

Phone (605) 977-7740
Fax (605) 977-7747
www.hdrinc.com

HDR ONE COMPANY | Many Solutions™

Hydrogeologic Evaluation

Leggette, Brashears & Graham, Inc. of Sioux Falls, South Dakota, completed a hydrogeologic assessment of the expansion area of the Landfill in 2010. The results and conclusions of the assessment were presented in a report titled Hydrogeologic Assessment of the Vermillion Landfill, dated November 12, 2010. The Assessment presented the soil sampling results from ten soil borings and two ground water wells completed at the Landfill in 2010. It found that the underlying soils are predominantly clay and have a permeability of less than $1x10^{-7}$ cm/sec (i.e. the required minimum permeability for clay liners). In conclusion, the Assessment states that the site appears well-suited for cell construction to an approximate elevation of 1172.5.

Furthermore, based on soil borings and well installation data in the area the shallowest elevation of the underlying Lower Vermillion Missouri aquifer is 1115 ft., which indicates that there should be at least 50 feet of low permeability clay between the new base of the landfill and the underlying aquifer. Included at the end of the attached Figures section is a copy of the Vermillion Landfill Study Surface Soil Profile, which shows the estimated elevation of the aquifer. The Figure was completed by Bernhard, Eisenbraun and Associates in 1991 as part of a site characterization study that was completed for the Landfill.

Base Grade and Cell Orientation

Based on a new cell excavation plan with a minimum elevation of 1172.5, a new base grade and cell orientation plan was developed for the Landfill. Existing topographical conditions at the Landfill are shown on Figure 1. The proposed excavation plan for future cells is shown on Figure 2. The new plan includes 10 cells (i.e. Cells 5 through 14).

In the new plan, the floor of Cells 5 through 13 slopes at a 2% grade from the south down to the north with a center leachate collection pipe that drains into a leachate collection sump located on the north side of the cells. There is also a 2% cross slope that slopes the east and west sides of the cells into the leachate collection pipe (note that the combined affect of the 2% leachate collection pipe slope and the 2% cross slope is a 2.85% slope that runs at a 45° angle into the collection pipe). Sideslopes of the excavation have been drawn at 3:1 (horizontal:vertical) grades (or 33%). Cell 14 slopes from east to west at a 2% grade into a sump with 2% cross slopes similar to Cells 5 through 13.

As shown on Figure 2 and Figure 3 (Cell 5 only), Cell 5 is located directly east of existing Trench 4. It does not go as far south as Trench 4 because the excavation created by the deeper cell bottom requires a longer south sideslope that stretches closer to the existing baler building.

As shown on Figure 2, Cells 10 through 13 lay to the south of Cells 5 through 9 and will have their leachate collection lines connect into the south end of Cells 5 through 9 in order to have the leachate collected in the leachate sumps located at the north side of the Cells. The existing baler building will need to be relocated during the excavation of Cell

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11 because it lies within the Cell 11 excavation area. Based on current waste projections, the excavation of Cell 11 will likely occur around the year 2030. Also shown on this Figure, the grading in Cell 14 is such that the base of Cell 14 will be graded to the east until it daylights directly into the sideslope of the Cell 13 excavation.

The leachate from Cells 5 through 13 will be collected in leachate collection pipes that drain into leachate collection sumps that pump the leachate to a new leachate pond located on the northeast corner of the Landfill property. In Cell 14, the existing manholes for Trenches 1 through 4 will be removed and the leachate piping will be tied into a new Cell 14 leachate collection pipe that will drain to a leachate collection sump on the west end of Cell 14. Leachate collected in the Cell 14 leachate collection sump will likely be collected and pumped into a leachate tank on the west side of the property (as shown on Figure 2), or all the way around the landfill to the new leachate pond in the northeast corner of the property.

The following table presents the excavation and fill quantities for Cell 5, as well as for the overall deeper excavation area (Cells 5 through 14). Cross sections of the new landfill design are shown on Figure 5.

Cell Size Summary Table

	Final Cover and Waste Volume (CY)[1, 2]	Waste Capacity Volume (CY)[2]	Soil Excavation Volume (CY)[3]	Cell Area (acres)[4]	Final Cover Area (acres)[5]	Life of Cell (years)[6]
Cell 5	348,000	341,000	536,000	6.2	1.4	5.5
Cells 5 to 14	3,460,000	3,290,000	1,990,000	35.0	36.2	40

Notes:

1. Final cover thickness is 4.5'. Includes 6" topsoil, 3' alternative cap, and 12" intermediate cover.
2. Waste volumes are based on currently permitted final cover grades.
3. Soil excavation quantities are based on the existing grades at the landfill (surveyed by HDR in March 2010 and March, 2011). It represents the amount of soil that needs to be excavated to construct the Cells to the proposed grades.
4. Cell area is the plan view area of the cells.
5. The final cover area for Cell 5 is the area of Cell 5 that is at final grade (see Figure 5 Sections A-A).
6. The life of the landfill is based on a waste growth of 1% per year, annual tonnage of 36,500 in the first year, and an airspace utilization factor of 0.617 tons/cubic yard.

Liner System

No change to the existing liner system section is requested as part of this permit modification request. It will remain as currently permitted, which is 2-feet of compacted clay (minimum permeability of 1×10^{-7} cm/sec) covered with 12 inches of drainage sand (as shown in Detail 1 of Figure 5). The liner system section may need to be modified as part future cell design if unfavorable soil types and/or groundwater conditions are

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encountered during future cell excavations, or through further hydrogeologic study of the area.

Leachate Generation Estimates

A HELP model was run to demonstrate that this liner system design can maintain less than 12-inches of leachate head on the liner system. The attached HELP memorandum summarizes the calculations completed as part of the HELP modeling. Results of the HELP model were also used to size the leachate collection piping and the leachate collection sump pump.

Leachate Collection Piping

The leachate collection piping for the deeper cell excavations has been designed to manage a peak daily flow of 2,610 cubic feet per day. This is the "worst case" flow calculated by the HELP model which occurs when the waste has been filled to final elevations but the final cover has not been installed (i.e. Scenario 4 of the HELP model). Attached are calculation sheets that demonstrate that a 6-inch HDPE SDR 11 pipe will provide the capacity to carry the peak flow to the leachate collection sump, as well as provide the strength to avoid crushing when placed under 100 feet of waste and final cover (i.e. the maximum depth of waste over the pipe based on the proposed base contours and the currently permitted final cover contours). Also attached is a second version of the HELP model's Scenario 4. In this version the leachate generated from the base sideslopes during Scenario 4 are calculated. This leachate generation value is added to the base leachate generation value (original Scenario 4) to get the total "worst case" flow to be managed by the leachate collection piping.

The bedding around the leachate collection pipe will be as shown on Detail 2 of Figure 6. The three layers of material (i.e. drain sand, pea gravel, and rock) provide a media that filters out solids in the leachate and is less likely to plug compared to a geotextile material. The pea gravel will have a gradation that that fits the following two requirements. The requirements ensure that the pea gravel does not wash through the rock, and that the drain sand does not wash through the pea gravel.

- Based on the pea gravel gradation and the rock gradation, the following criteria shall be met using ASTM D422:
  - $D_{15\,(rock)} / D_{85\,(pea\ gravel)} < 4$
  - $D_{15\,(rock)} / D_{15\,(pea\ gravel)} > 5$
- Based on the drain sand gradation and the pea gravel gradation, the following criteria shall be met using ASTM D422:
  - $D_{15\,(pea\ gravel)} / D_{85\,(drain\ sand)} < 4$
  - $D_{15\,(pea\ gravel)} / D_{15\,(drain\ sand)} > 5$

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Underneath the rock, and on top of the clay liner, a liner material will be placed to prevent silt from washing into the rock and fouling the leachate collection system. The liner will likely be a geotextile material.

The leachate collection pipes drain into leachate collection sumps located at the low point of the Cells. Detail 3 on Figure 6 shows a typical leachate collection sump detail.

Leachate Collection Sump Pump

The leachate collected in the sumps (see Detail 3 on Figure 6) will be pumped out of the cells and directly into the proposed leachate pond or storage tank. Leachate pump sizes may vary based on the different head scenarios for each sump pump. To show that there are feasible alternatives for pumping leachate out of the cells and directly to the leachate pond or underground storage tank, HDR has looked at the "worst case" head scenario which would be for the Cell 5 sump pumping to the leachate pond. In this scenario, the pump will need to perform at a rate of 13.5 gallons per minute (i.e. the HELP model's peak daily flow of 2,610 cubic feet per day) with a total dynamic head of approximately 80 feet. EPG Companies, Inc. produces leachate pumps that are specifically designed for landfill applications. Their model 5-4, 1 HP SurePump would work in this scenario. Details and specifications on this pump, including a pump curve, are attached. Environmental Pump Solutions, Inc. also manufactures landfill specific pumps that can meet this scenario (Model: 25SRPF07-4). Details and a pump curve for a pump that would work in this scenario are also attached.

Leachate Management

As shown on Figure 2, leachate collected from the Cells will be stored in a leachate pond or underground storage tank. The primary means of leachate disposal will be surface application over daily or interim cover areas that are underlaid by both a liner system and a leachate collection system. If additional leachate disposal is required, the leachate will be tested and compared to 40 C.F.R. Part 403, (July 1, 1991). If the leachate meets the requirements of 40 C.F.R. Part 403, (July 1, 1991), the leachate will be loaded into tanker trucks, and hauled to a wastewater treatment facility. If testing shows that the leachate does not meet 40 C.F.R. Part 403, (July 1, 1991), or if the owners of regional wastewater treatment facilities do not provide permission to dispose of the leachate at their facility, onsite treatment of the leachate will be attempted to get the leachate within requirements of 40 C.F.R. Part 403, (July 1, 1991), and/or to a composition acceptable for disposal at the wastewater facilities, so that it can be hauled off-site for disposal.

The following subsections provide a description of the proposed leachate storage facilities at the site, and of a proposed modification to the existing Trench 4 leachate management piping.

Leachate Pond and Underground Storage Tank

After leachate from Cell's 5 through 13 is collected in the sumps it will be pumped to a new leachate pond located on the northeast corner of the landfill property. The exact size of the pond will be determined as part of the design of

Draft

Cell 5; however, it's likely to be approximately 100' x 200' pond, 15 feet deep with 3:1 sideslopes, providing approximately 1,000,000 gallons of leachate storage. This size will give the landfill operator more leachate management flexibility than is currently available. Large flows of leachate due to rain events or spring runoff can be more easily managed because the pond provides more storage than the Landfill's existing underground storage tank; and thus, the pond provides a longer period of time before it fills up and requires disposal of the leachate.

At this time, it is anticipated that the leachate pond will be lined with an HDPE geomembrane liner and have an aeration system. The aerators will provide treatment of volatile organic compounds in the leachate, as well as keep the pond from turning anaerobic or septic, which can produce odor issues.

Leachate from Cell 10 may be collected and pumped to an underground storage tank (as shown on attached Figure 2) or pumped around the landfill to the proposed leachate pond.

Trench 4 Piping Modification

To reduce the amount of leachate that flows through the existing leachate collection system from Trenches 1 through 4, the Trench 4 leachate piping will be modified to drain Trench 4 leachate into the south side of the leachate collection pipe of Cell 5. The piping modification will require re-plumbing of the pipe in Manhole #5 and the installation of a gravity line that connects Manhole #5 to the Cell 5 leachate collection pipe. The orientation of the proposed piping is shown on Figure 3.

Closing

If you have any questions while reviewing this document, or need additional information, please feel free to either call myself at 763-591-5417 (or e-mail at matthew.evans@hdrinc.com) or call Bob Iverson, City of Vermillion, at 605-677-7076 (or e-mail at bobi@cityofvermillion.com).

Draft

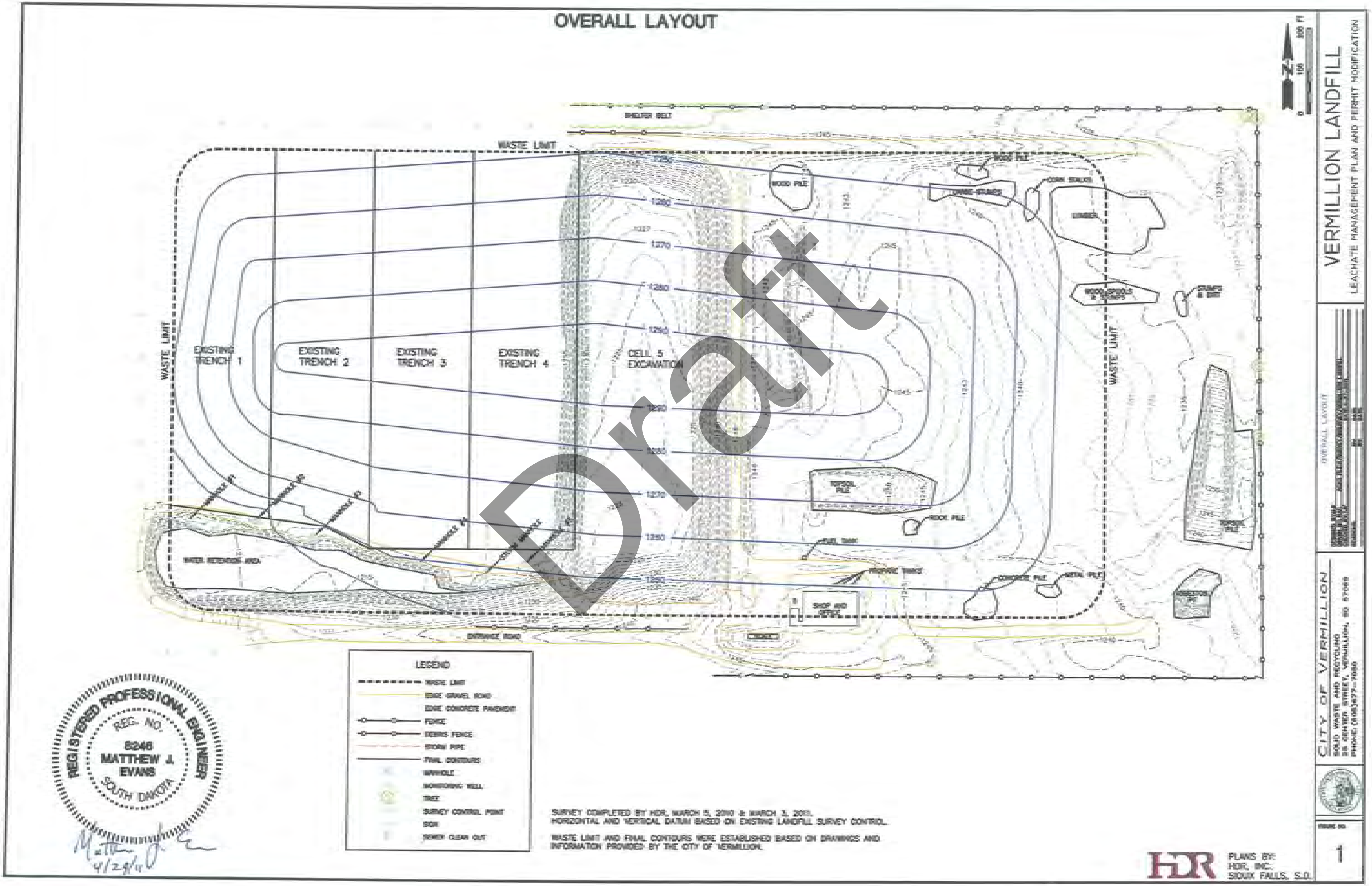
Sincerely,

HDR ENGINEERING, INC.

Matthew J. Evans, P.E.
Project Manager

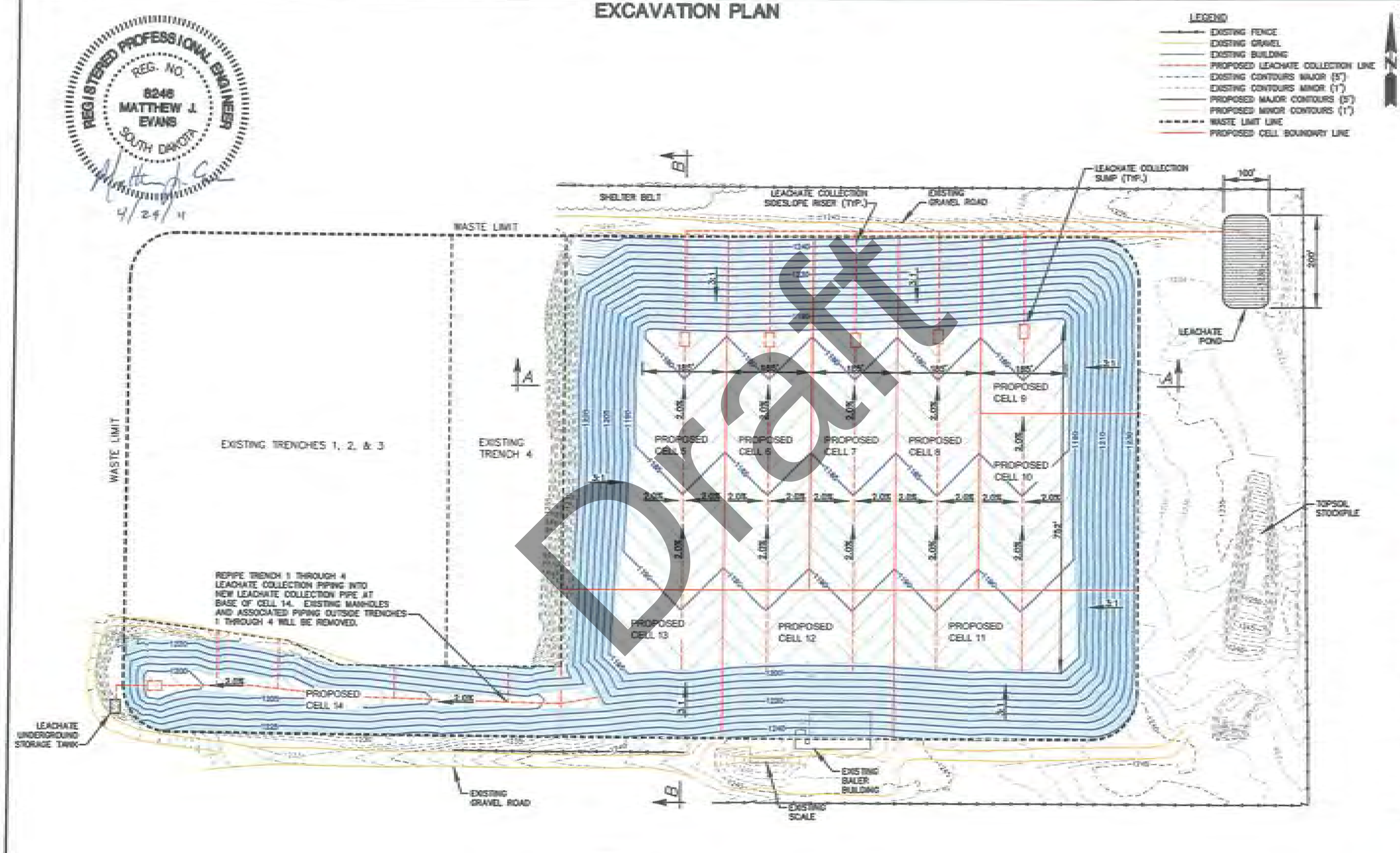
Figures

Draft



OVERALL LAYOUT
SHELTER BELT
WASTE LIMIT
EXISTING TRENCH 1
EXISTING TRENCH 2
EXISTING TRENCH 3
EXISTING TRENCH 4
CELL 5 EXCAVATION
1250
1260
1270
1280
1290
WOOD PILE
CORN STALKS
LUMBER
WOOD SPOOLS & STUMPS
STUMPS & DIRT
TOPSOIL PILE
ROCK PILE
FUEL TANK
PROPANE TANKS
CONCRETE PILE
METAL PILE
SHOP AND OFFICE
WATER RETENTION AREA
ENTRANCE ROAD
LEGEND
WASTE LIMIT
EDGE GRAVEL ROAD
EDGE CONCRETE PAVEMENT
FENCE
DEBRIS FENCE
STORM PIPE
FINAL CONTOURS
MANHOLE
MONITORING WELL
TREE
SURVEY CONTROL POINT
SIGN
SEWER CLEAN OUT
SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
WASTE LIMIT AND FINAL CONTOURS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.
REGISTERED PROFESSIONAL ENGINEER
REG. NO.
8246
MATTHEW J. EVANS
SOUTH DAKOTA
4/29/11
HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.
VERMILLION LANDFILL
LEACHATE MANAGEMENT PLAN AND PERMIT MODIFICATION
OVERALL LAYOUT
CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
0
100
200 FT
1

EXCAVATION PLAN



NOTES:
1. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
2. WASTE LIMITS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.

HDR PLANS BY: HDR, INC. SIOUX FALLS, S.D.

VERMILLION LANDFILL
LEACHATE MANAGEMENT PLAN AND PERMIT MODIFICATION

EXCAVATION PLAN

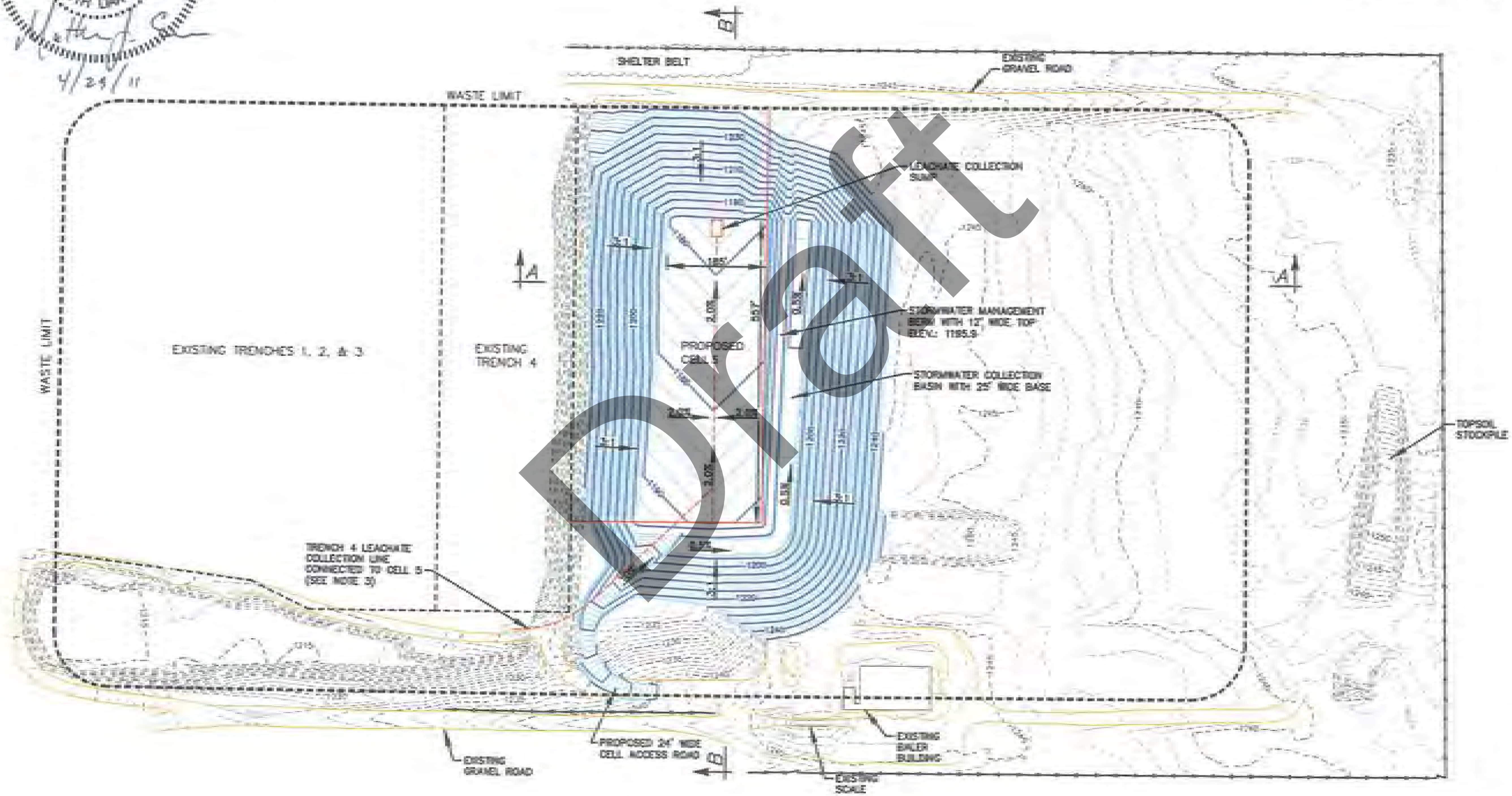
CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO. 2

CELL 5 EXCAVATION PLAN

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA
4/29/11

LEGEND
EXISTING FENCE
EXISTING GRAVEL
EXISTING BUILDING
PROPOSED LEACHATE COLLECTION LINE
EXISTING CONTOURS MAJOR (5')
EXISTING CONTOURS MINOR (1')
PROPOSED MAJOR CONTOURS (5')
PROPOSED MINOR CONTOURS (1')
WASTE LIMIT LINE
PROPOSED CELL BOUNDARY LINE



NOTES:
1. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
2. WASTE LIMITS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.
3. AS PART OF CELL 5 CONSTRUCTION, THE EXISTING LEACHATE COLLECTION LINE COMING FROM TRENCH 4 WILL BE REPIPED TO GRAVITY DRAIN INTO THE NEW CELL 5 LEACHATE COLLECTION LINE.

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
LEACHATE MANAGEMENT PLAN AND PERMIT MODIFICATION

CELL 5 EXCAVATION PLAN

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
3

CELL 5 FILL PLAN

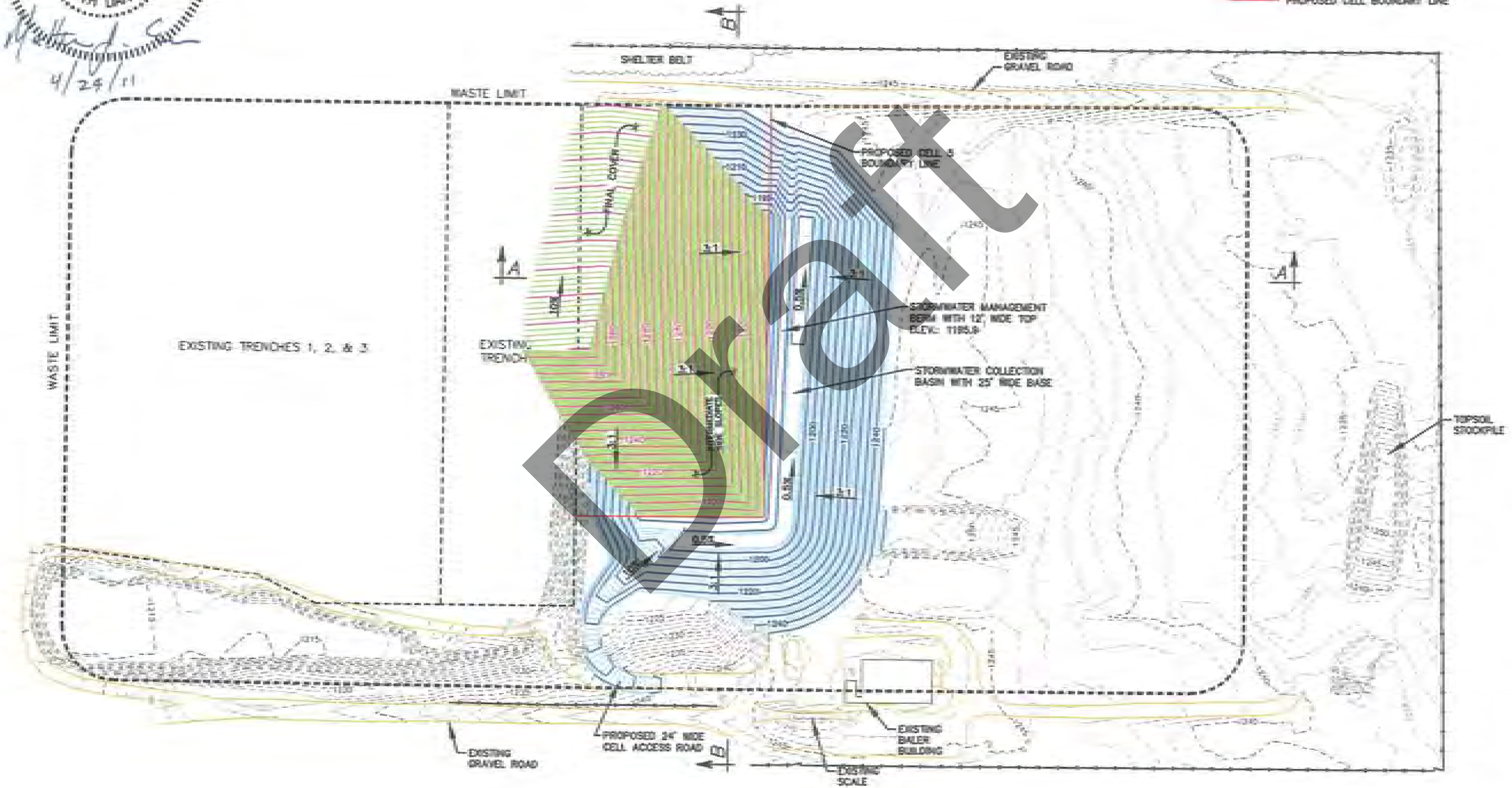
REGISTERED PROFESSIONAL ENGINEER
REG. NO.
8246
MATTHEW J.
EVANS
SOUTH DAKOTA

4/24/11

LEGEND

- EXISTING FENCE
- EXISTING GRAVEL
- EXISTING BUILDING
- EXISTING CONTOURS MAJOR
- EXISTING CONTOURS MINOR
- PROPOSED MAJOR CONTOURS (EXCAVATION)(5')
- PROPOSED MINOR CONTOURS (EXCAVATION)(1')
- PROPOSED MAJOR CONTOURS (FILL)(5')
- PROPOSED MINOR CONTOURS (FILL)(1')
- WASTE LIMIT LINE
- PROPOSED CELL BOUNDARY LINE

0 100 200 FT



NOTES:

1. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
2. WASTE LIMIT AND FINAL CONTOURS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.

HDR

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
LEACHATE MANAGEMENT PLAN AND PERMIT MODIFICATION

CELL 5 FILL PLAN

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7080

FIGURE NO.
4

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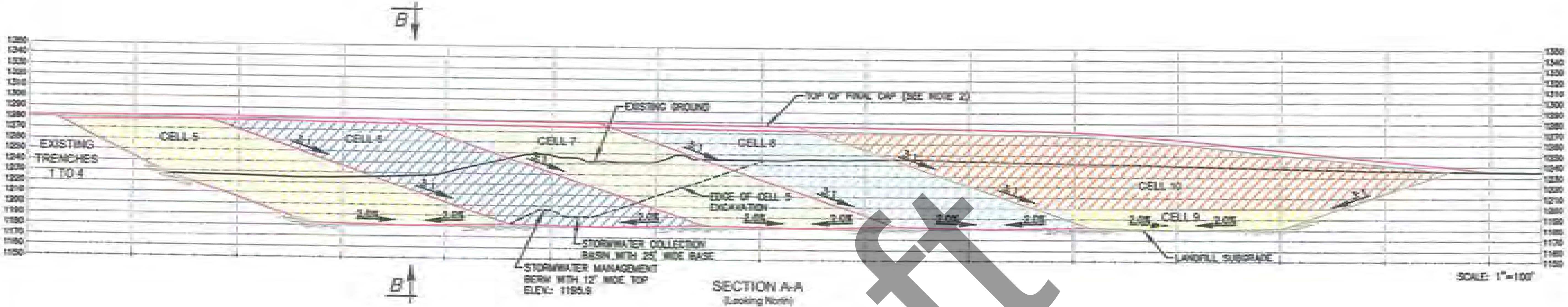
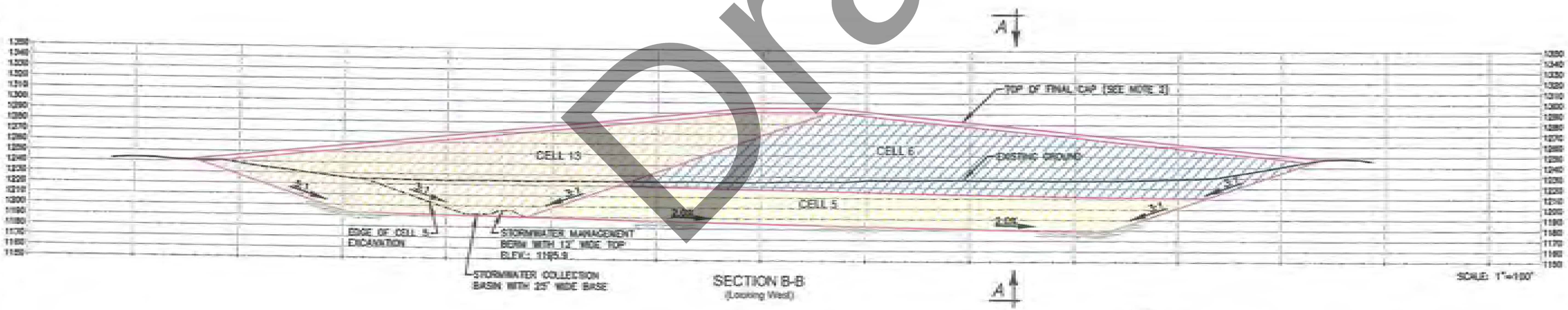
SECTIONS



SECTION A-A
(Looking North)

SCALE: 1"=100'



SECTION B-B
(Looking West)

SCALE: 1"=100'

NOTE:

1. THE VERTICAL LAYERING OF CELLS SHOWN IN THE SECTION VIEWS ARE THE RESULT OF NEWER CELLS "PIGGY BACKING" OVER OLDER CELLS.
2. TOP OF FINAL CAP ELEVATIONS SHOWN ARE BASED ON CURRENTLY PERMITTED FINAL COVER CONTOURS AS SHOWN ON FIGURE 1.
3. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
4. WASTE LIMITS AND FINAL CONTOURS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA
4/29/11

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
LEACHATE MANAGEMENT PLAN AND PERMIT MODIFICATION

SECTIONS

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.
5

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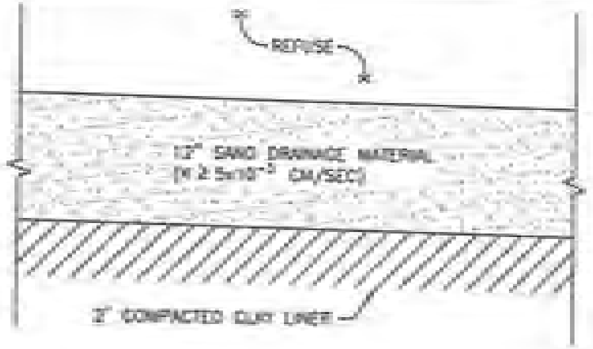
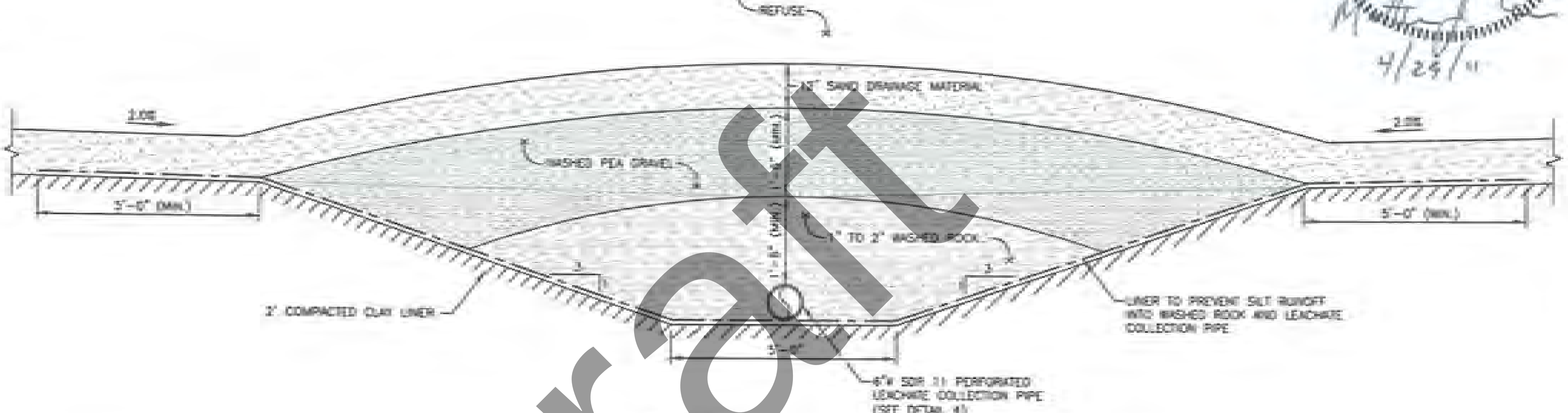
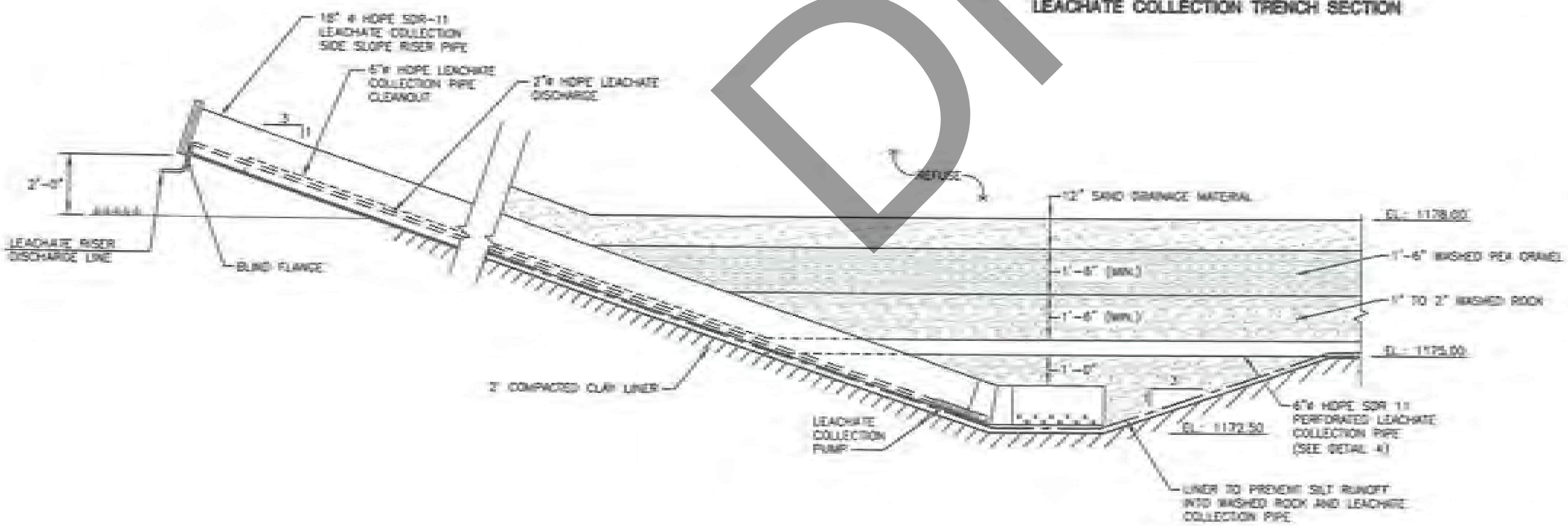
DETAILS



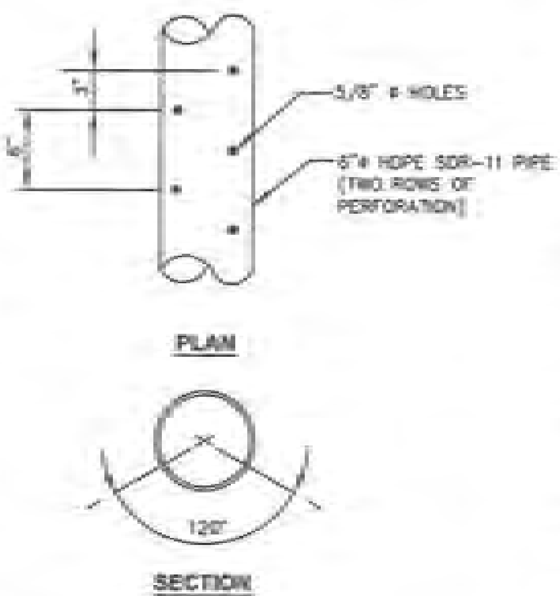
DETAIL 1
TYPICAL LINER SECTION



DETAIL 2
LEACHATE COLLECTION TRENCH SECTION



DETAIL 3
LEACHATE COLLECTION SUMP SECTION



DETAIL 4
LEACHATE COLLECTION PIPE PERFORATION DETAIL

REGISTERED PROFESSIONAL ENGINEER
REG. NO.
6246
MATTHEW J. EVANS
SOUTH DAKOTA
4/25/11

VERMILLION LANDFILL
LEACHATE MANAGEMENT PLAN AND PERMIT MODIFICATION

DETAILS

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE (605)677-7050

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

6

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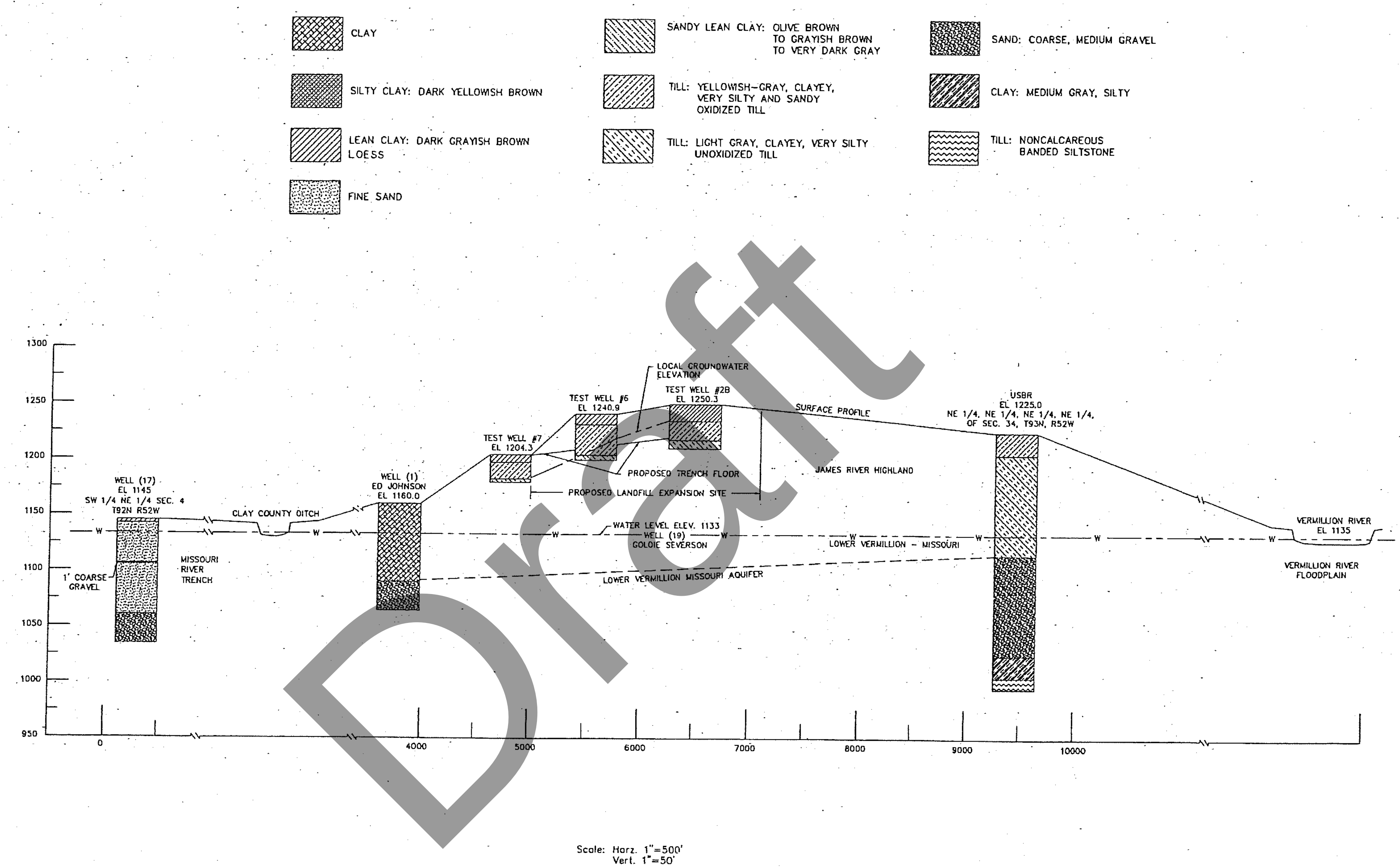

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VERMILLION LANDFILL STUDY
SUB-SURFACE SOIL PROFILE

PROJECT NAME: VERMILLION LANDFILL STUDY		
SHEET NAME: SUB-SURFACE SOIL PROFILE		
JOB NO.: 90-068	DRAWING NO.: 90068-7	SHEET: 7 of 7
DRAWN BY: JLA	CHECKED BY: KJA	DATE: 04/22/91

B&E
Bernhard, Eiser
and Associa
124 Walnut - Suite
Yankton, South Dakota
605-665-8092
FAX 605-665-052

HELP Model

Draft

HDR | ONE COMPANY *Many Solutions*℠

Memo

To:	Matt Evans, PE		
From:	Joel Miller	Project:	Vermillion
Date:	April 27, 2011	Job No:	135-159220

RE: Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07
Basis of Design Report
Vermillion Landfill

Introduction
This basis of design memo presents the background data and results for the HELP water balance model for the expansion design at the City of Vermillion Landfill. The following waste column has been modeled (from top to bottom) during various phases of waste filling:

1. 6-inches of topsoil using on-site soil (for scenario 5 – final closure only)
2. 18-inches of clay (for scenario 5 – final closure only)
3. 6-inches of daily/interim cover using on-site soil (all scenarios)
4. 0 - 100 feet of baled MSW waste (scenarios 1 – 4 model the filling of the waste cell over time)
5. 12-inches of sand drainage layer (all scenarios)
6. 24-inches of compacted clay liner (all scenarios)

This waste column is modeled as a conservative, representative column of waste with a thickness and model duration consistent with the filling and daily cover in the future cells at Vermillion. This includes scenarios where final cover, interim cover, and future cell piggybacking are applicable. It should be noted that the Vermillion Landfill is permitted to use an alternative final cover that consists of 36-inches of clay soil covered with 6-inches of topsoil. The alternative cover was not modeled because by permit it must have a permeability that is equal to or less than a conventional Subtitle D final cover (i.e. the modeled final cover which consists of 18-inches of clay covered with 6-inches of topsoil); therefore, the permitted Subtitle D final cover is a more conservative than the alternative final cover for HELP modeling purposes.

HELP Model Scenarios and Input Data
The primary goal of the HELP modeling is to demonstrate that the proposed leachate collection system will be able to keep the maximum hydraulic head on the landfill liner below the regulatory limit of 12 inches (30 centimeters) in accordance with SDCL 74:27:13:24. The second aim of modeling is to demonstrate the hydraulic head does not exceed the thickness of the leachate collection/drainage layer. The third aim of the modeling is to estimate leachate production for sizing the leachate conveyance system and to provide adequate storage for leachate.

Draft

In the design, the following HELP model scenarios have been utilized to characterize the waste filling over time:

- Scenario 1 models the base floor of the future cells with 25 feet of waste in place after 3 years.
- Scenario 2 models the base floor of the future cells with 50 feet of waste in place after 6 years.
- Scenario 3 models the base floor of the future cells with 75 feet of waste in place after 9 years.
- Scenario 4 models the base floor of the future cells with 100 feet of waste in place after 12 years.
- Scenario 5 models the base floor of the future cells with 100 feet of waste in place and final cover layers (as described above) after 12 years.

Each scenario was modeled as a one-acre area with the modeled profile layers are as described above. The table provided in Attachment 1 summarizes the model input data and results of the scenarios. Model run output files for each scenario are presented in Attachment 2.

Temperature, solar radiation and evapotranspiration data were synthetically generated by the HELP model using coefficients from Omaha, Nebraska. The evaporative zone depth was set at 6 inches for daily cover. Maximum leaf area index was set at the default of 1.0 for the interim cover scenarios (poor/minimal vegetation).

Precipitation was synthetically generated from a nearby National Oceanic and Atmospheric Administration (NOAA) monitoring station. This data was published in *Climatography of the United States No. 81*, dated February 2002, which lists the average monthly precipitation data from 1971-2000.

Material Properties and Landfill Geometry

Layer 1 – Final Cover Topsoil
This layer is only used in scenario 5 to model the final cover. Topsoil was assumed 6-inches thick and to be sourced from on-site material. Soil texture 14 (silty-clay) was chosen based on soil data provided in the *Hydrogeologic Assessment, Vermillion Landfill, Vermillion, South Dakota (Leggette, Brashears and Graham, Inc., November 12, 2010).*

Layer 2 – Final Cover Liner
This layer is only used in scenario 5 to model the final cover. According to Attachment D of the landfill permit, the final cover shall include an infiltration layer with a permeability less than or equal to the permeability of the bottom liner system. Therefore, this final cover liner layer is assumed to consist of on-site sourced clay. In the Hydrogeologic Assessment report cited above, this clay can meet and exceed the required $1.0x10^{-7}$ cm/sec hydraulic conductivity.

Layer 3 Daily/Interim Cover
Daily/Interim cover was assumed as 6-inches thick and to be sourced from on-site material. Soil texture 14 (silty-clay) was chosen based on soil data provided in the *Hydrogeologic Assessment, Vermillion Landfill, Vermillion, South Dakota (Leggette, Brashears and Graham, Inc., November 12, 2010).*

Layer 4 – MSW Waste
The majority of MSW waste received at the Landfill is baled on-site prior to landfilling. Therefore, soil texture 19 was chosen based on HELP guidance documentation to model the "channelizing" of liquids between the bales and the limited field capacity of baled waste.

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Layer 5 – Drainage Layer
The lateral drainage layer was modeled as sand with a hydraulic conductivity of $5.0x10^{-3}$ cm/sec. This hydraulic conductivity is slightly more conservative than the HELP model's default value ($5.8x10^{-3}$ cm/sec). This value most closely represents the sand material used previously on site; and is consistent with permeability test data obtained during the construction of Trench 4. Based on discussions with site personnel, the previous sand material was sourced locally and is still readily available in the area. Copies of the Trench 4 sand permeability test data are attached for reference.

Layer 6 – Compacted Clay Liner Layer
As permitted, the clay liner at the base of the cells will consist of 24-inches of compacted clay. In the Hydrogeologic Assessment report cited above, this clay can meet and exceed the required $1.0x10^{-7}$ cm/sec hydraulic conductivity. For conservative modeling purposes the hydraulic conductivity of the liner was kept at the regulatory maximum..

Drainage Length and Slope
The design slopes at the base of the cells were modeled at 2.85%. This is the gradient of the resulting slope of the 2% leachate collection line slope that runs north/south, and the 2% east/west cross slope (i.e. it is the flow path of the leachate at the base cells, which is perpendicular to the contours). The maximum flow path modeled is for leachate to travel perpendicular to the base contours from the interior toe of slope to the point at which the leachate will enter an interceptor gravel/pipe trench for conveyance to the sump. The longest flow path across the base floor (i.e. the "worst case" scenario) is in the southwest corner, traveling through Cell 12 and into Cell 5. This drainage length is 200 feet.

Lift Thickness and Scenario Length of Time
The HELP model requires the user to specify the number of simulation years for each scenario. This was calculated using the waste thickness and a cell life estimate based on the design expansion plans. These scenarios characterize approximately four, 25-foot lifts of waste every three years. The greatest waste thickness over the cells is approximately 100 feet in scenarios 4 and 5 (e.g. when Cell 5 is filled and Cell 6 has piggybacked on top of Cell 5). This will occur approximately 12 years after waste placement begins in the cells. Note that this is for modeling purposes and actual waste thicknesses and fill placement timing will vary. This is a "representative" column of waste that models situations over time that are likely to have the greatest leachate generation (most conservative model).

Initial Moisture Content
Initial moisture content for all layers was calculated utilizing the default moisture content calculation in the HELP model.

Leachate Disposal on Daily Cover and Intermediate Cover
All scenarios except for scenario 5 accounted for 100% of leachate collected to be disposed of on top of daily cover and intermediate cover in the future cells. HELP models this disposal technique as leachate recirculation and assumes that leachate collected is stored for a day, and then distributed to the top layer during the following day. This is consistent with practice at the site and South Dakota leachate disposal regulations. Scenario 5 models final cover and assumes 0% leachate disposal on the Landfill.

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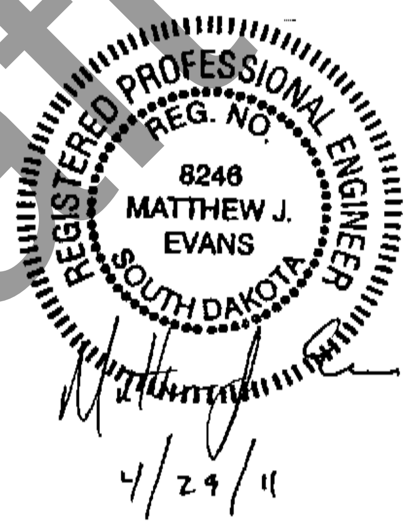
Runoff Area
The HELP model requires an estimate of the area that will allow runoff of stormwater. This is assumed at 80% of the modeled area. This is imposed upon the 1-acre in the HELP model. Extrapolating this assumption into actual practice will require that 80% of the future cell areas be allowed to actively manage stormwater runoff while below the final grade. This can be accomplished by the use of berms and other strategies. This means that at any one time, the site can operate with an open face of approximately 20% of the surface area of the whole cell. For a total Cell 5 size of approximately 6 acres, this equates to a maximum open face of approximately 225'x225'.

Model Outputs and Regulatory Compliance

The table provided in Attachment 1 summarizes the model outputs for each of the scenarios considered. The model demonstrates that the proposed design will comply with applicable solid waste regulations. More specifically, maximum head on the base liner is less than one foot, as allowed by regulation. The peak head on the liner in any scenario is 10.6 inches (scenario 4), less than the thickness of the lateral drainage layer at full loading.

Draft



Attachment 1
HELP Model Results
Vermillion Landfill Deeper Cell Excavation Permit Modification Request
Apr-11

Input Data

Parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
SCS runoff curve number	96.5	96.5	96.5	96.5	96.5
fraction of area allowing runoff (%)	80	80	80	80	100
area simulated (acres)	1	1	1	1	1
evaporative zone depth (inches)	6	6	6	6	6
leaf area index	1	1	1	1	1
soil cover depth (inches)	6	6	6	6	6
soil cover initial moisture content (%)	26.42	26.32	26.32	26.34	26.3
waste layer thickness (feet) - average	25	50	75	100	100
waste initial moisture content (%)	7.3	7.3	7.3	7.3	7.3
waste k (cm/sec) (effective - baled waste)	1x10^-3	1x10^-3	1x10^-3	1x10^-3	1x10^-3
drainage layer thickness (inches)	12	12	12	12	12
drainage layer k (cm/sec)	5.0x10^-3	5.0x10^-3	5.0x10^-3	5.0x10^-3	5.0x10^-3
liner base thickness (inches)	24	24	24	24	24
liner base k (cm/sec) (regulatory minimum)	1x10^-7	1x10^-7	1x10^-7	1x10^-7	1x10^-7
drainage layer slope (%)	2.85	2.85	2.85	2.85	2.85
drainage length (feet)	200	200	200	200	200
recirculation? (amount recirculated)	Y-100%	Y-100%	Y-100%	Y-100%	N-0%
number of years simulated	3	6	9	12	12

Output Data

average annual leachate collected in drainage layer (ft^3)	7,450	8,777	8,479	10,290	35
average annual leachate recirculated to layer 1 from drainage layer (ft^3)	7,450	8,777	8,479	10,290	0
average annual head on primary base liner (inches)	1.386	1.635	1.579	1.918	0.006
peak day head on primary base liner (inches)	8.073	7.858	8.102	10.625	0.215

Draft

VERMILLION/YANKOTN/CLAY LANDFILL

TRENCH #4 CONSTRUCTION

CITY OF VERMILLION

VI. LEACHATE COLLECTION MATERIAL PERMEABILITY TEST RESULTS – TETRA TECH

Draft

TETRA TECH, INC.

Tetra Tech, Inc.
601 East 48th Street North
Sioux Falls, South Dakota 57104-0698
(605) 332-5371
Fax: (605) 332-8488

November 1, 2006

Mr. William Welk
City of Vermillion
25 Center Street
Vermillion, South Dakota 57069

Dear Mr. Welk:

Subj: Permeability Testing
Fine Leachate Material
Vermillion Landfill Trench #4
Vermillion, South Dakota
Tetra Tech #643-0496

This letter concerns our recent permeability testing for the above referenced project. The purpose of our involvement was to perform permeability testing on soil samples obtained by to our office by Arens Engineering. Our work was performed in accordance with the written authorization of the City of Vermillion.

Two samples were submitted and received at our laboratory for permeablity testing on October 25, 2006. The samples were identified as samples #1 (Fine Leachate Material) and #2 (Fine Leachate Material).

Each sample was placed in a chamber similar to a triaxial chamber and subjected to an effective confining fluid pressure of 2.0 pounds per square inch (psi) which was applied and accurately maintained throughout the test to completely seal off the interface between the specimens and the membrane. A maximum head differential of 5' was utilized for the tests. The specimens were allowed to saturate after which readings were taken over a period of several minutes. The test results present an average of the readings. The results of the permeability tests are shown on the attached data sheet.

If you have any questions or comments regarding the test results or if we can be of further assistance, please contact us.

Very Truly Yours,

Bruce W. Card, PE
Branch Manager

cc: Arens Engineering

Enclosure

Draft

PERMEABILITY TEST DATA

PROJECT Vermillion Landfill DATE 10/31/2006

REPORTED TO City of Vermillion JOB NO. 643-0496

cc: Arens Engineering

Sample No.	1	2		
Sample Type	Fine Leachate Material	Fine Leachate Material		
Elevation	—	—		
Type of Sample	Bag	Bag		
Date Received	10/25/2006	10/26/2006		
Soil Classification (ASTM: D 2487) Symbol	Silty Sand, Fine Grained, Brown (SC)	Sand W/Silt, Fine Grained, Brown (SP-SC)		
In-place Moisture Content (%)	Dry	Dry		
Moisture Density Relation of Soil (ASTM:D698)				
Max. Dry Density (PCF)	—	—		
Optimum Moisture Content (%)	—	—		
Permeability Test				
Trial No.	17	17		
Type of Test	Falling head	Falling head		
Type of Specimen	Remolded	Remolded		
Specimen Height (inches)	2.99	2.99		
Specimen Diameter (inches)	2.88	2.88		
Dry Density (PCF)	—	—		
Percent of Max. Density	—	—		
Moisture Content (%)	Dry	Dry		
Max. Head Differential (ft)	5	5		
Confining Pressure (effective-PSI)	2	2		
Water Temperature (°C)	20	20		
Coefficient of Permeability				
K @ 20°C (cm/sec)	5.72×10^{-3}	5.85×10^{-3}		
K @ 20°C (ft/min)	1.12×10^{-2}	1.15×10^{-2}		
Atterberg Limits				
Liquid Limit (%)	Not Tested	Not Tested		
Plastic Limit (%)	Not Tested	Not Tested		
Plastic Index	Not Tested	Not Tested		

Draft

REISSUE

PERMEABILITY TEST DATA

PROJECT Vermillion Landfill

DATE 12/14/2006

REPORTED TO City of Vermillion

JOB NO. 643-0496

cc: Arens Engineering

Sample No.	3	4		
Sample Type	Fine Leachate Material	Fine Leachate Material		
Elevation	—	---		
Type of Sample	Bag	Bag		
Date Received	11/1/2006	11/3/2006		
Soil Classification (ASTM: D 2487) Symbol	Silty Sand, Fine Grained, Brown (SM)	Silty Sand, Fine Grained, Brown (SM)		
In-place Moisture Content (%)	Dry	Dry		
Moisture Density Relation of Soil (ASTM:D698)	---	---		
Max. Dry Density (PCF)	---	---		
Optimum Moisture Content (%)	---	---		
Permeability Test				
Trial No.	17	17		
Type of Test	Falling Head	Falling Head		
Type of Specimen	Remolded	Remolded		
Specimen Height (inches)	2.99	2.99		
Specimen Diameter (inches)	2.88	2.88		
Dry Density (PCF)	---	---		
Percent of Max. Density	—	---		
Moisture Content (%)	Dry	Dry		
Max. Head Differential (ft)	5	5		
Confining Pressure (effective-PSI)	2	2		
Water Temperature (^{o}C)	20	20		
Coefficient of Permeability				
K @ 20^{o}C (cm/sec)	$5.73X10^{-3}$	$6.04X10^{-3}$		
K @ 20^{o}C (ft/min)	$1.12X10^{-2}$	$1.18X10^{-2}$		
Atterberg Limits				
Liquid Limit (%)	Not Tested	Not Tested		
Plastic Limit (%)	Not Tested	Not Tested		
Plastic Index	Not Tested	Not Tested		

Draft

TETRA TECH, INC.

Tetra Tech, Inc.
601 East 48th Street North
Sioux Falls, South Dakota 57104-0698
(605) 332-5371
Fax: (605) 332-8488

December 20, 2006

Mr. William Welk
City of Vermillion
25 Center Street
Vermillion, South Dakota 57069

Dear Mr. Welk:

Subj: Permeability Testing
Fine Leachate Material
Vermillion Landfill Trench #4
Vermillion, South Dakota
Tetra Tech #643-0496

This letter concerns our recent permeability testing for the above referenced project. The purpose of our involvement was to perform permeability testing on soil samples submitted to our office by Arens Engineering. Our work was performed in accordance with the written authorization of the City of Vermillion.

Two samples were submitted and received at our laboratory for permeablity testing. Four samples were received on December 19, 2006. The samples were identified as samples #5, #6, #7 and #8 (Fine Leachate Material).

Each sample was placed in a chamber similar to a triaxial chamber and subjected to an effective confining fluid pressure of 2.0 pounds per square inch (psi) which was applied and accurately maintained throughout the test to completely seal off the interface between the specimens and the membrane. A maximum head differential of 5' was utilized for the tests. The specimens were allowed to saturate after which readings were taken over a period of several minutes. The test results present an average of the readings. The results of the permeability tests are shown ou the attached data sheet.

If you have any questions or comments regarding the test results or if we can be of further assistance, please contact us.

Very Truly Yours,

Adam Johnson
Senior Engineering Technician

cc: Arens Engineering

Enclosure

Draft

PERMEABILITY TEST DATA

PROJECT Vermillion Landfill DATE 12/14/2006

REPORTED TO City of Vermillion JOB NO. 643-0496

cc: Arens Engineering

Sample No.	5	6	7	8
Sample Type	Fine Leacheate Material	Fine Leachate Material	Fine Leachate Material	Fine Leachate Material
Elevation	---	---	---	---
Type of Sample	Bag	Bag	Bag	Bag
Date Received	12/19/2006	12/19/2006	12/19/2006	12/19/2006
Soil Classification (ASTM: D 2487) Symbol				
In-place Moisture Content (%)	Dry	Dry	Dry	Dry
Moisture Density Relation of Soil (ASTM:D698)				
Max. Dry Density (PCF)	---	---	---	---
Optimum Moisture Content (%)	---	---	---	---
Permeability Test				
Trial No.	17	17	17	17
Type of Test	Falling head	Falling head	Falling head	Falling head
Type of Specimen	Remolded	Remolded	Remolded	Remolded
Specimen Height (inches)	2.99	2.99	2.99	2.99
Specimen Diameter (inches)	2.88	2.88	2.88	2.88
Dry Density (PCF)	---	---	---	---
Percent of Max. Density	---	---	---	---
Moisture Content (%)	Dry	Dry	Dry	Dry
Max. Head Differential (ft)	5	5	5	5
Confining Pressure (effective-PSI)	2	2	2	2
Water Temperature (°C)	20	20	20	20
Coefficient of Permeability				
K @ 20°C (cm/sec)	5.82×10^{-3}	5.71×10^{-3}	6.20×10^{-3}	5.60×10^{-3}
K @ 20°C (ft/min)	1.14×10^{-2}	1.12×10^{-2}	1.22×10^{-2}	1.10×10^{-2}
Atterberg Limits				
Liquid Limit (%)	Not Tested	Not Tested	Not Tested	Not Tested
Plastic Limit (%)	Not Tested	Not Tested	Not Tested	Not Tested
Plastic Index	Not Tested	Not Tested	Not Tested	Not Tested

Draft

Pipe Sizing Calculations

Draft

Job No		No.	1

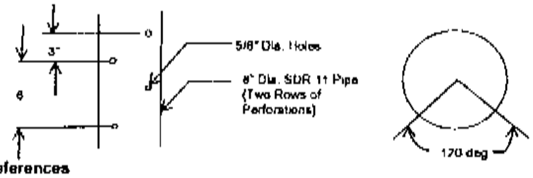
HDR Engineering, Inc.

HDR

Project	Vermillion Leachate Management Plan	Computed	TJY	Date	4/7/2011
Subject	Leachate Collection System	Checked	MJE	Date	4/27/2011
Task	Leachate Pipe Structural Strength Analysis				

Problem

Evaluate structural integrity of the leachate collection pipe (6" HDPE SDR 11).



References

PolyPipe, Inc. "Design and Engineering Guide for Polyethlene Piping", September 2008, http://www.polypipeinc.com
U.S. EPA, "Lining of Waste Containment and other Impoundment Facilities", September 1988, EPA/600/2-88/052
Chevron Phillips Chemical Company, LP "Polyethylene Piping Systems Manual"

Calculations

Given

0.625	in	perforation diameter
2		perforation around diameter of pipe
4		perforations per foot
730	ft	length of pipe run
5.348	in	inside diameter of 6-inch SDR 11 HDPE pipe
6.625	in	outer diameter of 6-inch SDR 11 HDPE pipe
11		dimension ratio of pipe

Loading Conditions

The highest design loading on the leachate collection pipe will be stress from overlying waste and soils.

	Full Build-out	
	Layer Thickness (ft)	Specific Weight (lb/ft^3)
Top Soil	0.5	120
Final and Intermediate Cover	4	120
Waste & Daily Cover	100	76
Sand , Pea Gravel, Rock	4	120

Prismatic Pressure Load	8,620	psf
Prismatic Pressure Load	59.9	psi
Average Density of Soil Cover and Waste	79.45	lb/cf

To account for the supporting system of the trench backfill material, use the modified Marston formula. The load must be increased to account for inlet holes drilled into the pipe as depicted above.

$$W = \frac{C_d \cdot p \cdot B_d \cdot D}{144} \qquad W_{design} = \frac{12}{12 - l_p} * W$$

where,

Value	Variable	
2.6	C_d	Trench Coefficient (dimensionless)
8	B_d	trench width at top of pipe (feet)
6.625	D	outside diameter (in)
79.45	p	soil density (lb/ft^3), average density of waste and soil cover material shown in above table
2.50	l_p	cumulative length of perforations per foot of pipe (in)
76	W	**loading per unit length of pipe (lbs/in)**
98	W_{design}	**design loading per unit length of pipe (lbs/in)**

Deflection Calculation using Modified Spangler Formula

$$\Delta x = \frac{D_L \cdot K \cdot W}{[\frac{2E}{3(DR-1)^3}] + 0.061E'}$$

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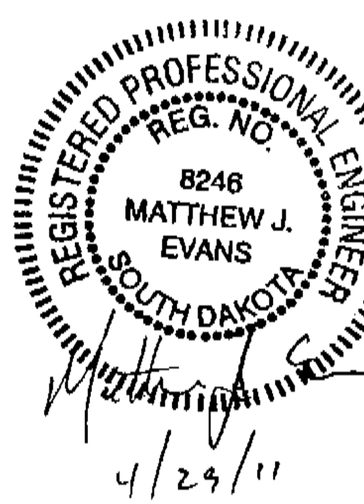

where,

Value	Variable	
1.0	D_L	deflection lag factor (dimensionless)
0.1	K	bedding constant (dimensionless)
96	W	load per unit length of pipe (lbs/in)
30,000	E	modulus of elasticity of the pipe material (psi)
700	E'	modulus of soil reactions (lbs/in^2)
11	DR	dimension ratio (dimensionless)
6.625	D	outside diameter (in)
0.15	Δ	horizontal deflection or change in diameter (in)
2.31%		**percent deflection, deflection/outside diameter**
2.7%		manufacturer's maximum allowable design limit for deflection

Wall Buckling Calculation

$$P_{cb} = \frac{1}{SF} \cdot \left(\frac{2.67 \cdot R_w \cdot B \cdot E_s \cdot E}{DR^3}\right)^{1/2} \qquad R_w = 1 - \left(0.33 \cdot \frac{H_w}{H}\right) \qquad B = \frac{1}{1 + 4 \cdot e^{-0.065H}} \qquad \text{(Att. 1)}$$

Value	Variable	
700	E_s	soil modulus
30,000	E	pipe modulus of elasticity (psi)
11	DR	dimension ratio (dimensionless)
0.45	H_w	height of water table above pipe (ft)
109	H	height of soil cover above pipe (ft)
0.997	B	empirical coefficient of elastic support (dimensionless)
0.9986	R_w	water buoyancy factor (dimensionless)
205	P_{cb}	**critical buckling stress (psi)**
3.4		**factor of safety (critical buckling stress/prismatic loading)**

Therefore, 6-inch SDR 11 is structurally suitable for use as the leachate collection piping.

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HDR Engineering, Inc.

Project	Vermillion Leachate Management Plan	Computed	TJY	Date	4/7/2011
Subject	Leachate Collection System	Checked	MJE	Date	4/7/2011
Task	Leachate Pipe Capacity			Revised	

Problem
Evaluate the flow capacity of the leachate collection pipe.

Calculations
Given:

0.625	in	perforation diameter
2		perforation around diameter of pipe
25	%	reduction in perforation diameter due to clogging
0.469	in	revised perforation diameter
4		perforations per foot
730	ft	length of pipe run
5.348	in	inside diameter of 6 inch SDR 11 HDPE pipe
102	cf/ac/day	peak leachate collection layer flow (Bottom)
3.2	ac	contributing area of flow (Bottom)
466	cf/ac/day	peak leachate collection layer flow (Side)
4.9	ac	contributing area of flow (Side)
2,610	**cf/day**	**peak leachate collection layer flow**

Determine the Capacity through the Slotted Perforations

$$Q_{perf} = C_d \times A \times (2gh)^{0.5}$$ Orifice Equation

where:
- Qperf = flow through perforations (cfs)
- A = cross sectional area through one perforation
- Cd = orifice coefficient = 0.6
- g = acceleration due to gravity = 32.2 ft/s^2
- h = head of water above the orifice = 1 in = 0.0833 ft

A: 0.172 in^2
0.00119 ft^2

Q: 1.66E-03 cfs per perforation
6.64E-03 cfs per foot of pipe
4.85 cfs per entire length of pipe
418,774 ft^3 day per entire length of pipe

Determine the Capacity of the Pipe

$$Q_p = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$ Manning's Equation

where:
- Qp = pipe capacity (cfs)
- n = Manning's roughness coefficient (dimensionless)
- A = cross section area (sq. feet)
- R = hydraulic radius = area/wetted perimeter (ft)
- S = slope of pipe (ft/ft)

n	0.013		HDPE pipe
A	22.45	in^2	3.14 * inner diameter^2/4
	0.156	ft^2	
R	0.111	ft	assume full flow
S	0.0200		slope of pipe post-settlement
Q_p	0.63	ft^3 / sec	
	54,772	**ft^3 / day**	

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA
4/29/11

Therefore, the limiting factor is pipe flow. Accordingly, the calculated factor of safety is 21 (flow capacity through pipe/peak day leachate collection) which means a 6-inch slotted pipe is sufficient.

Draft

HDR Engineering, Inc.

Project	Vermillion Leachate Management Plan	Computed TJY	Date 4/7/2011
Subject	Liner System Design	Checked MJE	Date 4/27/2011
Task	Overburden Stress Calculation		

No

Problem

Determine the loading stress on the proposed bottom liner system.

References

Townsend, T.G., *Selection of Densities for Use in Landfill Design Calculations*

Calculations

Given:

100	feet	landfill thickness
76	lb/cf	Density of MSW and daily/intermediate cover
120	lb/cf	Density of final cover

Layer Description	15-ft of Waste		100-ft of Waste with Final Cove	
	Layer Thickness (ft)	Specific Weight (lb/ft^3)	Layer Thickness (ft)	Specific Weight (lb/ft^3)
Topsoil	0	120	0.5	120
Final and Int. Cover	0	120	4	120
Waste & Daily/ Intermediate Cover*	15	76	100	76
Sand, Pea Gravel, and Rock	4	120	4	120

	15-ft of Waste	100-ft of Waste with Final Cove
F (lb/ft^2)	1,620	8,620
F (lb/in^2)	11.3	59.9

Conclusion

A design loading stress of 8,012 lb/ft^2 (or 59.9 lb/in^2) is sufficient to use design calculations in Cell. This is a conservative estimate for design because the waste density assumes a 20% by volume of intermediate/daily cover soil which is equivalent to a six inch-thick layer of soil per 2 feet of compacted waste. In practice, the daily lifts of waste will be thicker and the soil to overall volume ratio will be less.

REGISTERED PROFESSIONAL ENGINEER REG. NO. 8246 MATTHEW J. EVANS SOUTH DAKOTA

4/29/11

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* SCENARIO 4 - SIDESLOPE
- USED TO CALCULATE TOTAL FLOW THAT NEEDS TO BE MANAGED BY THE LEACHATE COLLECTION SYSTEM.

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HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
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HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)
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DEVELOPED BY ENVIRONMENTAL LABORATORY
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**
USAE WATERWAYS EXPERIMENT STATION
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FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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PRECIPITATION DATA FILE:	c:\help3\verm\VERM-P.D4
TEMPERATURE DATA FILE:	c:\help3\verm\VERM-T.D7
SOLAR RADIATION DATA FILE:	c:\help3\verm\VERM-SR.D13
EVAPOTRANSPIRATION DATA:	c:\help3\verm\VERM-ET.D11
SOIL AND DESIGN DATA FILE:	c:\help3\verm\VERM4-SS.D10
OUTPUT DATA FILE:	c:\help3\verm\verm4-ss.OUT

TIME: 14: 8 DATE: 4/28/2011

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TITLE: VERMILLION LF - Scenario 4 - Side Slope

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4790 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2849 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04 CM/SEC

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 3 IS RECIRCULATED INTO THIS LAYER.
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 1.80 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	1200.00 INCHES
POROSITY	=	0.1680 VOL/VOL
FIELD CAPACITY	=	0.0730 VOL/VOL
WILTING POINT	=	0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0620 VOL/VOL
WILTING POINT	=	0.0240 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0622 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.499999989000E-02 CM/SEC
SLOPE = 33.00 PERCENT
DRAINAGE LENGTH = 200.0 FEET

NOTE: 100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS LAYER IS RECIRCULATED INTO LAYER # 1.

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E 06	CM/SEC

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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #14 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 132. FEET.

SCS RUNOFF CURVE NUMBER	=	96.50	
FRACTION OF AREA ALLOWING RUNOFF	=	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.709	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.874	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.506	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	100.304	INCHES
TOTAL INITIAL WATER	=	100.304	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
OMAHA NEBRASKA

STATION LATITUDE = 41.30 DEGREES
MAXIMUM LEAF AREA INDEX = 1.00
START OF GROWING SEASON (JULIAN DATE) = 112
END OF GROWING SEASON (JULIAN DATE) = 290
EVAPORATIVE ZONE DEPTH = 6.0 INCHES
AVERAGE ANNUAL WIND SPEED = 10.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 69.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 64.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 71.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR GRAND ISLAND NEBRASKA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.37	0.49	1.80	2.76	3.74	3.61
3.40	2.82	2.41	1.97	1.47	0.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR OMAHA NEBRASKA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.70	25.30	35.20	50.40	61.70	71.20
75.70	73.50	64.40	53.60	38.00	26.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR OMAHA NEBRASKA AND STATION LATITUDE = 41.30 DEGREES

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ANNUAL TOTALS FOR YEAR 1

INCHES CU. FEET PERCENT

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PRECIPITATION	19.48	70712.398	100.00
RUNOFF	3.176	11530.208	16.31
EVAPOTRANSPIRATION	15.816	57411.383	81.19
RECIRCULATION INTO LAYER 1	1.094535	3973.161	5.62
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	1.094535	3973.161	5.62
PERC./LEAKAGE THROUGH LAYER 4	0.476701	1730.424	2.45
AVG. HEAD ON TOP OF LAYER 4	0.0709		
CHANGE IN WATER STORAGE	0.011	40.905	0.06
SOIL WATER AT START OF YEAR	100.304	364103.375	
SOIL WATER AT END OF YEAR	100.315	364144.281	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0001	-0.523	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.26	117103.781	100.00
RUNOFF	8.000	29041.049	24.80
EVAPOTRANSPIRATION	22.984	83431.023	71.25
RECIRCULATION INTO LAYER 1	4.234200	15370.147	13.13
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	4.234200	15370.147	13.13
PERC./LEAKAGE THROUGH LAYER 4	0.732509	2659.009	2.27
AVG. HEAD ON TOP OF LAYER 4	0.2726		
CHANGE IN WATER STORAGE	0.543	1972.870	1.68
SOIL WATER AT START OF YEAR	100.315	364144.281	
SOIL WATER AT END OF YEAR	100.499	364810.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.360	1307.034	1.12
ANNUAL WATER BUDGET BALANCE	0.0000	-0.172	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.22	84288.609	100.00
RUNOFF	5.452	19791.930	23.48
EVAPOTRANSPIRATION	17.227	62535.254	74.19
RECIRCULATION INTO LAYER 1	2.727795	9901.896	11.75
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	2.727795	9901.896	11.75
PERC./LEAKAGE THROUGH LAYER 4	0.576137	2091.376	2.48
AVG. HEAD ON TOP OF LAYER 4	0.1769		
CHANGE IN WATER STORAGE	-0.036	-130.008	-0.15
SOIL WATER AT START OF YEAR	100.499	364810.125	
SOIL WATER AT END OF YEAR	100.347	364259.375	
SNOW WATER AT START OF YEAR	0.360	1307.034	1.55
SNOW WATER AT END OF YEAR	0.476	1727.763	2.05
ANNUAL WATER BUDGET BALANCE	0.0000	0.061	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.52	92637.617	100.00
RUNOFF	6.262	22730.357	24.54
EVAPOTRANSPIRATION	17.685	64196.000	69.30
RECIRCULATION INTO LAYER 1	3.737436	13566.892	14.65
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	3.737436	13566.892	14.65
PERC./LEAKAGE THROUGH LAYER 4	0.694147	2519.755	2.72
AVG. HEAD ON TOP OF LAYER 4	0.2407		
CHANGE IN WATER STORAGE	0.855	3104.104	3.35
SOIL WATER AT START OF YEAR	100.347	364259.375	
SOIL WATER AT END OF YEAR	101.678	369091.250	
SNOW WATER AT START OF YEAR	0.476	1727.763	1.87
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0241	87.398	0.09

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.53	96303.906	100.00
RUNOFF	6.554	23790.988	24.70
EVAPOTRANSPIRATION	19.924	72323.195	75.10
RECIRCULATION INTO LAYER 1	5.057572	18358.986	19.06
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	5.057572	18358.986	19.06
PERC./LEAKAGE THROUGH LAYER 4	0.997863	3622.242	3.76
AVG. HEAD ON TOP OF LAYER 4	0.3278		
CHANGE IN WATER STORAGE	-0.928	-3368.008	3.50
SOIL WATER AT START OF YEAR	101.678	369091.250	
SOIL WATER AT END OF YEAR	100.750	365723.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

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ANNUAL WATER BUDGET BALANCE -0.0178 -64.511 -0.07

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.51	81711.320	100.00
RUNOFF	5.482	19899.424	24.35
EVAPOTRANSPIRATION	16.946	61514.512	75.28
RECIRCULATION INTO LAYER 1	2.179663	7912.176	9.68
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	2.179663	7912.176	9.68
PERC./LEAKAGE THROUGH LAYER 4	0.463974	1684.225	2.06
AVG. HEAD ON TOP OF LAYER 4	0.1415		
CHANGE IN WATER STORAGE	-0.376	-1363.984	-1.67
SOIL WATER AT START OF YEAR	100.750	365723.250	
SOIL WATER AT END OF YEAR	100.177	363643.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

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SNOW WATER AT END OF YEAR 0.197 715.777
0.88

ANNUAL WATER BUDGET BALANCE -0.0063 -22.853 -
0.03

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ANNUAL TOTALS FOR YEAR 7

INCHES CU. FEET
PERCENT

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PRECIPITATION 25.47 92456.102
100.00

RUNOFF 5.440 19745.658
21.36

EVAPOTRANSPIRATION 19.525 70874.461
76.66

RECIRCULATION INTO LAYER 1 3.808969 13826.556
14.95

DRAINAGE COLLECTED FROM LAYER 3 0.0000 0.000
0.00

RECIRCULATION FROM LAYER 3 3.808969 13826.556
14.95

PERC./LEAKAGE THROUGH LAYER 4 0.672233 2440.207
2.64

AVG. HEAD ON TOP OF LAYER 4 0.2468

CHANGE IN WATER STORAGE -0.166 -604.250 -
0.65

SOIL WATER AT START OF YEAR 100.177 363643.500

SOIL WATER AT END OF YEAR 100.208 363755.000

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SNOW WATER AT START OF YEAR	0.197	715.777	0.77
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.029	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.40	77682.016	100.00
RUNOFF	4.962	18013.725	23.19
EVAPOTRANSPIRATION	15.139	54955.766	70.74
RECIRCULATION INTO LAYER 1	2.259218	8200.960	10.56
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	2.259218	8200.960	10.56
PERC./LEAKAGE THROUGH LAYER 4	0.588919	2137.775	2.75
AVG. HEAD ON TOP OF LAYER 4	0.1466		
CHANGE IN WATER STORAGE	0.709	2574.721	3.31
SOIL WATER AT START OF YEAR	100.208	363755.000	

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SOIL WATER AT END OF YEAR	100.917	366329.719
SNOW WATER AT START OF YEAR 0.00	0.000	0.000
SNOW WATER AT END OF YEAR 0.00	0.000	0.000
ANNUAL WATER BUDGET BALANCE 0.00	0.0000	0.024

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.75	82582.508	100.00
RUNOFF	5.376	19515.053	23.63
EVAPOTRANSPIRATION	16.268	59051.391	71.51
RECIRCULATION INTO LAYER 1	4.854613	17622.244	21.34
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	4.854613	17622.244	21.34
PERC./LEAKAGE THROUGH LAYER 4	0.624083	2265.422	2.74
AVG. HEAD ON TOP OF LAYER 4	0.3140		

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CHANGE IN WATER STORAGE	0.481	1747.010	2.12
SOIL WATER AT START OF YEAR	100.917	366329.719	
SOIL WATER AT END OF YEAR	101.399	368076.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0010	3.631	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.28	109916.398	100.00
RUNOFF	7.677	27865.842	25.35
EVAPOTRANSPIRATION	21.393	77658.375	70.65
RECIRCULATION INTO LAYER 1	11.455647	41584.000	37.83
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	11.455647	41584.000	37.83
PERC./LEAKAGE THROUGH LAYER 4	0.856292	3108.339	2.83

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AVG. HEAD ON TOP OF LAYER 4	0.7423		
CHANGE IN WATER STORAGE	0.325	1181.345	1.07
SOIL WATER AT START OF YEAR	101.399	368076.750	
SOIL WATER AT END OF YEAR	101.724	369258.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0282	102.495	0.09

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	19.50	70785.008	100.00
RUNOFF	3.692	13400.264	18.93
EVAPOTRANSPIRATION	16.036	58209.520	82.23
RECIRCULATION INTO LAYER 1	3.759971	13648.695	19.28
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
RECIRCULATION FROM LAYER 3	3.759971	13648.695	19.28

PERC./LEAKAGE THROUGH LAYER 4	0.856220	3108.080	4.39
AVG. HEAD ON TOP OF LAYER 4	0.2433		
CHANGE IN WATER STORAGE	-1.054	-3826.691	-5.41
SOIL WATER AT START OF YEAR	101.724	369258.094	
SOIL WATER AT END OF YEAR	100.613	365224.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.057	206.627	0.29
ANNUAL WATER BUDGET BALANCE	0.0292	-106.166	0.15

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.59	89261.711	100.00
RUNOFF	5.046	18318.189	20.52
EVAPOTRANSPIRATION	19.026	69066.000	77.37
RECIRCULATION INTO LAYER 1	6.818323	24750.514	27.73
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00

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RECIRCULATION FROM LAYER 3 6.818323 24750.514
27.73

PERC./LEAKAGE THROUGH LAYER 4 0.731786 2656.385
2.98

AVG. HEAD ON TOP OF LAYER 4 0.4423

CHANGE IN WATER STORAGE -0.215 -778.874 -
0.87

SOIL WATER AT START OF YEAR 100.613 365224.781

SOIL WATER AT END OF YEAR 100.369 364340.562

SNOW WATER AT START OF YEAR 0.057 206.627
0.23

SNOW WATER AT END OF YEAR 0.086 311.962
0.35

ANNUAL WATER BUDGET BALANCE 0.0000 0.010
0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 12

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.37	0.53	1.80	2.56	3.50	2.90
	3.17	2.82	2.52	2.46	1.43	0.40

STD. DEVIATIONS	0.34	0.33	0.87	1.16	1.57	1.23
	1.61	1.32	1.34	1.62	1.05-	0.38

RUNOFF

TOTALS	0.030	0.048	0.607	0.625	0.739	0.584
	0.830	0.516	0.629	0.588	0.364	0.033
STD. DEVIATIONS	0.081	0.056	0.421	0.420	0.550	0.491
	0.704	0.378	0.528	0.546	0.350	0.101

EVAPOTRANSPIRATION

TOTALS	0.320	0.387	1.153	1.970	2.745	2.535
	2.296	2.315	1.709	1.352	0.952	0.428
STD. DEVIATIONS	0.268	0.192	0.571	0.786	1.096	0.715
	0.936	1.047	0.735	0.668	0.454	0.182

LATERAL DRAINAGE RECIRCULATED INTO LAYER 1

TOTALS	0.1106	0.0608	0.4115	0.6359	0.5387	0.3821
	0.2538	0.0981	0.1398	0.5446	0.6977	0.4586
STD. DEVIATIONS	0.2555	0.1279	0.4516	0.6707	0.4563	0.2791
	0.2710	0.1390	0.1318	0.6586	0.9254	0.5345

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE RECIRCULATED FROM LAYER 3

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TOTALS	0.1106	0.0608	0.4115	0.6359	0.5387	0.3821
	0.2538	0.0981	0.1398	0.5446	0.6977	0.4586
STD. DEVIATIONS	0.2555	0.1279	0.4516	0.6707	0.4563	0.2791
	0.2710	0.1390	0.1318	0.6586	0.9254	0.5345

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0212	0.0180	0.0491	0.0868	0.0826	0.0832
	0.0665	0.0444	0.0524	0.0659	0.0561	0.0630
STD. DEVIATIONS	0.0412	0.0372	0.0407	0.0281	0.0390	0.0307
	0.0330	0.0326	0.0254	0.0389	0.0421	0.0492

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0846	0.0513	0.3147	0.5026	0.4120	0.3020
	0.1941	0.0751	0.1105	0.4165	0.5514	0.3507
STD. DEVIATIONS	0.1954	0.1083	0.3454	0.5301	0.3489	0.2206
	0.2072	0.1063	0.1042	0.5037	0.7313	0.4088

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 12

	INCHES		CU. FEET	PERCENT
PRECIPITATION	24.46	(3.910)	88786.8	100.00
RUNOFF	5.593	(1.4065)	20303.56	22.868
EVAPOTRANSPIRATION	18.164	(2.4258)	65935.57	74.263
DRAINAGE RECIRCULATED INTO LAYER 1	4.33233	(2.70816)	15726.352	17.71249
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
DRAINAGE RECIRCULATED FROM LAYER 3	4.33233	(2.70816)	15726.352	17.71249
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.68924	(0.15899)	2501.937	2.81792
AVERAGE HEAD ON TOP OF LAYER 4	0.280	(0.176)		
CHANGE IN WATER STORAGE	0.013	(0.6071)	45.76	0.052

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 12

	(INCHES)	(CU. FT.)
PRECIPITATION	2.23	8094.900
RUNOFF	1.145	4154.5972
DRAINAGE RECIRCULATED INTO LAYER 1	0.12836	

465.95932

DRAINAGE COLLECTED FROM LAYER 3	0.00000	

0.00000

DRAINAGE RECIRCULATED FROM LAYER 3	0.12836	

465.95932 - PEAK LEACHATE COLLECTED FROM LANDFILL BOTTOM SIDESLOPES (CF/AC/DAY)

PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003833	

13.91328

AVERAGE HEAD ON TOP OF LAYER 4	3.043	
MAXIMUM HEAD ON TOP OF LAYER 4	5.908	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.68	6099.5435
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4790
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.2510

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****
*****

Draft

****

FINAL WATER STORAGE AT END OF YEAR 12

LAYER	(INCHES)	(VOL/VOL)
1	1.7773	0.2962
2	87.6000	0.0730
3	0.7440	0.0620
4	10.2480	0.4270
SNOW WATER	0.086	

****

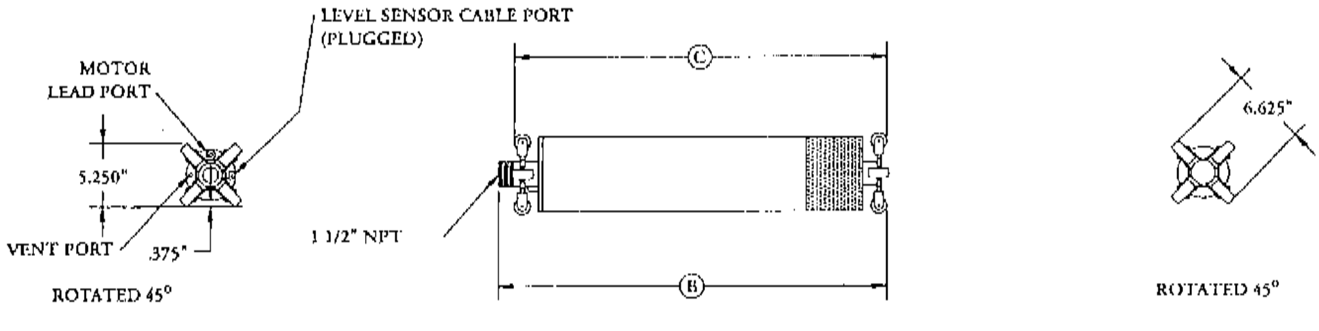
****

Draft

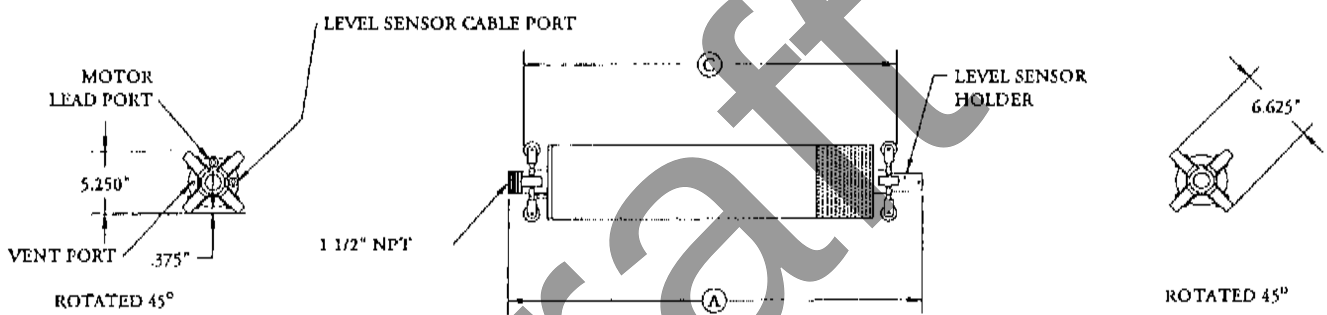
Leachate Sump Pump

Draft

SERIES 5 SIZE 4 WHEELED SUMP DRAINER



WSD



WSDPT

Draft

MODEL	HP	PHASE	A	B	C	*APPROX. SHIPPING WEIGHT	
						WSD	WSDPT
5-2	0.50	1	31.02	29.90	29.15	61.47	66.47
5-2	0.50	3	31.02	29.90	29.15	61.47	66.47
5-3	0.75	1	32.98	31.86	31.11	66.24	71.24
5-3	0.75	3	32.98	31.86	31.11	66.24	71.24
5-4	1.00	1	34.90	33.78	33.03	70.98	75.98
5-4	1.00	3	34.90	33.78	33.03	70.98	75.98
5-5	1.00	1	35.73	34.61	33.86	71.88	76.88
5-5	1.00	3	35.73	34.61	33.86	71.88	76.88
5-6	1.50	1	38.43	37.31	36.56	79.22	84.22
5-6	1.50	3	36.56	35.44	34.69	72.77	77.77
5-7	1.50	1	39.26	38.14	37.39	80.12	85.12
5-7	1.50	3	37.39	36.27	35.52	73.67	78.67
5-8	2.00	1	41.59	40.47	39.72	85.17	90.17
5-8	2.00	3	40.09	38.97	38.22	81.01	86.01

MODEL	HP	PHASE	A	B	C	*APPROX. SHIPPING WEIGHT	
						WSD	WSDPT
5-9	2.00	1	42.42	41.30	40.55	86.07	91.07
5-9	2.00	3	40.92	39.80	39.05	81.90	86.90
5-10	2.00	1	43.25	42.13	41.38	86.96	91.96
5-10	2.00	3	41.75	40.63	39.88	82.80	87.80
5-11	2.00	1	44.08	42.96	42.21	87.86	92.86
5-11	2.00	3	42.58	41.46	40.71	83.69	88.69
5-12	2.00	1	44.91	43.79	43.04	88.75	93.75
5-12	2.00	3	53.41	52.29	51.54	92.35	97.35
5-13	3.00	1	54.24	53.12	52.37	119.24	124.24
5-13	3.00	3	51.24	50.12	49.37	105.91	110.91
5-14	3.00	1	55.07	53.95	53.20	120.14	125.14
5-14	3.00	3	52.07	50.95	50.20	106.81	111.81
5-15	3.00	1	55.90	54.78	54.03	121.03	126.03
5-15	3.00	3	52.90	51.78	51.03	107.70	112.70

NOTE: ALL DIMENSIONS ARE IN INCHES.

*SHIPPING WEIGHT INCLUDES
WSD: CRATE, 50' OF 14-4 MOTOR LEAD, 50' OF 1/8" SS CABLE.
WSDPT: CRATE, 50' OF 14-4 MOTOR LEAD, 50' OF 1/8" SS CABLE, LEVEL SENSOR AND CABLE.

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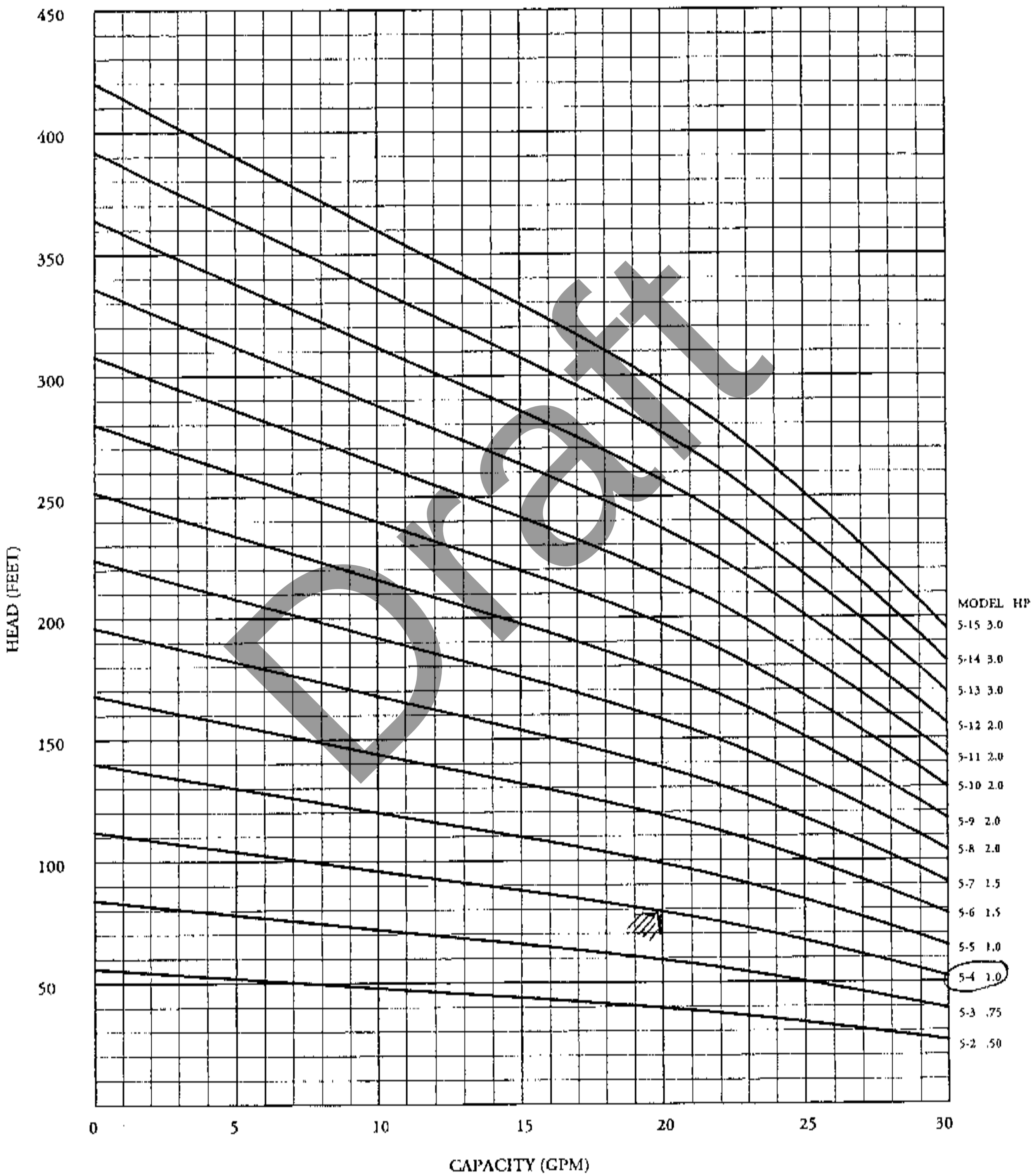
SurePump is a Reg. TM of EPG Companies Inc.

SERIES 5 SurePump™
Flow Range 15-30 GPM
60 Hz



DATA SUBJECT TO CHANGE WITHOUT NOTICE

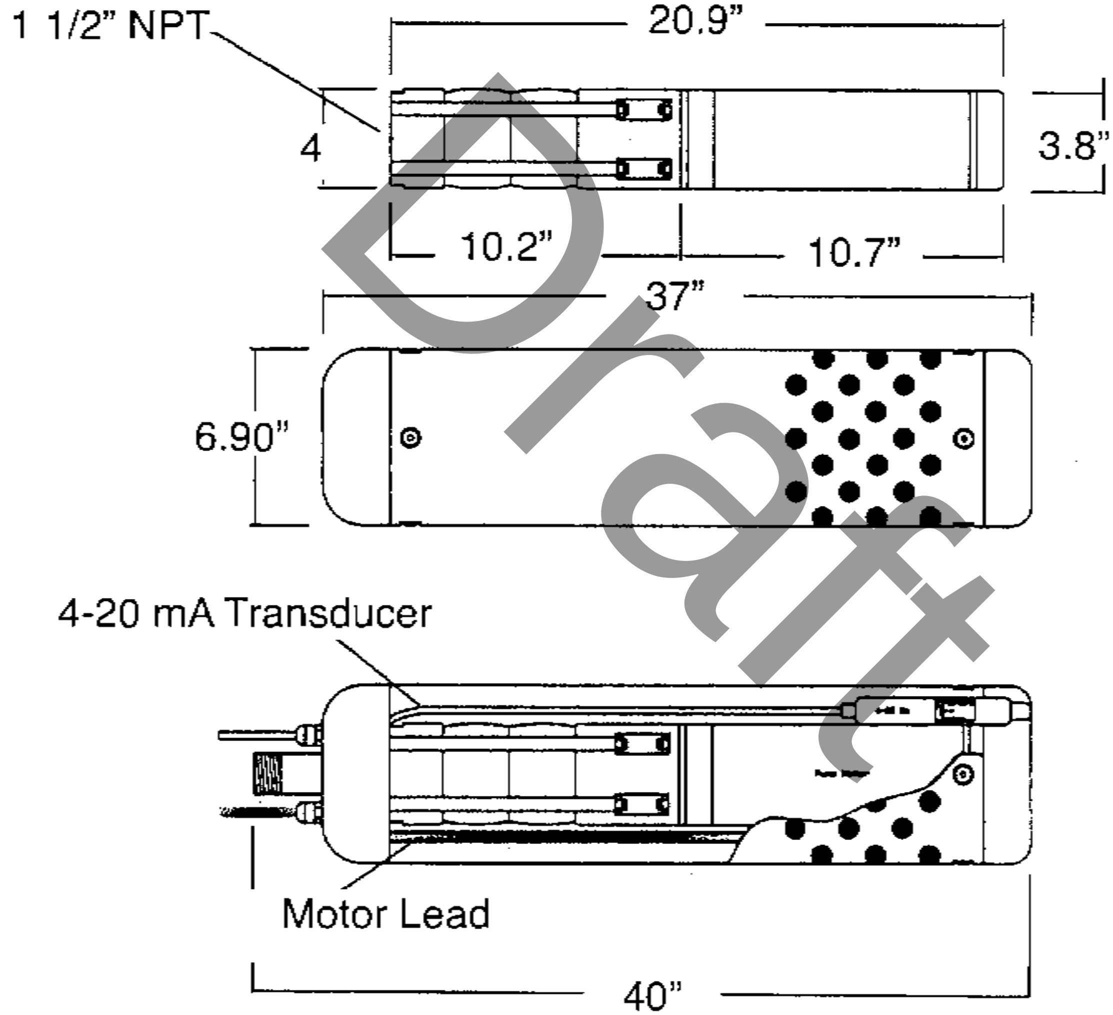
© 2003 EPG Companies Inc.
SurePump is a Reg. TM of EPG Companies Inc.

Model: 25SRPF07-4

EPS Environmental Pump Solutions

Pump Model	HP	PH I V
25SRPF07-4	.75	1 I 220

EPS Environmental Pump Solutions



Draft

Pump Model #
25SRPF07-4

LEGGETTE, BRASHEARS & GRAHAM, INC.

PROFESSIONAL GROUNDWATER AND
ENVIRONMENTAL ENGINEERING SERVICES

140 EAST HINKS LANE, SUITE 126
SIOUX FALLS, SD 57104
605-334-6000
FAX 605-334-1850
www.lbgweb.com

August 11, 2011

Mr. Matt Evans, P.E.
HDR Engineering, Inc.
701 Xenia Avenue South
Minneapolis, MN 55416

RE: Comments on Permit Modification
Subtitle D Landfill
Vermillion, South Dakota

Draft

Dear Mr. Evans:

Pursuant to your request, LBG has reviewed the documents provided by HDR relative to the modification of the solid waste permit for the Vermillion Subtitle D Landfill. In general, the documents consisted of various design and topographic figures, HELP Model results, the results of various calculations, leachate sump pump information, and a draft letter to the DENR regarding the proposed modifications. The permit modifications seem to consist generally of a reconfiguration of the cell development plans including the provisions for deeper cells than previously planned. Our comments are primarily related to our long-term familiarity with the site (including the adjacent pre-Subtitle D Landfill) and the compatibility of the modifications with the development history and hydrogeology of the site. Our comments are not intended as a review of the technical merits of the modifications or the methodologies incorporated in developing the modifications.

In our opinion, the proposed cell development plan for Cells 5 through 13, including the proposed depth of the cells, is well-suited and does not present conflicts with the development history or hydrogeology of the site. It should be noted that during the excavation for existing trenches, particularly trenches 1 through 3, a water-bearing sand layer was encountered. A French drain was installed along the north perimeter of the site to intersect this sand layer and divert the groundwater away from the trenches. Lenses of silt with sand were encountered in the shallow intervals of LBG-1. While it is not likely that these silt layers are laterally extensive or related to the occurrence and deposition of the sand layers intercepted by the existing French drains, the north walls of Cells 5 through 9 should be monitored to determine the presence of this sand layer and the possible need for additional drainage efforts.

During the excavation of Cell 14, it should be noted that leakage from the manholes has been documented and that contaminated soils will be encountered. Based on available information, the magnitude of the contamination is not sufficient to warrant any special excavation or soil disposal considerations. During the removal of the manholes, seeps of leachate from the adjacent cells is possible and containment of the seeps might be necessary. Excursions of methane-rich landfill gas from the adjacent cells are also possible.

Draft

The excavation of Cell 14 will also necessitate the removal and replacement of MW-14. Given that Cell 14 appears to extend southward to the existing roadway and in consideration of the steep slopes between the existing road and the south property boundary, creating a suitable location for the replacement well to the south of Cell 14 may require additional dirtwork. The replacement well should be installed a minimum of 4 years prior to the excavation of Cell 14 in order to compile sufficient background data in a cost-effective manner.

Also during the excavation of Cell 14, it should be noted that a contaminant plume consisting of low concentrations of VOCs will be intercepted in the extreme southwest end of the cell. While it has been determined that the west-adjacent pre-Subtitle D cells are the source of the contaminant plume, it is likely that the contaminant plume will be encountered. Based on available information, the magnitude of the contamination is not sufficient to warrant any special excavation or soil disposal considerations. Groundwater in that area may be quite shallow and abundant, as that area is currently a gathering point for stormwater. Historically, leachate from the west adjacent pre-Subtitle D collected in and near that area, and the possibility of leachate seeps from the pre-Subtitle D cells is possible.

We are in agreement of the creation and location of the leachate pond and the transition of the reconfiguration of the leachate collection piping for Cells 1 through 4.

Based on our familiarity with the site, the placement of a higher quality clay cap on the west adjacent pre-Subtitle D cells should be considered. This would minimize the leachate generation of those cells and could consume some of the clay soils generated during the excavation of the cells.

The acquisition of property to the south, particularly in the area of Cell 14 and westward, should be considered to provide down-gradient buffer space.

Providing access to the landfill directly east to Highway 19 should also be considered. In addition to creating a shorter, more level access to the landfill, this would allow for the decommissioning of the existing roadway to the south of Cell 14 and westward and would provide for monitoring locations to the south of Cell 14.

If you have any questions or need additional information, please contact me at (605) 334-6000.

Sincerely,

LEGGETTE, BRASHEARS & GRAHAM, INC.

Tim Kenyon
Senior Vice President

TLK:kak

Draft

PARCEL LAYOUT

VERMILLION LANDFILL
LEACHATE MANAGEMENT PLAN AND PERMIT MODIFICATION

PARCEL LAYOUT

DESIGNED BY:MJE
DRAWN BY: RAC
CHECKED BY:TJY
ACAD FILE:H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011
REVISIONS: BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

FIGURE NO.
3

Job No.		Calc No.	

Computation

Project	Vermillion Landfill	Computed	JM
System	Facility Layout - West Portion	Date	8/1/2011
Component	Conceptual Detention Pond Sizing	Reviewed	
Task	Peak Runoff Calculation - Rational Method	Date	

Purpose

Calculate the 25 year and 100 year peak flows for watersheds under 200 acres using the Rational Method.
Methodology and variables are as outlined in the SD DOT Drainage Design Manual (Chapter 11).

Find

Description	Variable	Units
100-year runoff	Q_{100}	cfs
25-year runoff	Q_{25}	cfs

Given

Description	Value	Source
Drainage area	37.2 acres	Delineation based on CAD drawings (see Assumptions)
Runoff Coefficient	0.51	Weighted average bare earth, asphalt, and grassed areas
Time of Concentration	15 minutes	SD Design Manual nomograph, Figure 11-16
Rainfall Intensity	i_{25} = 4.8 i_{100} = 5.9	SD Design Manual, Table 11-9

Assumptions

Conservative assumption that all drainage from western portion of site will drain to same location.
C values based on SD Design Manual, Table 11-8.
Time of Concentration actually 6 minutes, but SD requires 15 minute minimum
Rainfall intensity for 25-yr and 100-yr events based on minimum ToC of 15 minutes

Equations

Q = C*i*A

Q = peak runoff
C = runoff coefficient
i = rainfall intensity
A = drainage area, acres

Calculation

Q_{25}	C	i_{25}	A
91	0.51	4.8	37.2

Q_{100}	C	i_{100}	A
112	0.51	5.9	37.2

Solution

Conceptual runoff from western portion of landfill is 91 - 112 cfs during peak flow from the 25-yr and 100-yr storm events, respectively. Conceptual design of stormwater detention pond for west portion of site based on these values.

Job No.

Calc No.

Computation

Com

Project	Vermillion Landfill
System	Facility Layout - East Portion
Component	Conceptual Detention Pond Sizing
Task	Peak Runoff Calculation - Rational Method

Draft

Purpose

Calculate the 25 year and 100 year peak flows for watershed [illegible] using the Rational Method.
Methodology and variables are as outlined in the SD DOT Drai[illegible] Design Manual (Chapter 11).

Find

Description	Variable	Units
100-year runoff	Q_{100}	cfs
25-year runoff	Q_{25}	cfs

Given

Description	Value	Source
Drainage area	70.55 acres	Delineation based on CAD drawings (see Assumptions)
Runoff Coefficient	0.41	Weighted average bare earth, asphalt, and grassed areas
Time of Concentration	15 minutes	SD Design Manual nomograph, Figure 11-16
Rainfall Intensity	i_{25} = 4.8 i_{100} = 5.9	SD Design Manual, Table 11-9

Assumptions

Conservative assumption that all drainage from eastern portion of site will drain to same location.

C values based on SD Design Manual, Table 11-8.

Time of Concentration actually 13 minutes, but SD requires 15 minute minimum

Rainfall intensity for 25-yr and 100-yr events based on minimum ToC of 15 minutes

Equations

$Q = C*i*A$

Q = peak runoff
C = runoff coefficient
i = rainfall intensity
A = drainage area, acres

Calculation

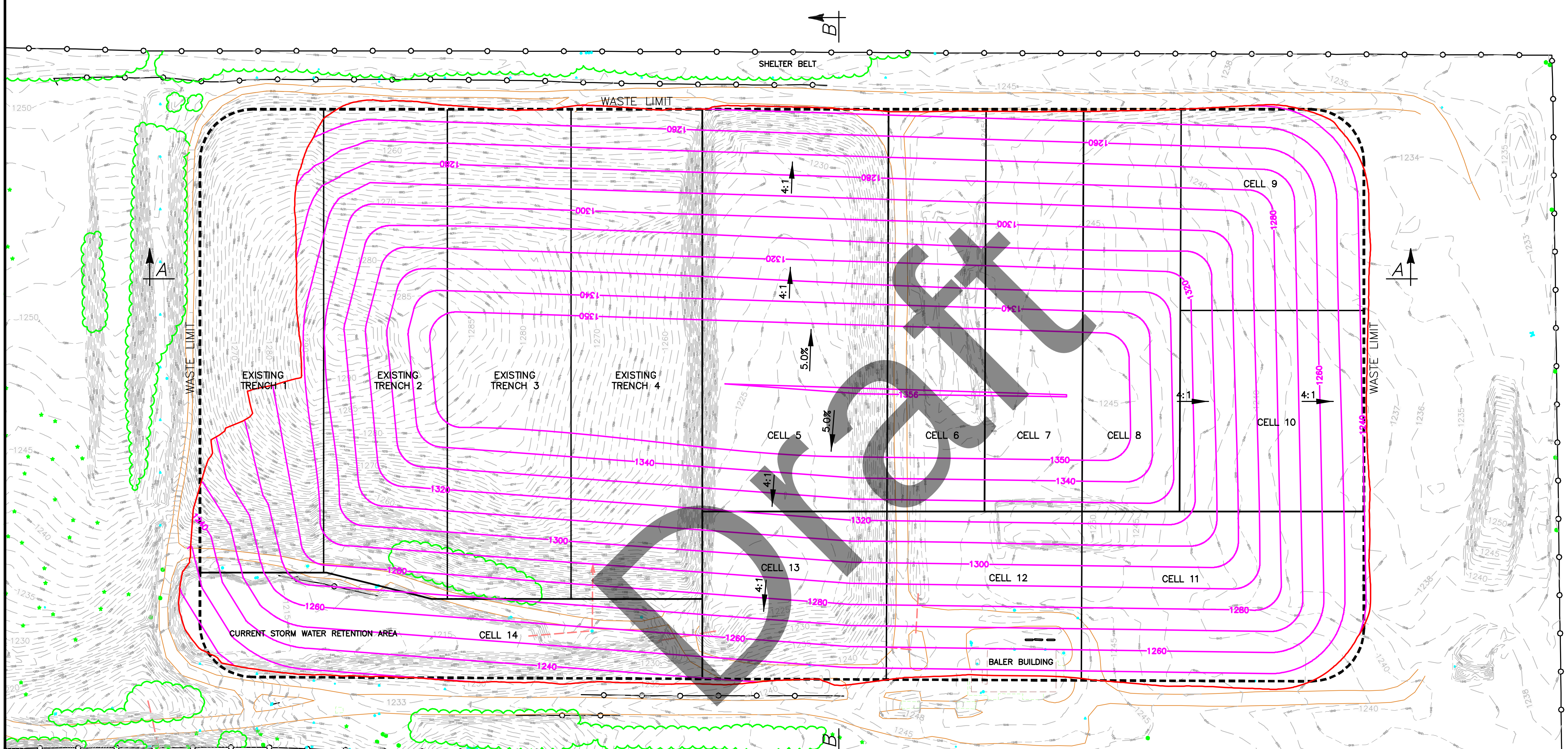
Q_{25}	C	i_{25}	A
139	0.41	4.8	70.55

Q_{100}	C	i_{100}	A
171	0.41	5.9	70.55

Solution

Conceptual runoff from eastern portion of landfill is 139-171 cfs during peak flow from the 25-yr and 100-yr storm events, respectively. Conceptual design of stormwater detention pond for east portion of site based on these values.

OPTION 1 - MAXIMUM FINAL ELEVATION OF 1356 LAYOUT



REGISTERED PROFESSIONAL ENGINEER
REG. NO.
8246
MATTHEW J. EVANS
SOUTH DAKOTA

LEGEND

- - - -	WASTE LIMIT
	EDGE GRAVEL ROAD
	EDGE CONCRETE PAVEMENT
	FENCE
	DEBRIS FENCE
	STORM PIPE
	FINAL CONTOURS
	MANHOLE
	MONITORING WELL
	TREE
	SURVEY CONTROL POINT
	SIGN
	SEWER CLEAN OUT

SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

0 100 200 FT

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

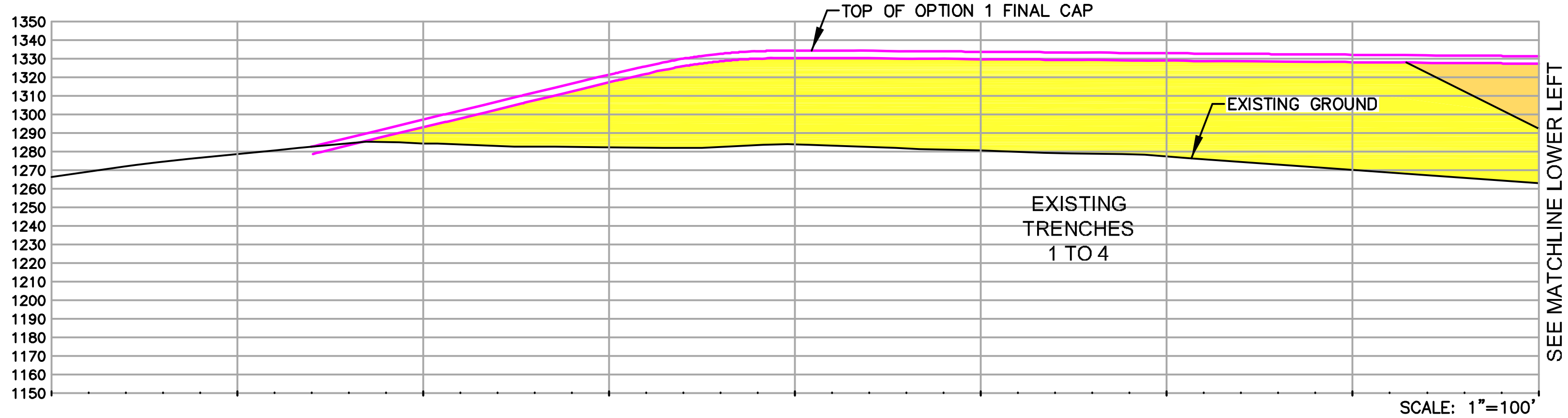
OPTION I LAYOUT

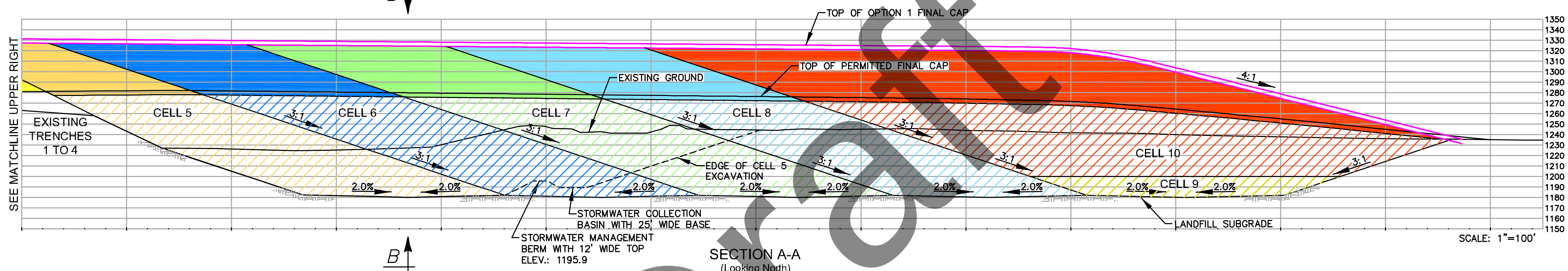
DESIGNED BY: BW
DRAWN BY: RAC
CHECKED BY: MJE
REVISIONS:
ACAD FILES/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011
BY: DATE:
BY: DATE:

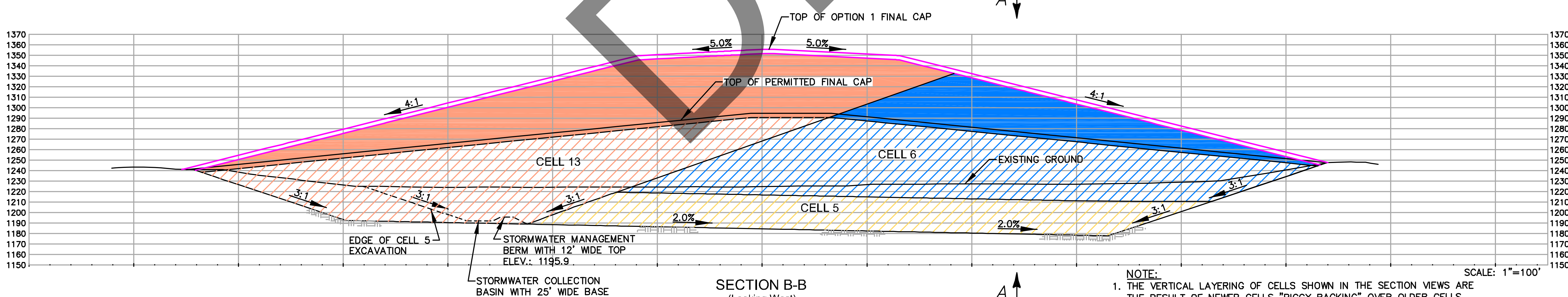
CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.
1

OPTION 1 - MAXIMUM FINAL ELEVATION OF 1356 CROSS SECTIONS







REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA

NOTE:

1. THE VERTICAL LAYERING OF CELLS SHOWN IN THE SECTION VIEWS ARE THE RESULT OF NEWER CELLS "PIGGY BACKING" OVER OLDER CELLS.
2. TOP OF FINAL CAP ELEVATIONS SHOWN ARE BASED ON CURRENTLY PERMITTED FINAL COVER CONTOURS..
3. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011 AND JULY 8, 2011.. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
4. WASTE LIMITS AND FINAL CONTOURS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.

HDR

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION I SECTIONS

DESIGNED BY: BW
DRAWN BY: RAC
CHECKED BY: MJE
REVISIONS:

ACAD FILE: /SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

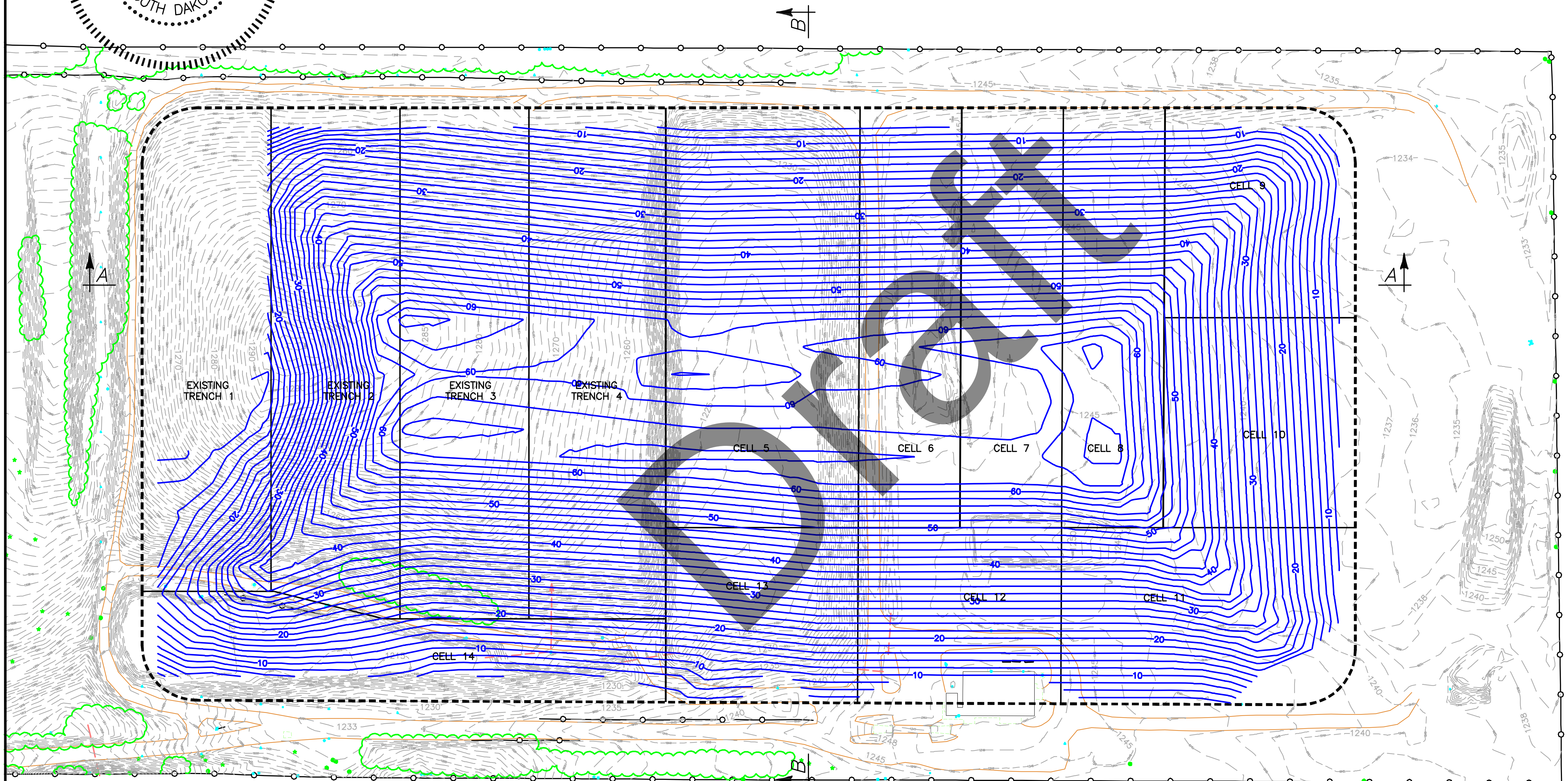
FIGURE NO.
2

OPTION 1 - MAXIMUM FINAL ELEVATION OF 1356
ADDITIONAL FILL CONTOURS

REGISTERED PROFESSIONAL ENGINEER
REG. NO.
8246
MATTHEW J.
EVANS
SOUTH DAKOTA

LEGEND
- EXISTING FENCE
- EXISTING GRAVEL
- EXISTING BUILDING
- EXISTING CONTOURS
- PROPOSED FILL CONTOURS (2' INTERVALS) (BETWEEN PERMITTED TOP AND OPTION 1 TOP)
- WASTE LIMIT LINE

0 100 200 FT



NOTES:
1. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011 & JULY 8, 2011. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
2. WASTE LIMITS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.
3. ADDITIONAL FILL CONTOURS REPRESENT FILL THICKNESS BETWEEN TOP OF PROPOSED FINAL CONTOURS AND CURRENTLY PERMITTED FINAL CONTOURS.

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

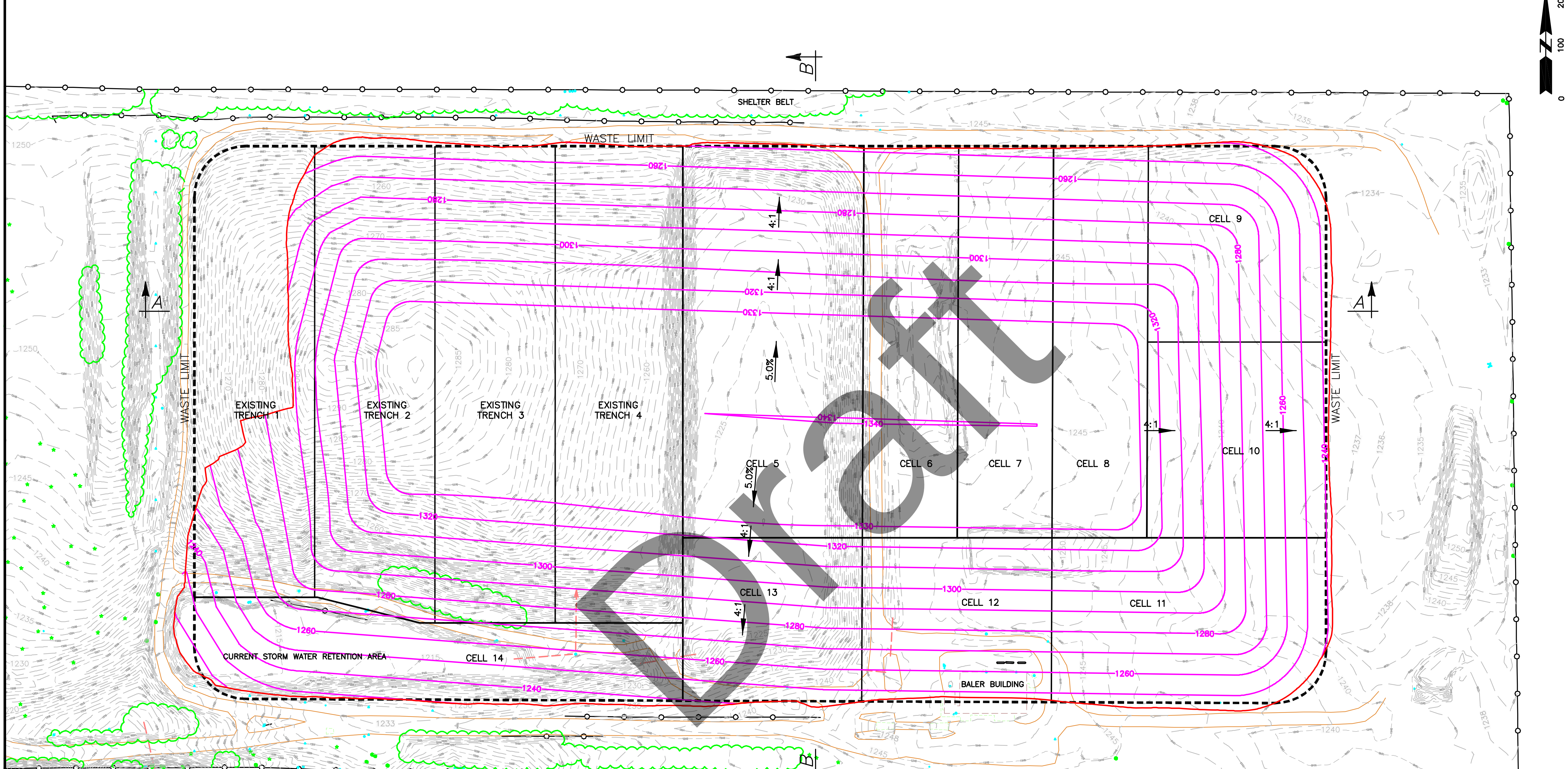
VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION 1 ADDITIONAL FILL CONTOURS

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
3

OPTION 2 - MAXIMUM FINAL ELEVATION OF 1340 LAYOUT



Draft

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA

LEGEND

- WASTE LIMIT
- EDGE GRAVEL ROAD
- EDGE CONCRETE PAVEMENT
- FENCE
- DEBRIS FENCE
- STORM PIPE
- FINAL CONTOURS
- MANHOLE
- MONITORING WELL
- TREE
- SURVEY CONTROL POINT
- SIGN
- SEWER CLEAN OUT

SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

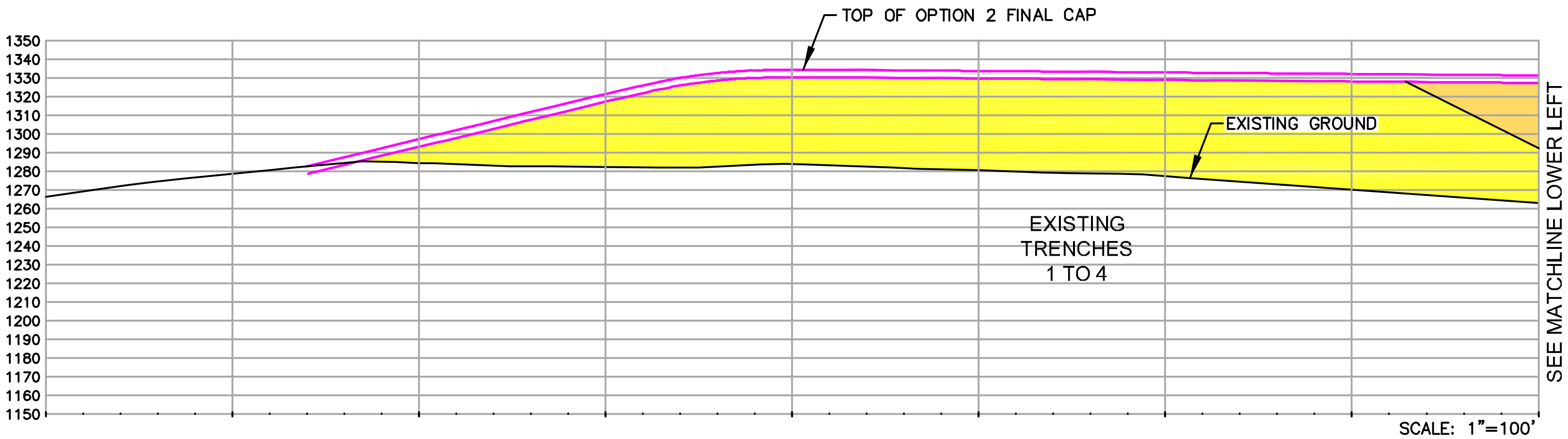
VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

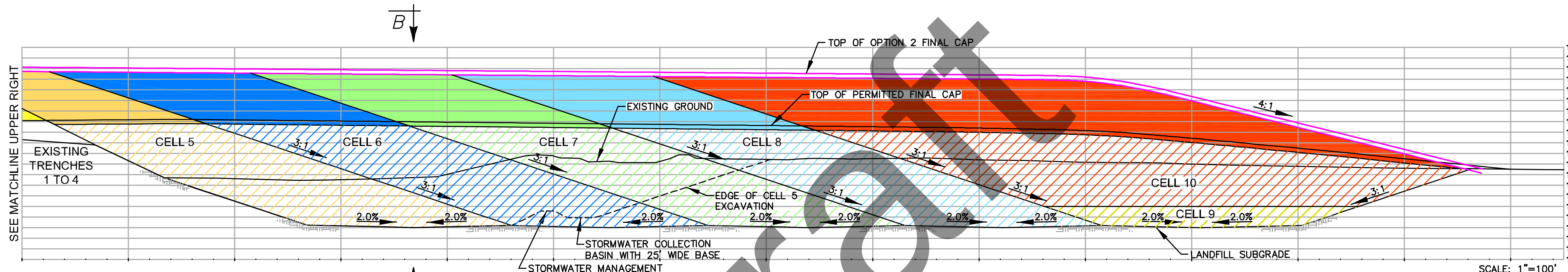
OPTION 2 LAYOUT

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

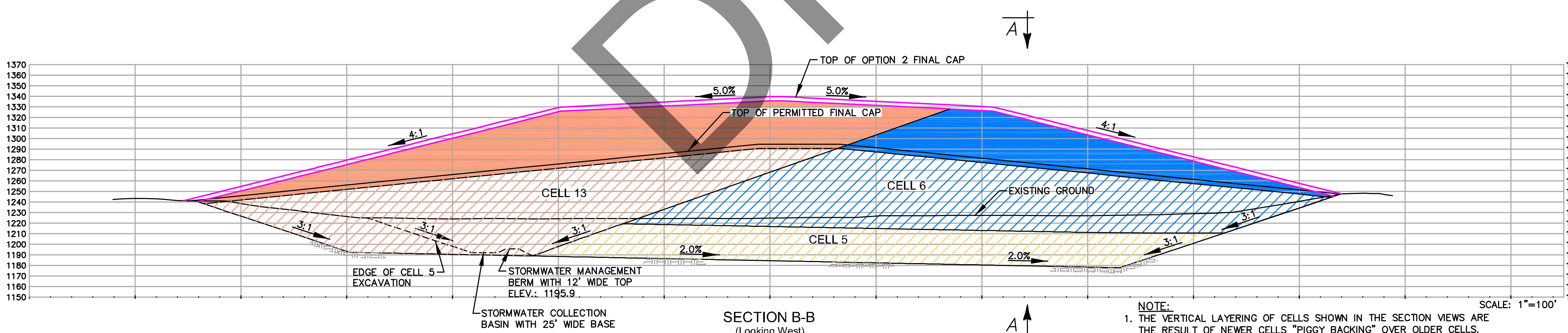
FIGURE NO.
4

OPTION 2 - MAXIMUM FINAL ELEVATION OF 1340 CROSS SECTIONS





SECTION A-A
(Looking North)



SECTION B-B
(Looking West)

NOTE:

1. THE VERTICAL LAYERING OF CELLS SHOWN IN THE SECTION VIEWS ARE THE RESULT OF NEWER CELLS "PIGGY BACKING" OVER OLDER CELLS.
2. TOP OF FINAL CAP ELEVATIONS SHOWN ARE BASED ON CURRENTLY PERMITTED FINAL COVER CONTOURS.
3. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011 AND JULY 8, 2011.. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
4. WASTE LIMITS AND FINAL CONTOURS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.

Draft

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION 2 SECTIONS

DESIGNED BY: RW
DRAWN BY: RAC
CHECKED BY: MJE
REVISIONS:
ACAD FILE: SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.
5

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

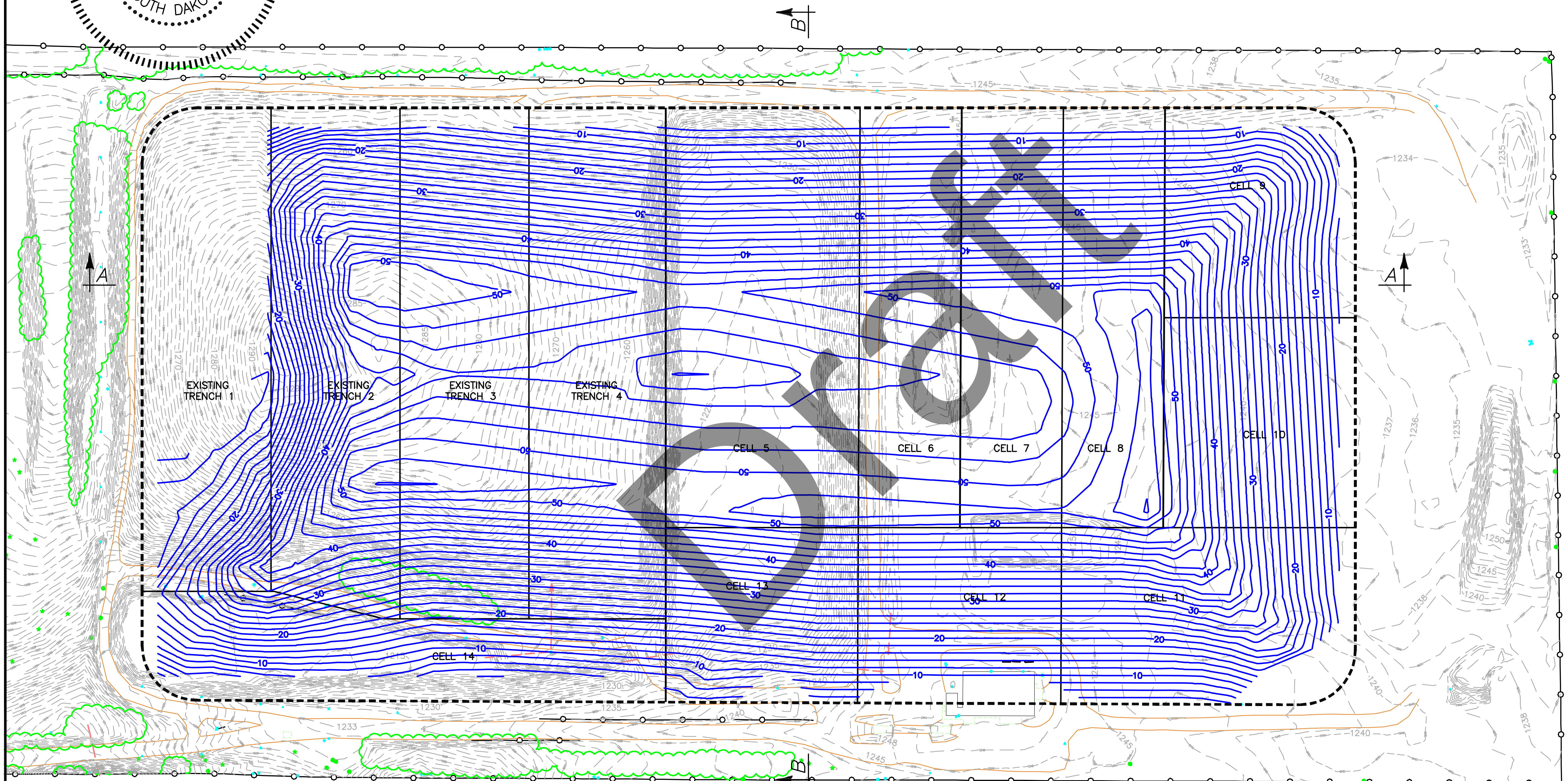
OPTION 2 - MAXIMUM FINAL ELEVATION OF 1340
ADDITIONAL FILL CONTOURS

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA

LEGEND

- EXISTING FENCE
- EXISTING GRAVEL
- EXISTING BUILDING
- EXISTING CONTOURS
- PROPOSED FILL CONTOURS (2' INTERVALS) (BETWEEN PERMITTED TOP AND OPTION 2 TOP)
- WASTE LIMIT LINE

0 100 200 FT



NOTES:

1. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011 & JULY 8, 2011. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
2. WASTE LIMITS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.
3. ADDITIONAL FILL CONTOURS REPRESENT FILL THICKNESS BETWEEN TOP OF PROPOSED FINAL CONTOURS AND CURRENTLY PERMITTED FINAL CONTOURS.

HDR

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

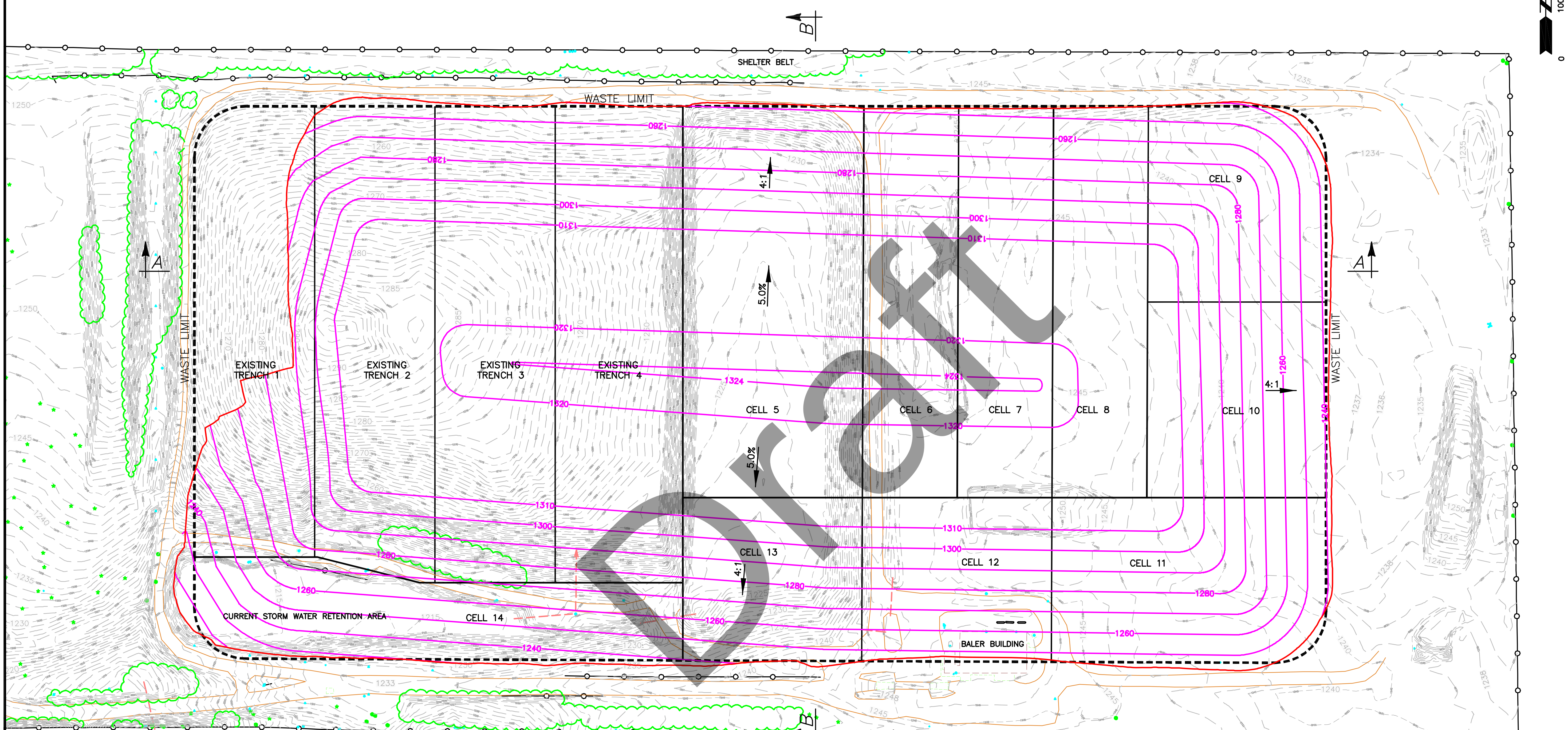
OPTION 2 ADDITIONAL FILL CONTOURS

DESIGNED BY: JBM
DRAWN BY: RAC ACAD FILE: H:/SURVEY/INSURVEY/VERMILLION LANDFILL
CHECKED BY: MJE DATE: 4-27-2011
REVISIONS: BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.
6

OPTION 3 - MAXIMUM FINAL ELEVATION OF 1324 LAYOUT



REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA

LEGEND

- WASTE LIMIT
- EDGE GRAVEL ROAD
- EDGE CONCRETE PAVEMENT
- FENCE
- DEBRIS FENCE
- STORM PIPE
- FINAL CONTOURS
- MANHOLE
- MONITORING WELL
- TREE
- SURVEY CONTROL POINT
- SIGN
- SEWER CLEAN OUT

SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

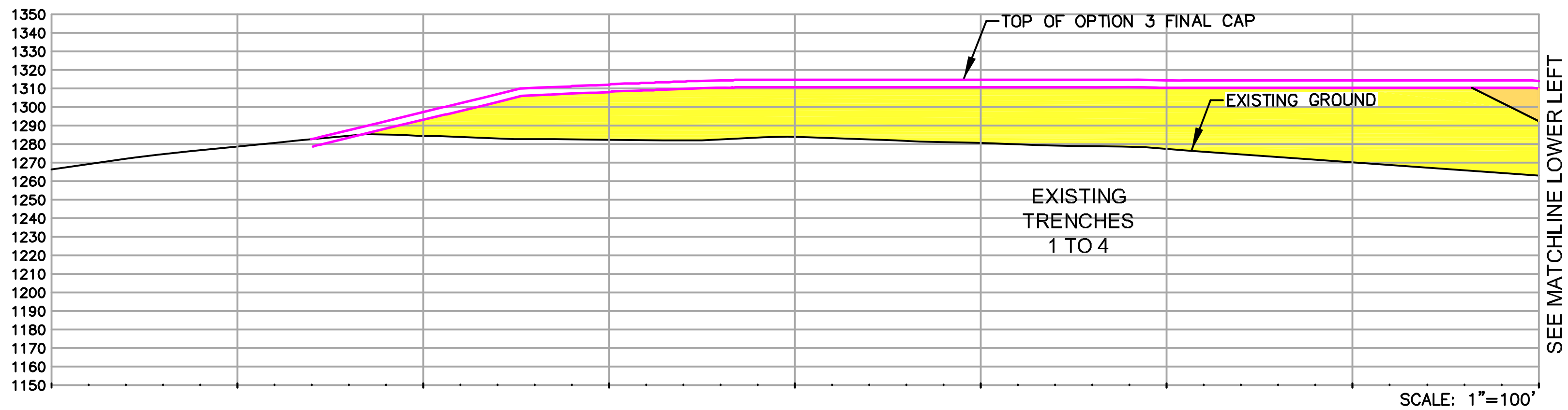
OPTION 3 LAYOUT

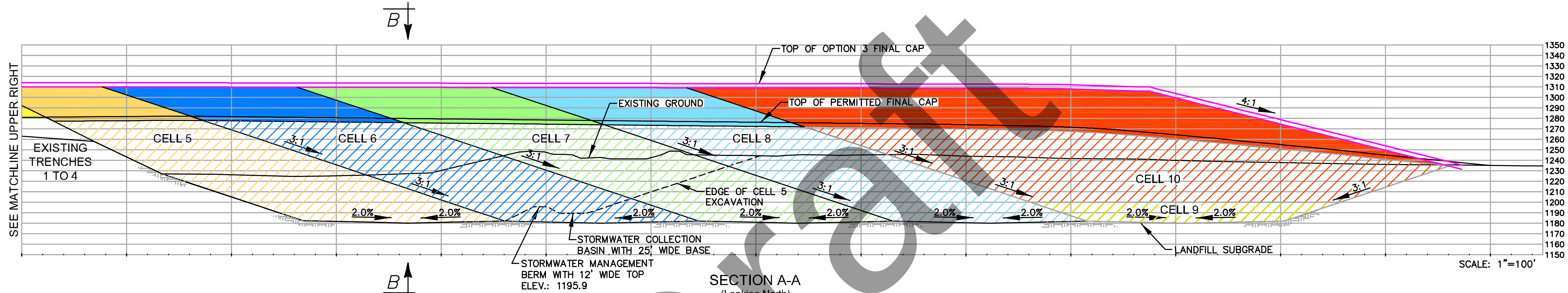
DESIGNED BY: RM
DRAWN BY: RAC
CHECKED BY: MJE
REVISIONS:
ACAD FILE: J:/SURVEY/INSURVEY/VERMILLION_LANDFILL
DATE: 4-27-2011

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

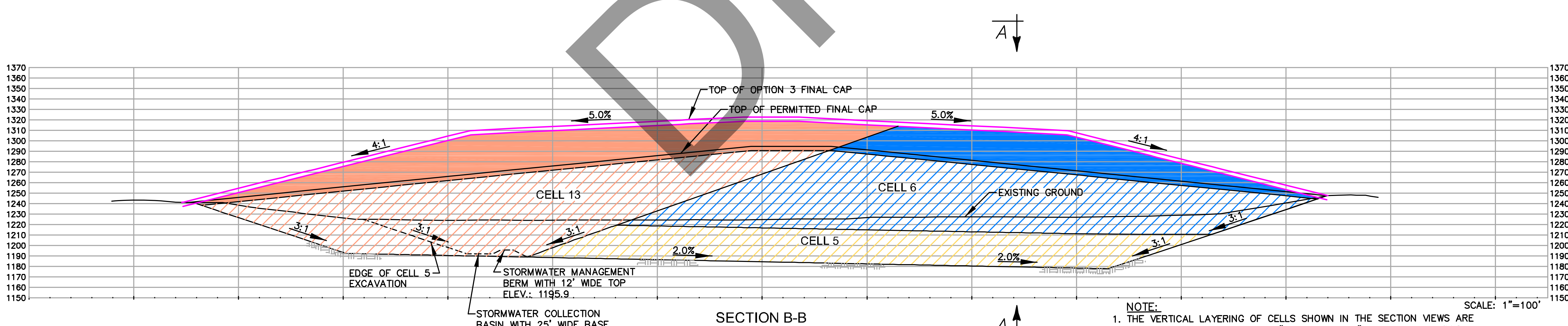
FIGURE NO.
7

OPTION 3 - MAXIMUM FINAL ELEVATION OF 1324 CROSS SECTIONS





SECTION A-A
(Looking North)



SECTION B-B
(Looking West)

NOTE:

1. THE VERTICAL LAYERING OF CELLS SHOWN IN THE SECTION VIEWS ARE THE RESULT OF NEWER CELLS "PIGGY BACKING" OVER OLDER CELLS.
2. TOP OF FINAL CAP ELEVATIONS SHOWN ARE BASED ON CURRENTLY PERMITTED FINAL COVER CONTOURS.
3. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011 AND JULY 8, 2011.. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
4. WASTE LIMITS AND FINAL CONTOURS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION 3 SECTIONS

DESIGNED BY: BJM
DRAWN BY: RAC
CHECKED BY: MJE
REVISIONS:
ACAD FILE: J/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011
BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

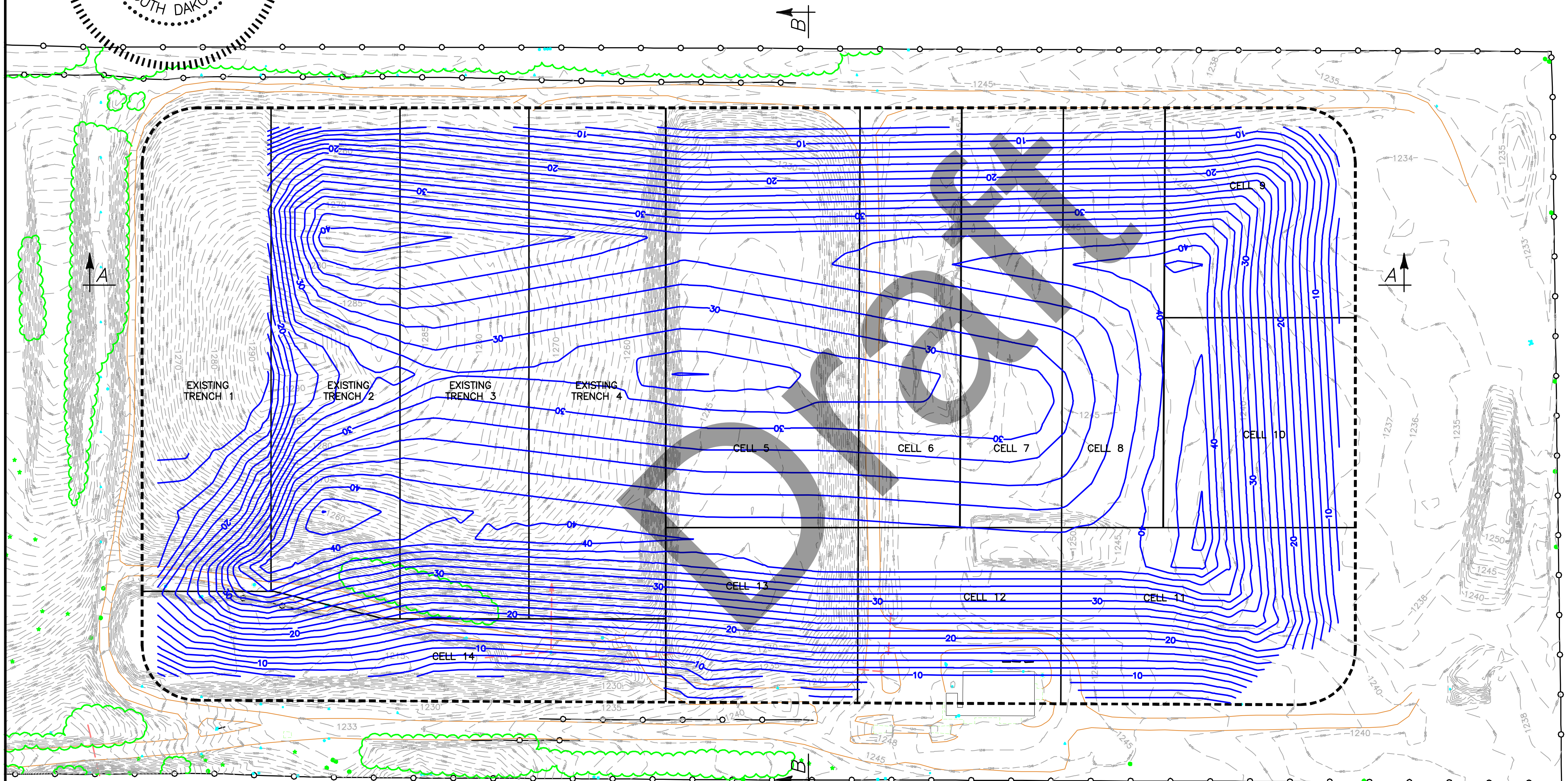
FIGURE NO.
8

Draft

OPTION 3 - MAXIMUM FINAL ELEVATION OF 1324
ADDITIONAL FILL CONTOURS

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8246
MATTHEW J. EVANS
SOUTH DAKOTA

LEGEND
- EXISTING FENCE
- EXISTING GRAVEL
- EXISTING BUILDING
- EXISTING CONTOURS
- PROPOSED FILL CONTOURS (2' INTERVALS) (BETWEEN PERMITTED TOP AND OPTION 3 TOP)
- WASTE LIMIT LINE



NOTES:
1. SURVEY COMPLETED BY HDR, MARCH 5, 2010 & MARCH 3, 2011 & JULY 8, 2011. HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.
2. WASTE LIMITS WERE ESTABLISHED BASED ON DRAWINGS AND INFORMATION PROVIDED BY THE CITY OF VERMILLION.
3. ADDITIONAL FILL CONTOURS REPRESENT FILL THICKNESS BETWEEN TOP OF PROPOSED FINAL CONTOURS AND CURRENTLY PERMITTED FINAL CONTOURS.

HDR
PLANS BY: HDR, INC. SIOUX FALLS, S.D.

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION 3 ADDITIONAL FILL CONTOURS

DESIGNED BY: JBM
DRAWN BY: RAC — ACAD FILE: H:/SURVEY/INSURVEY/VERMILLION LANDFILL
CHECKED BY: MJE — DATE: 4-27-2011
REVISIONS: BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
9

August 26, 2011

Mr. Steven Kropp, P.E.
Department of Environment and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3182

Re: Trenches 1 through 4 Grade Modification
Vermillion Landfill: Permit No. 10-04

Dear Mr. Kropp:

This letter has been prepared to document proposed fill changes in the development of Trenches 1 through 4 at the Vermillion Landfill. The proposal is to change the north sideslope from a 10:1 grade (horizontal:vertical) to a 4:1 grade. The ultimate height of the landfill will not be changed from the currently permitted final elevation of 1300.

The proposed slope changes are shown on attached Figure 1. The final contour grades include 3.5 feet of final cover and 1 foot of intermediate cover soil. The crown will be sloped at a 5% grade from the high point in the middle of the crown down to an elevation of 1284 at the point where the crown meets the sideslopes.

No additional waste will be placed in Trench 1. Additional clean soil from the excavation of Cell 5 will be placed over areas of Trench 1 in order to have a smooth transition into the grade changes in Trench 2. The final 3.5 feet of soil placed over Trench 1 will be placed as alternative final cover as part of the Trench 2 closure. The alternative final cover will be constructed as previously permitted by the Department of Environment and Natural Resources (DENR).

The east and south slopes of Trenches 1 through 4 will continue at their current grades (i.e. approximately 3:1 slopes). It should be noted that these slopes will eventually be covered with waste filled in future cells that will be "piggybacked" against them.

The attached Figure 2 shows two cross sections of Trenches 1 through 4 with the proposed grade changes. Figure 3 shows contours representing the remaining fill depths throughout Trenches 1 through 4. The following table summarizes the remaining volumes in Trenches 1 through 4.

HDR Engineering, Inc.

6300 S Old Village Place
Suite 100
Sioux Falls, SD 57108-2102

Phone: (605) 977-7740
Fax: (605) 977-7747
www.hdrinc.com

TRENCHES 1 THROUGH 4 REMAINING VOLUMES

Landfill Volume Remaining	Quantity (Cubic Yards)[1]
Total Volume	287,000
Municipal Solid Waste	189,000
Clean Soil (Trench 1)[2]	2,000
Final Cover and Intermediate Cover	96,000

Notes:
1. Volume quantities are based on topographical survey performed in May 2011.
2. The clean soil volume is the amount of clean soil needed to make a smooth transition in grading between Trenches 1 and 2. It does not include clean soil used in the final cover or intermediate cover construction.

In 2010, the Vermillion Landfill received approximately 36,400 tons of waste that was placed in the municipal solid waste (MSW) trenches. At this rate approximately 60,000 cubic yards of MSW airspace will be consumed each year (based on a calculated airspace utilization factory of approximately 1,200 lbs per cubic yard). Therefore, approximately 3 years of airspace are remaining in Trenches 1 through 4 if the proposed final contours are approved, which corresponds to a mid-2014 date of maximum volume attainment. Based on this schedule, construction of Cell 5 will need to be completed during the 2013 summer construction season. Without change of the final contours, Cell 5 construction will be needed in 2012.

If you have any questions, please feel free to call me at 763-591-5417, or via e-mail at matthew.evans@hdrinc.com, at your earliest convenience.

Sincerely,

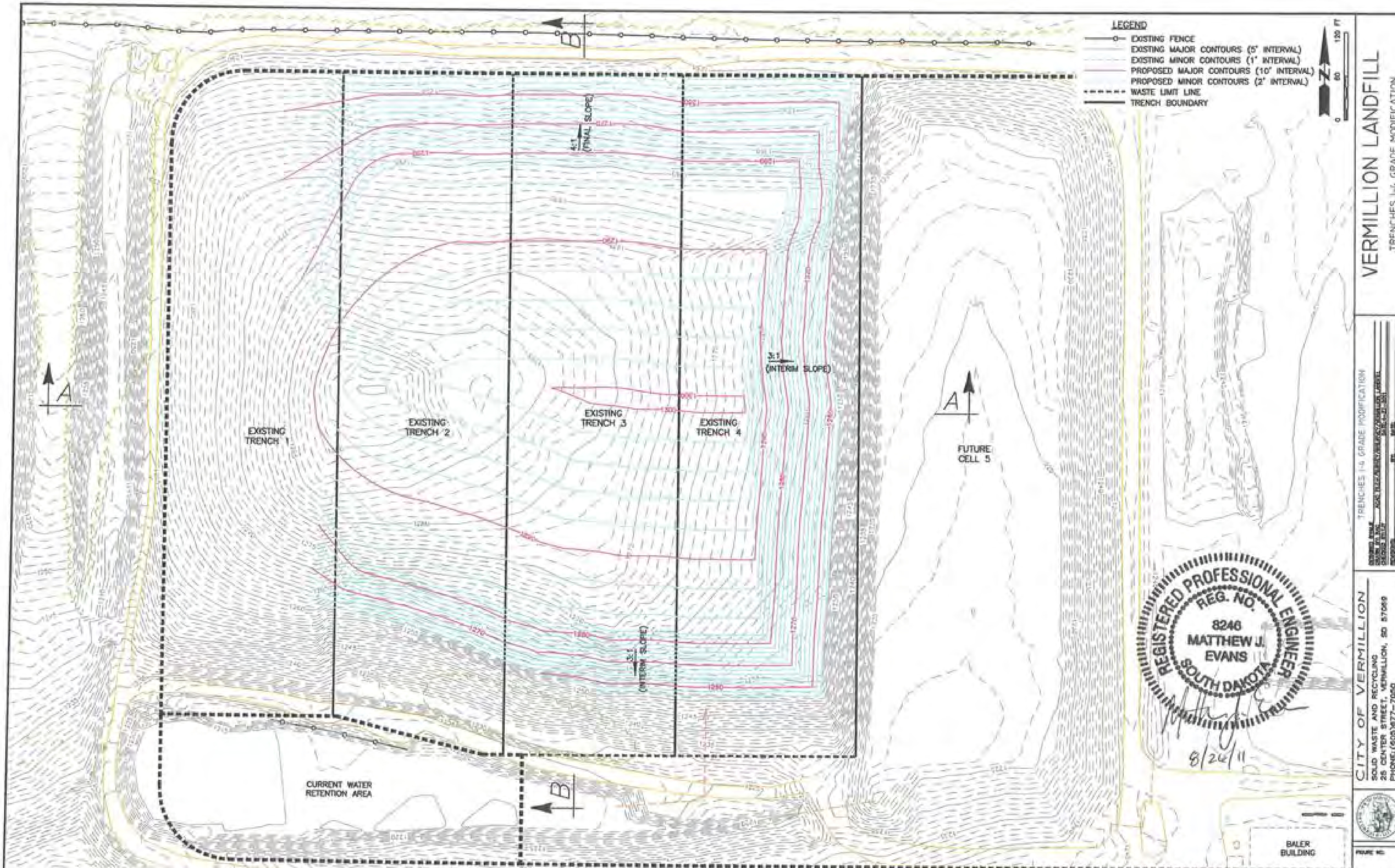
HDR ENGINEERING, INC.

Matthew J. Evans, P.E.
Project Manager

C: Bob Iverson, City of Vermillion

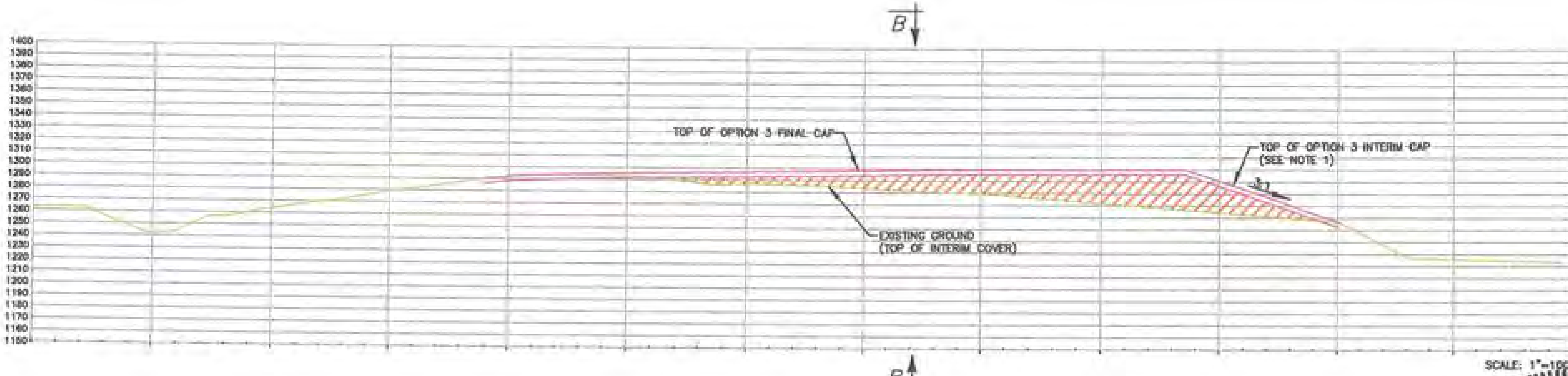
REGISTERED PROFESSIONAL ENGINEER
REG. NO.
8246
MATTHEW J.
EVANS
SOUTH DAKOTA

8/26/11



SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

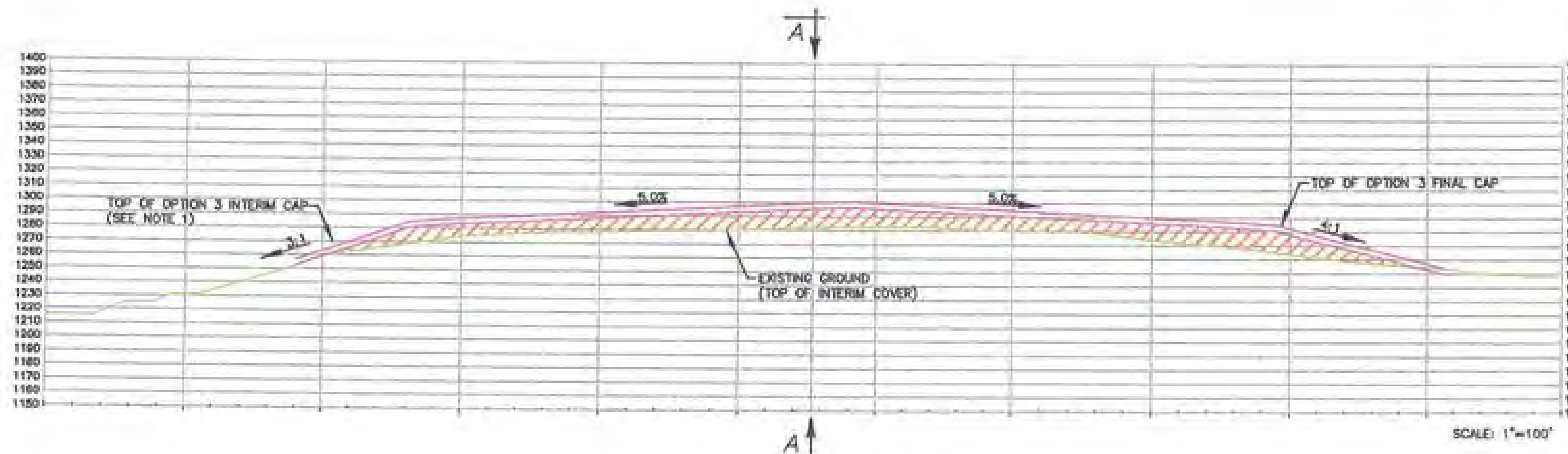


SECTION A–A
(Looking North)

NOTE 1:
AREAS WITH SLOPES OF 3:1 WILL BE COVERED BY WASTE DURING FUTURE FILLING OF CELL 5 TO THE EAST AND CELL 14 TO THE SOUTH.

REGISTERED PROFESSIONAL ENGINEER
REG. NO.
6246
MATTHEW J. EVANS
SOUTH DAKOTA

8/26/11



SECTION B–B
(Looking West)

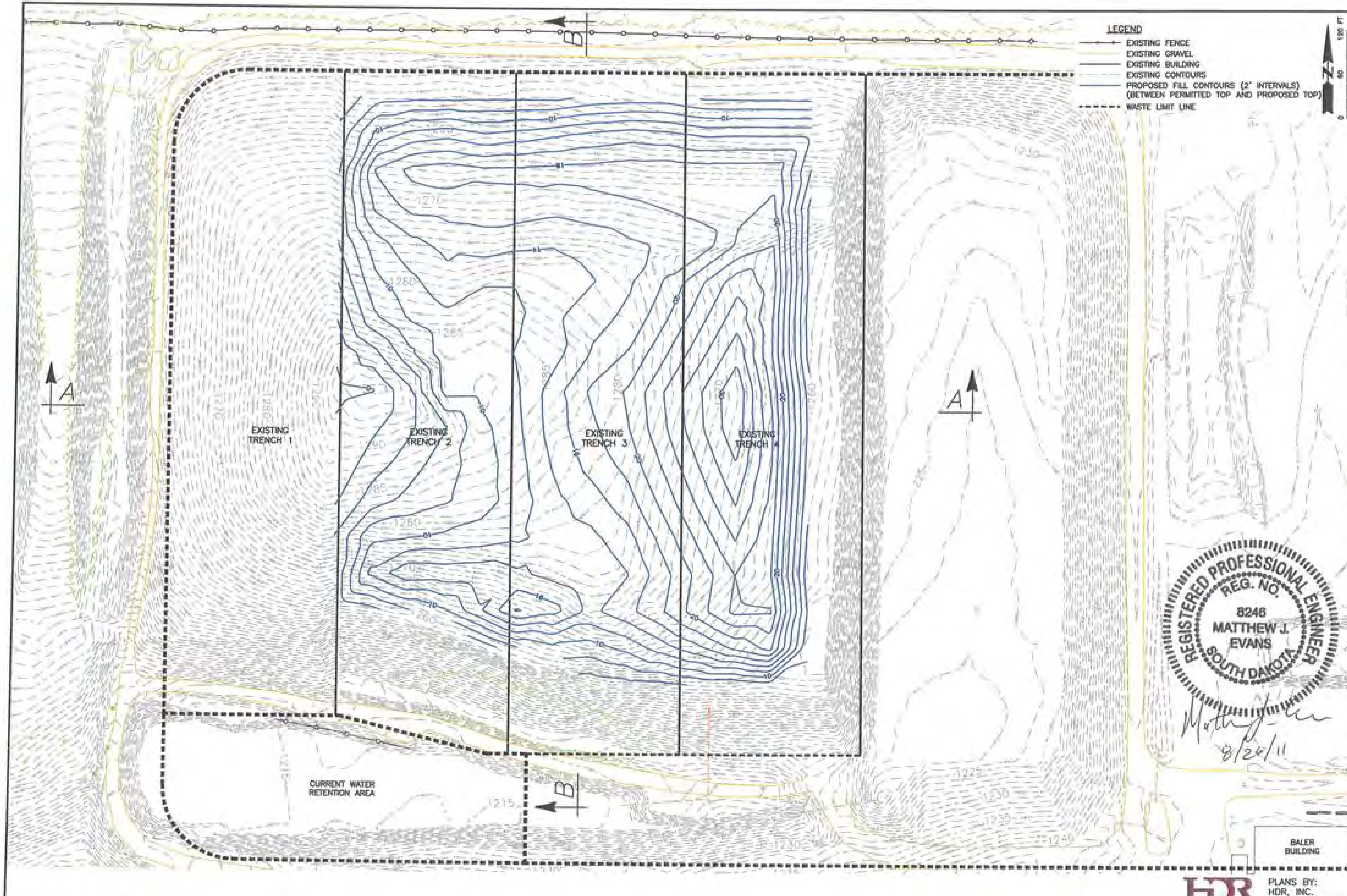
HDR PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
TRENCHES 1-4 GRADE MODIFICATION

TRENCHES 1-4 GRADE MODIFICATION SECTIONS

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
2



VERMILLION LANDFILL

TRENCHES 1-4 GRADE MODIFICATION

TRENCHES 1-4 GRADE MODIFICATION FILL CONTOURS

CITY OF VERMILLION

SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.

3

DEPARTMENT of ENVIRONMENT and NATURAL RESOURCES

PMB 2020
JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3182
www.state.sd.us/denr

September 6, 2011

Bob Iverson, Solid Waste Director
City of Vermillion
25 Center Street
Vermillion, SD 57069

Dear Mr. Iverson:

On August 29, 2011, our office received a request and supporting documentation through your engineering consultant for a grade modification request for Trenches 1-4 at the Vermillion landfill. The grade modification request would change the north side slope on Trenches 1-4 from a 10:1 (horizontal: vertical) to a 4:1 grade. No additional waste would be disposed of in Trench 1 because it's been capped and closed and the final height of the landfill would not change from the currently permitted final elevation of [illegible]00 ft. mean sea level (msl).

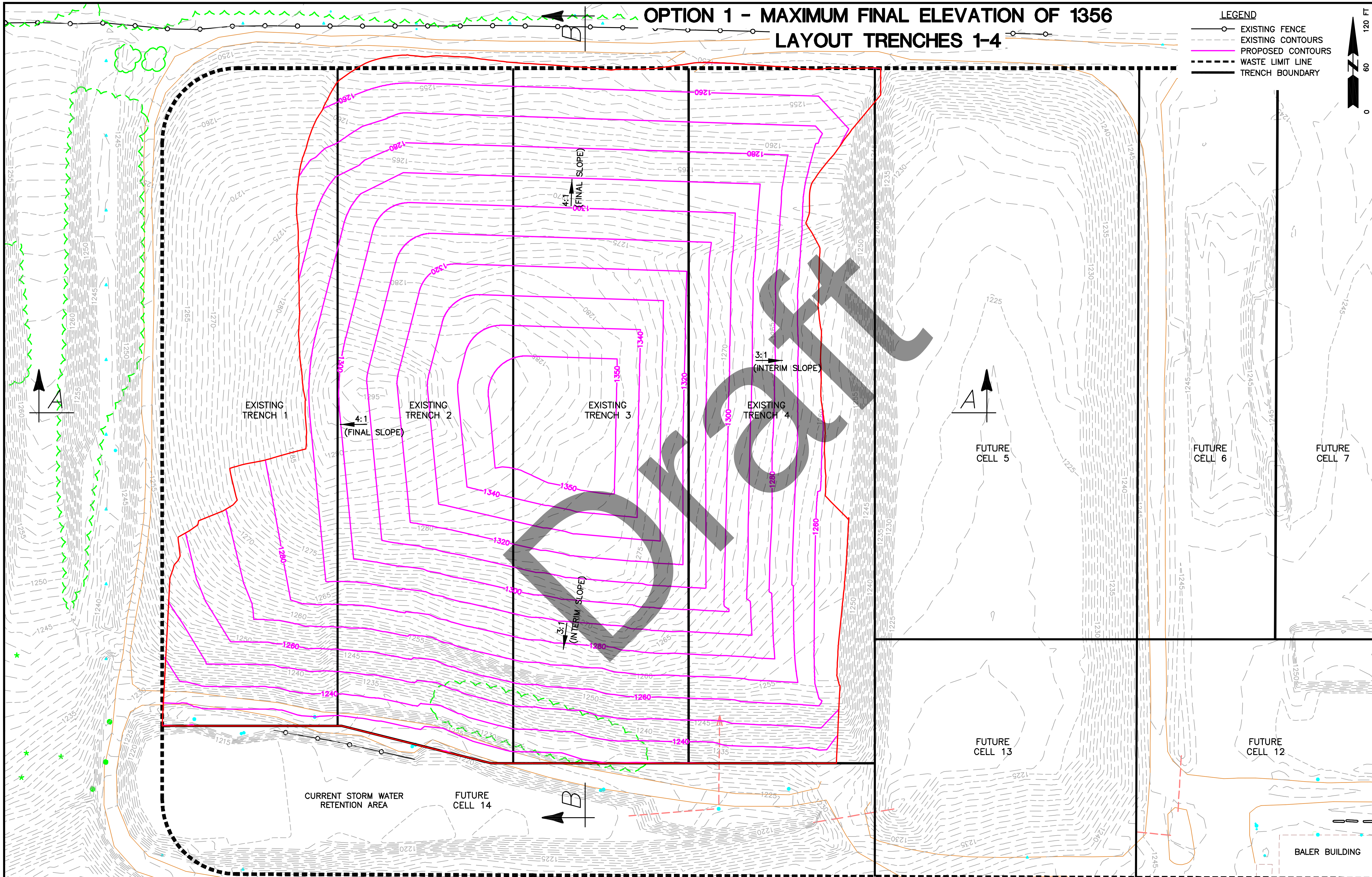
Our office has reviewed your request and supporting documentation and grants approval for the grade modification request for Trenches 1-4 at the Vermillion landfill. This approval is conditioned on no additional waste is disposed of in Trench 1 and the final permitted elevation of the landfill does not exceed [illegible]00 msl.

If you have any questions, please do not hesitate to contact me at (605) 773-3153.

Sincerely,

Steven Kropp, P.E.
Waste Management Program

Cc: Matt Evans, HDR, Inc., Minneapolis, MN ✓



SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

HDR

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

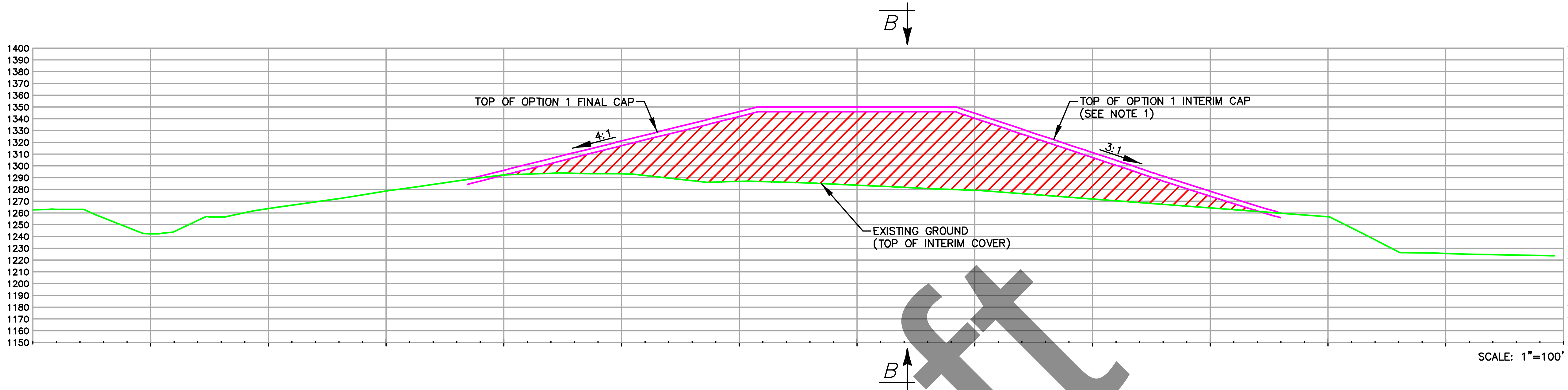
OPTION I LAYOUT TRENCHES I-4

DESIGNED BY:JBM
DRAWN BY: RAC
CHECKED BY:MJE
ACAD FILE:H:/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011
REVISIONS:
BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

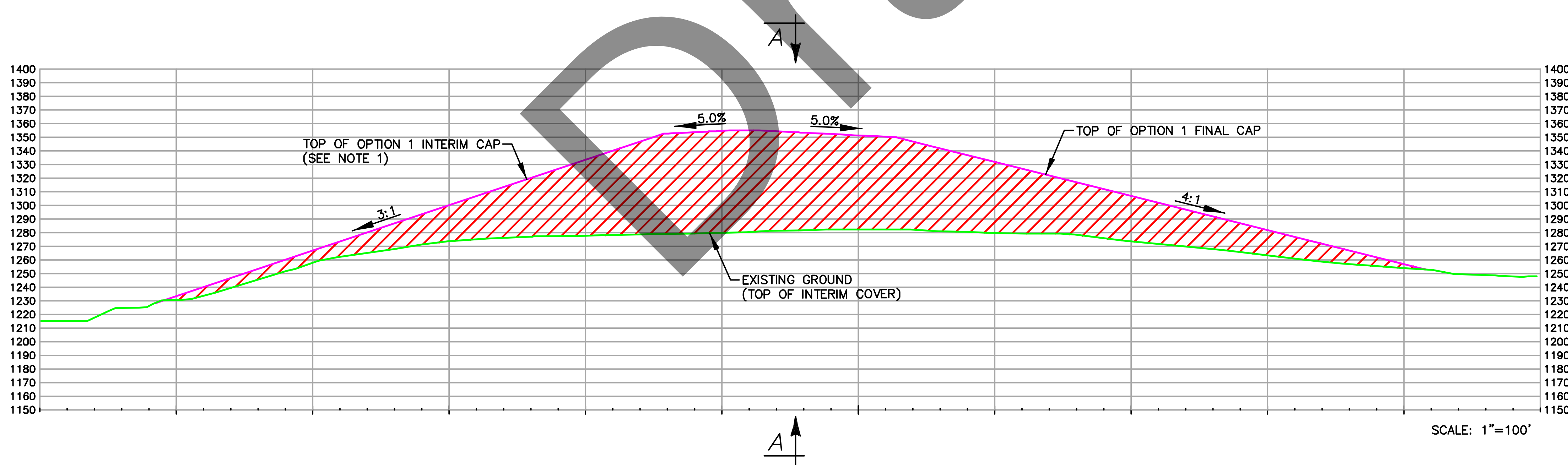
FIGURE NO.
1

OPTION 1 - MAXIMUM FINAL ELEVATION OF 1356
TRENCHES 1-4 SECTIONS



SECTION A–A
(Looking North)

NOTE 1:
AREAS WITH SLOPES OF 3:1 WILL BE COVERED BY WASTE DURING FUTURE FILLING OF CELL 5 TO THE EAST AND CELL 14 TO THE SOUTH.



SECTION B–B
(Looking West)

Draft

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

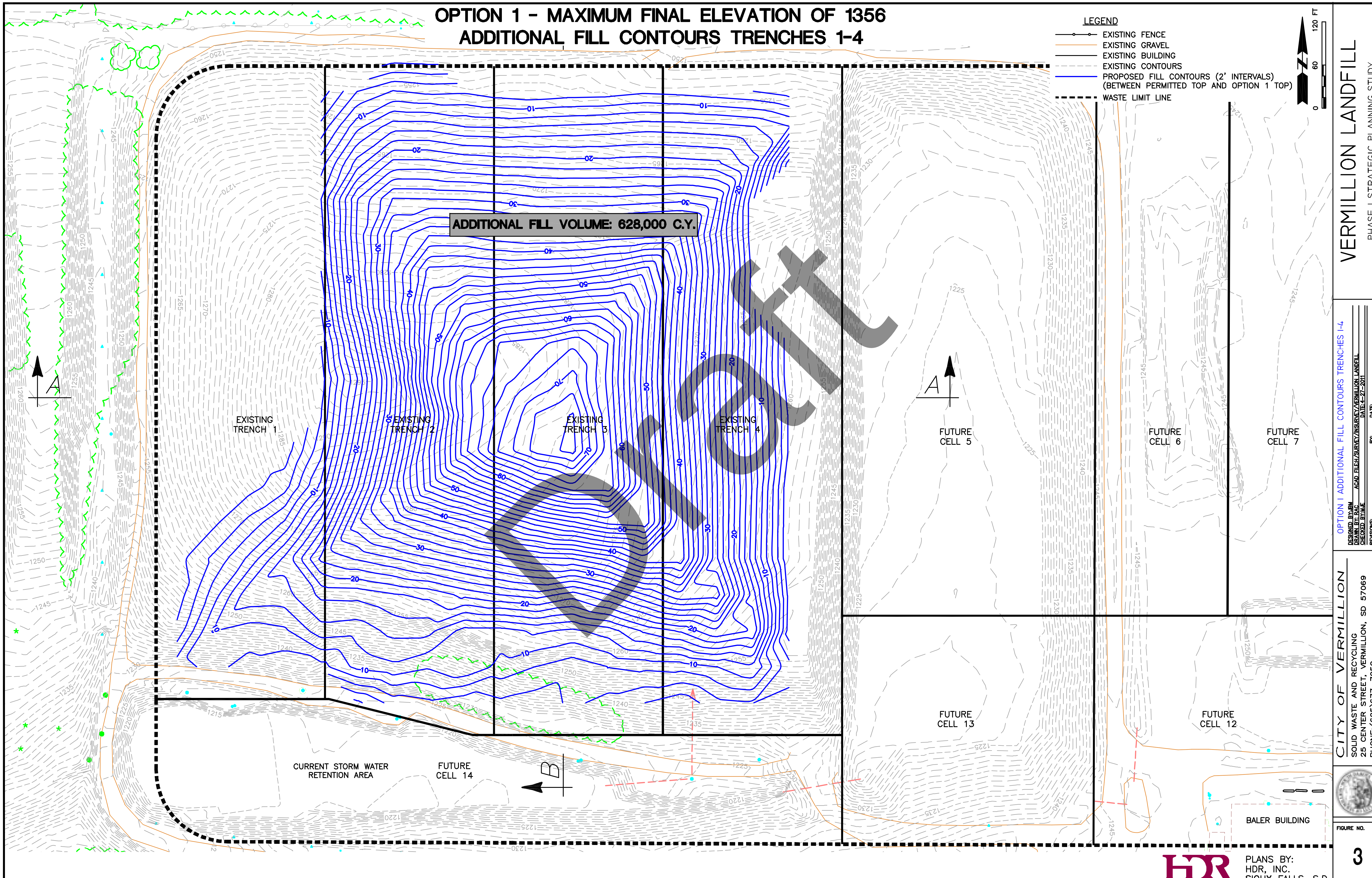
OPTION I TRENCHES 1-4 SECTIONS

DESIGNED BY: RM
DRAWN BY: RAC
CHECKED BY: MJE
REVISIONS:
ACAD FILES/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011
BY: DATE:
BY: DATE:

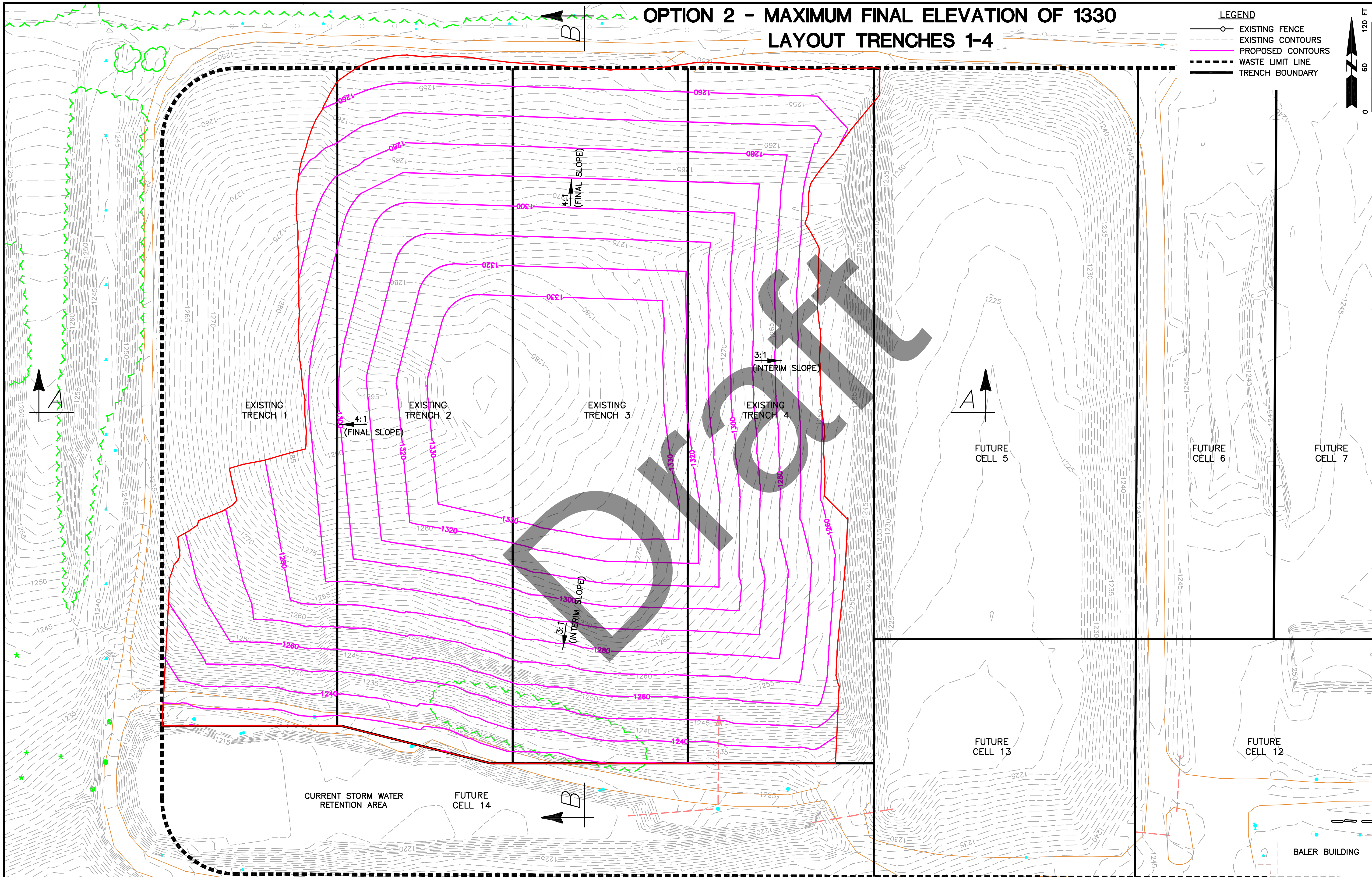
CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.
2

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.


OPTION 1 - MAXIMUM FINAL ELEVATION OF 1356
ADDITIONAL FILL CONTOURS TRENCHES 1-4
LEGEND
EXISTING FENCE
EXISTING GRAVEL
EXISTING BUILDING
EXISTING CONTOURS
PROPOSED FILL CONTOURS (2' INTERVALS)
(BETWEEN PERMITTED TOP AND OPTION 1 TOP)
WASTE LIMIT LINE
ADDITIONAL FILL VOLUME: 628,000 C.Y.
EXISTING TRENCH 1
EXISTING TRENCH 2
EXISTING TRENCH 3
EXISTING TRENCH 4
FUTURE CELL 5
FUTURE CELL 6
FUTURE CELL 7
FUTURE CELL 13
FUTURE CELL 12
FUTURE CELL 14
CURRENT STORM WATER RETENTION AREA
BALER BUILDING
Draft
VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY
OPTION I ADDITIONAL FILL CONTOURS TRENCHES 1-4
CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050
FIGURE NO.
3
HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

OPTION 2 - MAXIMUM FINAL ELEVATION OF 1330
LAYOUT TRENCHES 1-4



SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

Draft

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION 2 LAYOUT TRENCHES 1-4

CITY OF VERMILLION
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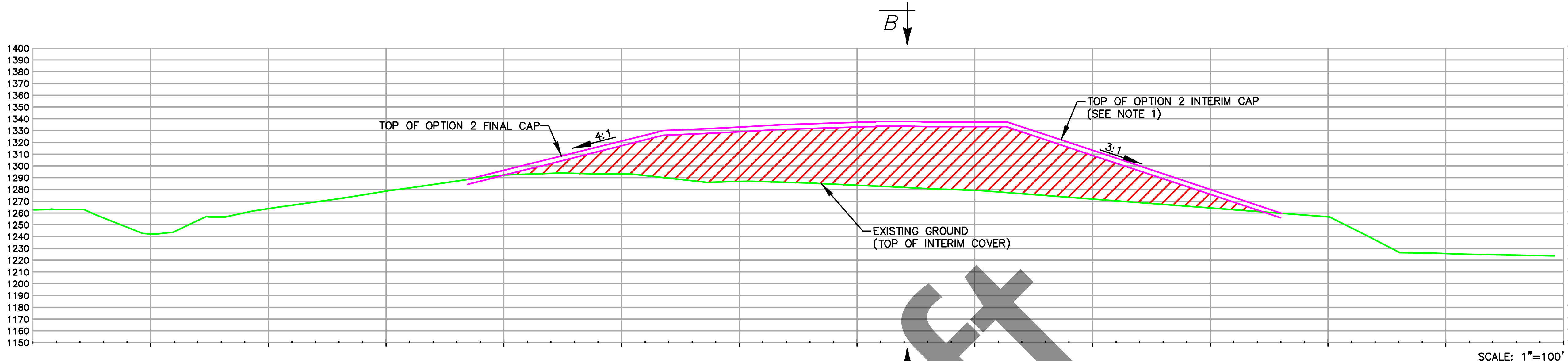
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

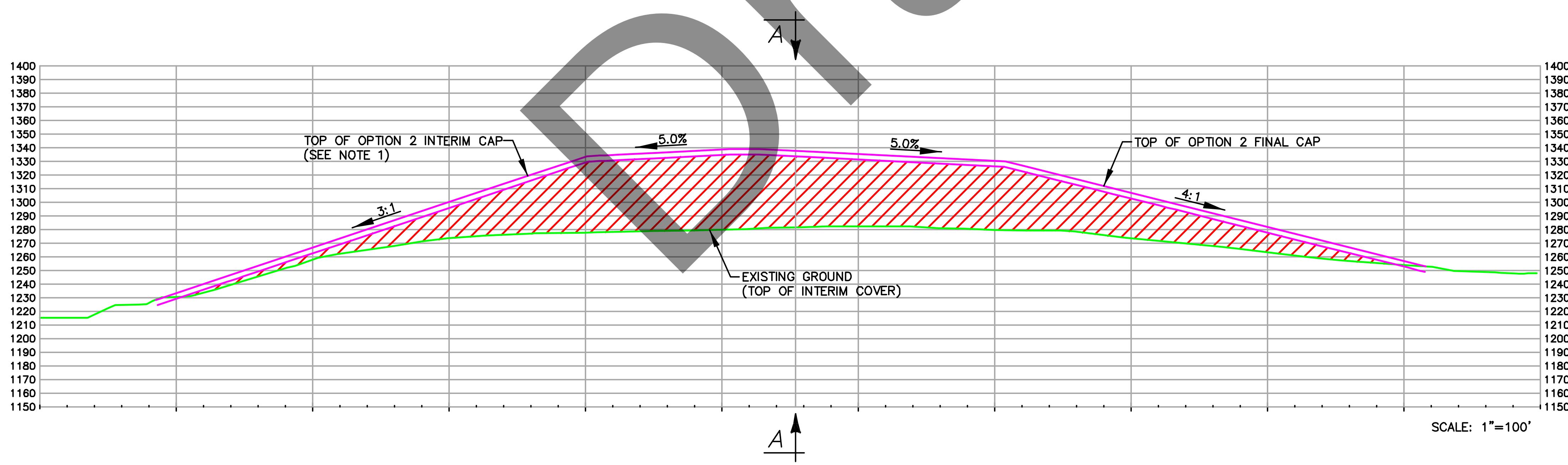
FIGURE NO. 4

OPTION 2 - MAXIMUM FINAL ELEVATION OF 1330
TRENCHES 1-4 SECTIONS



SECTION A–A
(Looking North)

NOTE 1:
AREAS WITH SLOPES OF 3:1 WILL BE COVERED BY WASTE DURING FUTURE FILLING OF CELL 5 TO THE EAST AND CELL 14 TO THE SOUTH.



SECTION B–B
(Looking West)

Draft

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

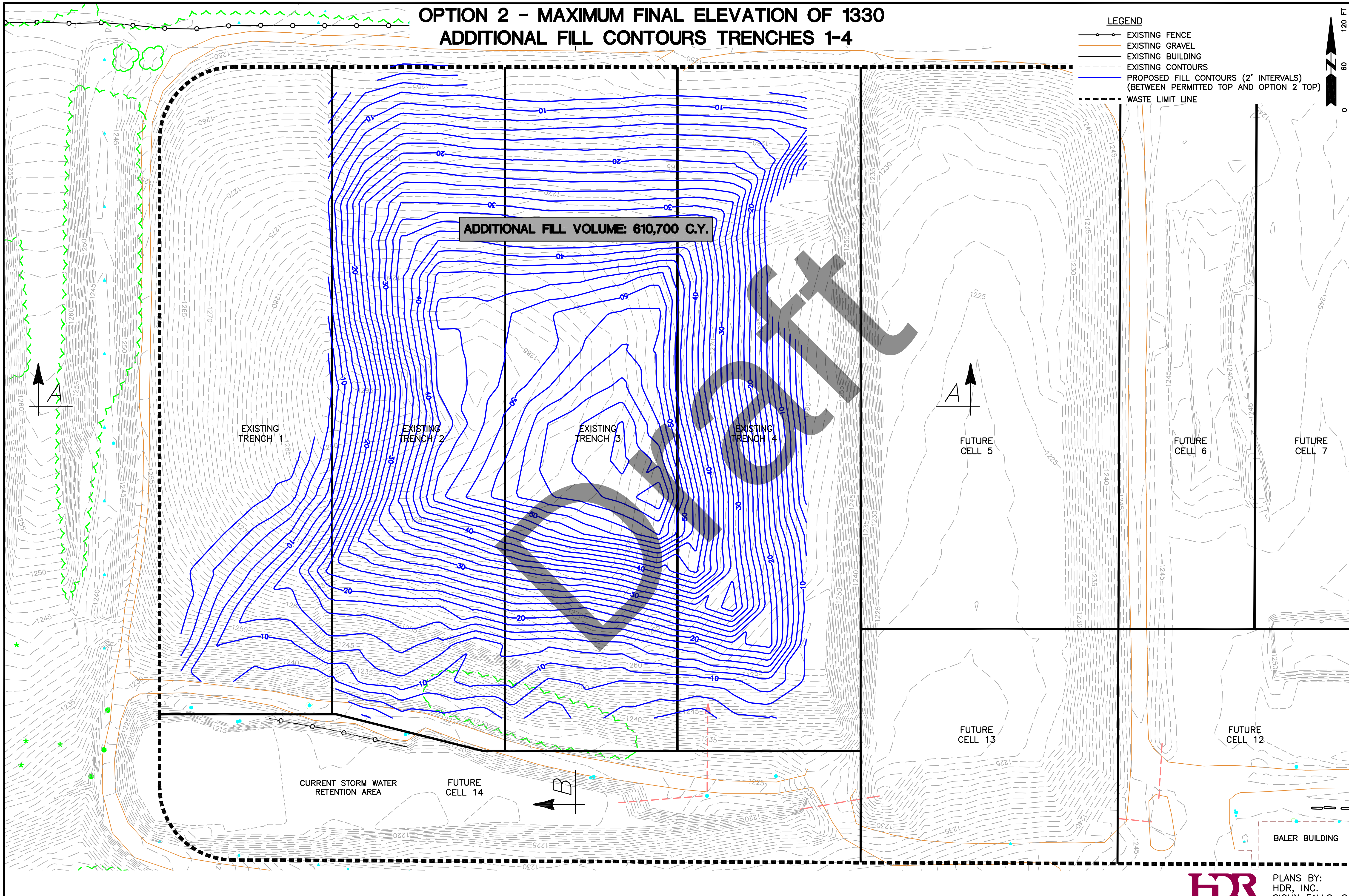
OPTION 2 TRENCHES 1-4 SECTIONS

DESIGNED BY: JBM
DRAWN BY: RAC
CHECKED BY: MJE
ACAD FILE: H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011
REVISIONS:
BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE: (605)677-7050

FIGURE NO.
5

OPTION 2 - MAXIMUM FINAL ELEVATION OF 1330
ADDITIONAL FILL CONTOURS TRENCHES 1-4



Draft

VERMILLION LANDFILL

PHASE I STRATEGIC PLANNING STUDY

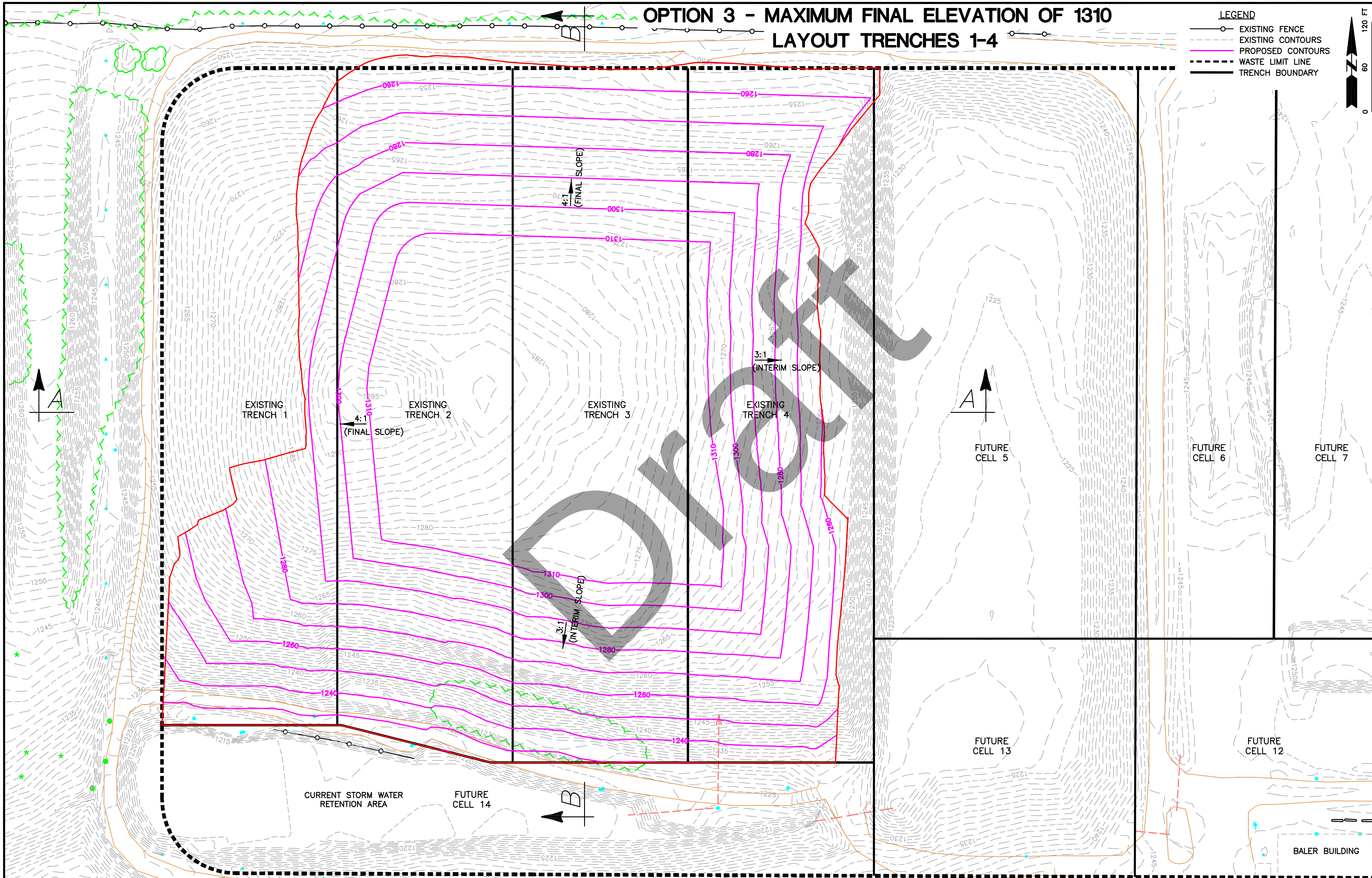
OPTION 2 ADDITIONAL FILL CONTOURS TRENCHES 1-4

DESIGNED BY: JRM
DRAWN BY: RAC
CHECKED BY: MJE
REVISIONS:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
6

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.



VERMILLION LANDFILL

PHASE I STRATEGIC PLANNING STUDY

OPTION 3 LAYOUT TRENCHES 1-4

CITY OF VERMILLION

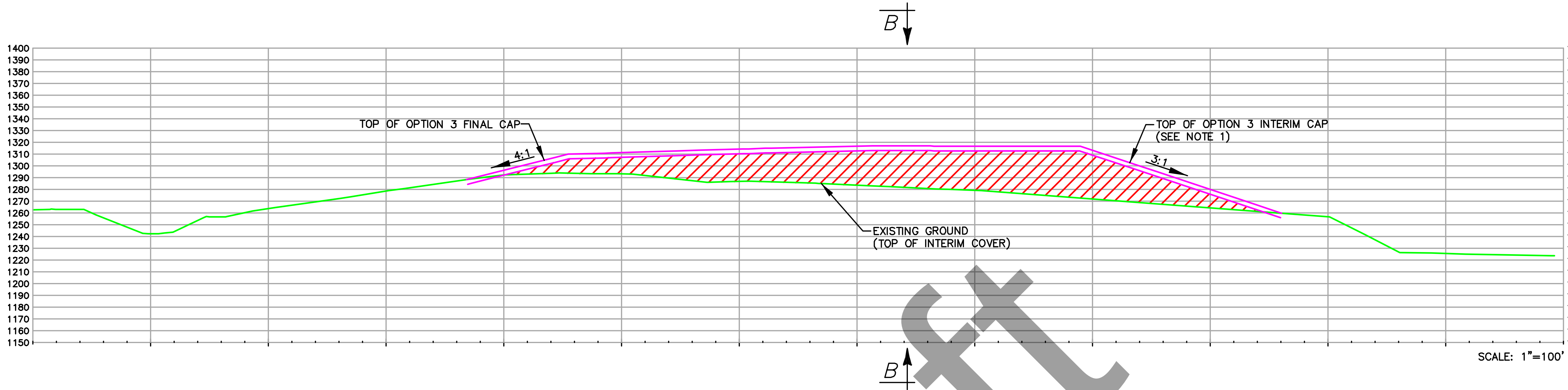
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
7

SURVEY COMPLETED BY HDR, MARCH 5, 2010, MARCH 3, 2011 & JULY 8, 2011.
HORIZONTAL AND VERTICAL DATUM BASED ON EXISTING LANDFILL SURVEY CONTROL.

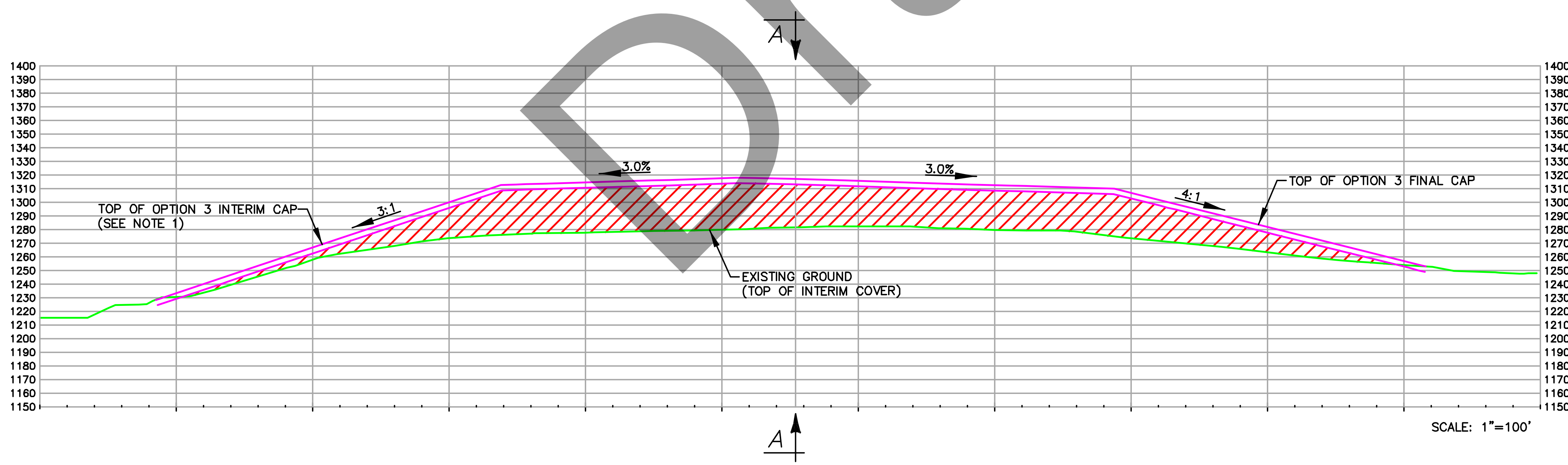
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

OPTION 3 - MAXIMUM FINAL ELEVATION OF 1310
TRENCHES 1-4 SECTIONS



SECTION A–A
(Looking North)

NOTE 1:
AREAS WITH SLOPES OF 3:1 WILL BE COVERED BY WASTE DURING FUTURE FILLING OF CELL 5 TO THE EAST AND CELL 14 TO THE SOUTH.



SECTION B–B
(Looking West)

Draft

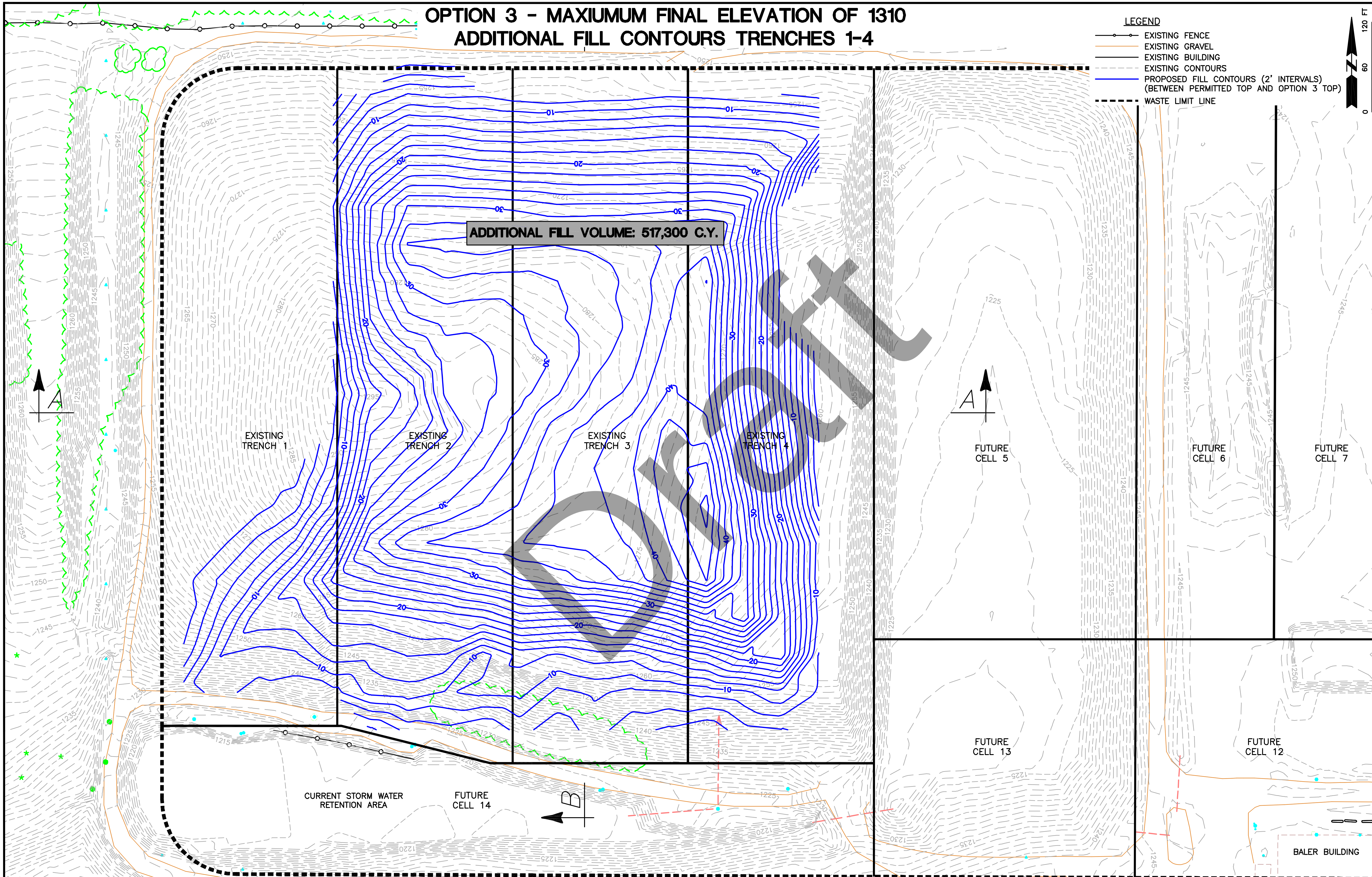
VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION 3 TRENCHES 1-4 SECTIONS

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
8

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.



VERMILLION LANDFILL
PHASE I STRATEGIC PLANNING STUDY

OPTION 3 ADDITIONAL FILL CONTOURS TRENCHES 1-4

DESIGNED BY:JBM
DRAWN BY: RAC
CHECKED BY:MJE
ACAD FILE:H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011
REVISIONS: BY: DATE:
BY: DATE:

CITY OF VERMILLION
SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

FIGURE NO.
9

HDR
PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

Technical Memorandum

To:	Vermillion/Yankton Joint Integrated Solid Waste Management System		
From:	HDR Engineering, Inc.	Project:	Phase I Strategic Planning Study
CC:			
Date:	November 2011	Job No:	HDR – 00000164381

Re: Transfer Station

Introduction

The Yankton Transfer Station provides environmentally safe municipal solid waste (MSW), construction and demolition (C&D) debris and rubble disposal for the City of Yankton and Yankton County. Annual throughput at the transfer station is approximately 20,000 tons/year, with 2,500 tons/year (12.5%) attributed to C&D. The current transfer station building layout is shown in Attachment A. The eastern half of the building is used for C&D waste, and the western half of the building is used for MSW waste. Entrance to the site is through an inbound scale facility. There is no outbound scale. All MSW and C&D waste is hauled to the Vermillion Landfill. Waste defined as "rubble" is disposed of in an on-site rubble pit.

I. Assessment

HDR staff toured the Yankton Transfer Station site and reviewed the layout, traffic flow, and overall operation of the facility. During the site visit, the following attributes and operations were observed or discussed:

- Transfer trucks drive in to either the MSW or C&D load-out pits in a forward direction, and then back out after loading. The truck cabs are covered by a portion of the tipping floor.
- The C&D building (eastern building) includes storage of shop equipment and baled recycling material. The C&D building has three 16' bays for entry and exit. Most vehicles back in and drive out.
- The MSW building (western building) includes a residential recycling drop off area in the northwest corner, and a paper/cardboard baler along the southern wall. The MSW building has only one 20' bay for entry and exit. Most vehicles back in and drive out.
- There has been some reported safety concerns when citizens wander from the residential recycling drop-off area and get onto the tipping floor and in the way of the heavy equipment near the waste pits.
- Ceiling height issues have been reported in the MSW building. Specifically, in the area just south of the pit, when trash haulers attempt to begin maneuvering to leave, while still in the process of dumping their waste.
- There is limited storage space for baled recyclables within the transfer station. In addition, the current bale storage location is near the C&D unloading area, which potentially causes a traffic flow problem when the bales are loaded into trailers for export off of site.

II. Recommendations

Based on the initial assessment, some preliminary recommendations can be made at this time. In order to make a more detailed recommendations, a more detailed study of the transfer station would be necessary, including more detailed information on traffic volumes, goals for facility functions and operations, and budget constraints for updates/modifications. Based on the assessment describe above, the following general recommendations should be taken into account, within the context of the city's financial and operational goals. These recommendations generally strive to optimize traffic flow as much as possible and minimize citizen, waste and equipment conflicts in the middle of the tipping area, e.g., crossing traffic and conflicting uses. These recommendations are segregated according to the MSW and C&D. Attachment A shows some of these recommendations graphically.

A. MSW Building

- Consider moving the residential recycling drop-off area to outside of the building – along the western outer wall, or to a remote area of the site. This will serve to free up floor space in the MSW building, and will also address the safety issue of citizens wandering on the tipping floor.
- With the recycling drop-off area moved outside the building, consider a new utilization of this space as baled recyclables storage area. The adjacent 16' load-out bay could be used to load out recyclables. This would free up space in the C&D building.
- Consider shifting the paper/cardboard baler to the western wall to be closer to the proposed load out and storage area, and to further separate recycling processes from the MSW storage and handling areas.
- With the baler relocated, consider adding a second entrance/exit bay (20' width) for trash haulers to the west of the existing single bay. This might even allow for circular traffic, with less need to back into the building.
- The inadequate roof height is unfortunately difficult to remedy, as it seems that the City has already removed all ancillary items from the roof in this area. The original design may not have taken into account all possible vehicles that might use the facility. Since it is not advisable (or allowable) to unload MSW outside, this situation will have to be tolerated until budget becomes available to make structural changes the building.

B. C&D Building

- As a broader planning alternative, consider the option of closing the C&D portion of the transfer station and requiring customers to dispose of C&D waste directly at the Vermillion Landfill.
- Alternatively, consider the option to site and permit a C&D landfill in Yankton, or near Yankton, for disposal of this waste.
- If C&D will continue to be accepted, consider moving all ancillary activities (recycling, baling) to the C&D building, and close the building to truck traffic. The MSW building could be utilized for receipt of both MSW and C&D waste, and waste could be segregated and loaded out when there is a full load available. Estimated cost: $0.
- If C&D will continue to be accepted at the transfer station, consider management of the entrance and exit bays to promote circular traffic flow, with designated in/out bays. Also consider closing one of the bays to promote this traffic flow.

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C. Recycling Considerations

- Utilize the space at the outdoor loading dock for a second trailer to store baled newspapers or OCC. In order to avoid double-handling of bales (i.e. transfer of bales to the broker's trailer), explore the possibility of broker leaving trailers on-site for direct loading/storage of baled materials or Yankton's purchase of dedicated trailers with broker/contract haul.
- Depending upon amount of tipping floor space required for municipal solid waste storage, consider stacking concrete blocks in 2-sided or 3-sided configuration on the tipping floor immediately north of the baler for loose OCC or newspaper storage. This could help free up areas along the west or north walls for bales.
- The configuration of the Transfer Station building, available wall space, and locations of overhead doors, loading docks and personnel doors make it difficult to further re-arrange the recycling operations and storage.

DRAFT

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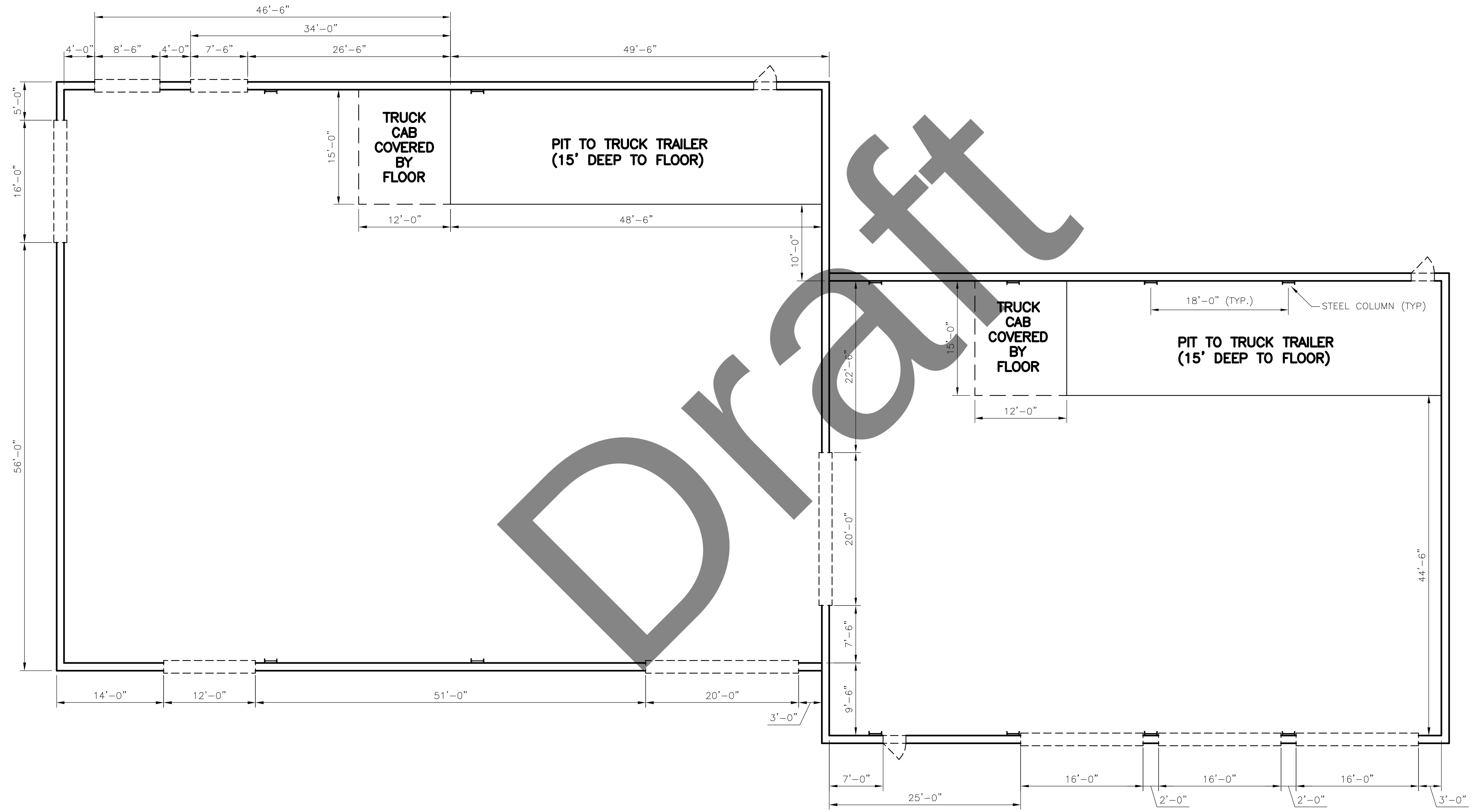
Suite 100
Sioux Falls, SD 57108
Phone (605) 977-7740
Fax (605) 977-7747
www.hdrinc.com

EXISTING TRANSFER STATION

SCALE: 1/16"=1'-0"

NOTES:

THE BUILDING DIMENSIONS SHOWN WERE MEASURED IN THE FIELD WITH A TAPE MEASURE. THEY ARE NOT INTENDED FOR CONSTRUCTION DESIGN.



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VERMILLION

SOLID WASTE MASTER PLAN

EXISTING TRANSFER STATION

DESIGNED BY: MJE
DRAWN BY: RAC
CHECKED BY: TJY
REVISIONS:

ACAD FILE: H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE: 4-27-2011
BY: DATE:
BY: DATE:

CITY OF VERMILLION

SOLID WASTE AND RECYCLING
25 CENTER STREET, VERMILLION, SD 57069
PHONE:(605)677-7050

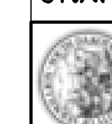
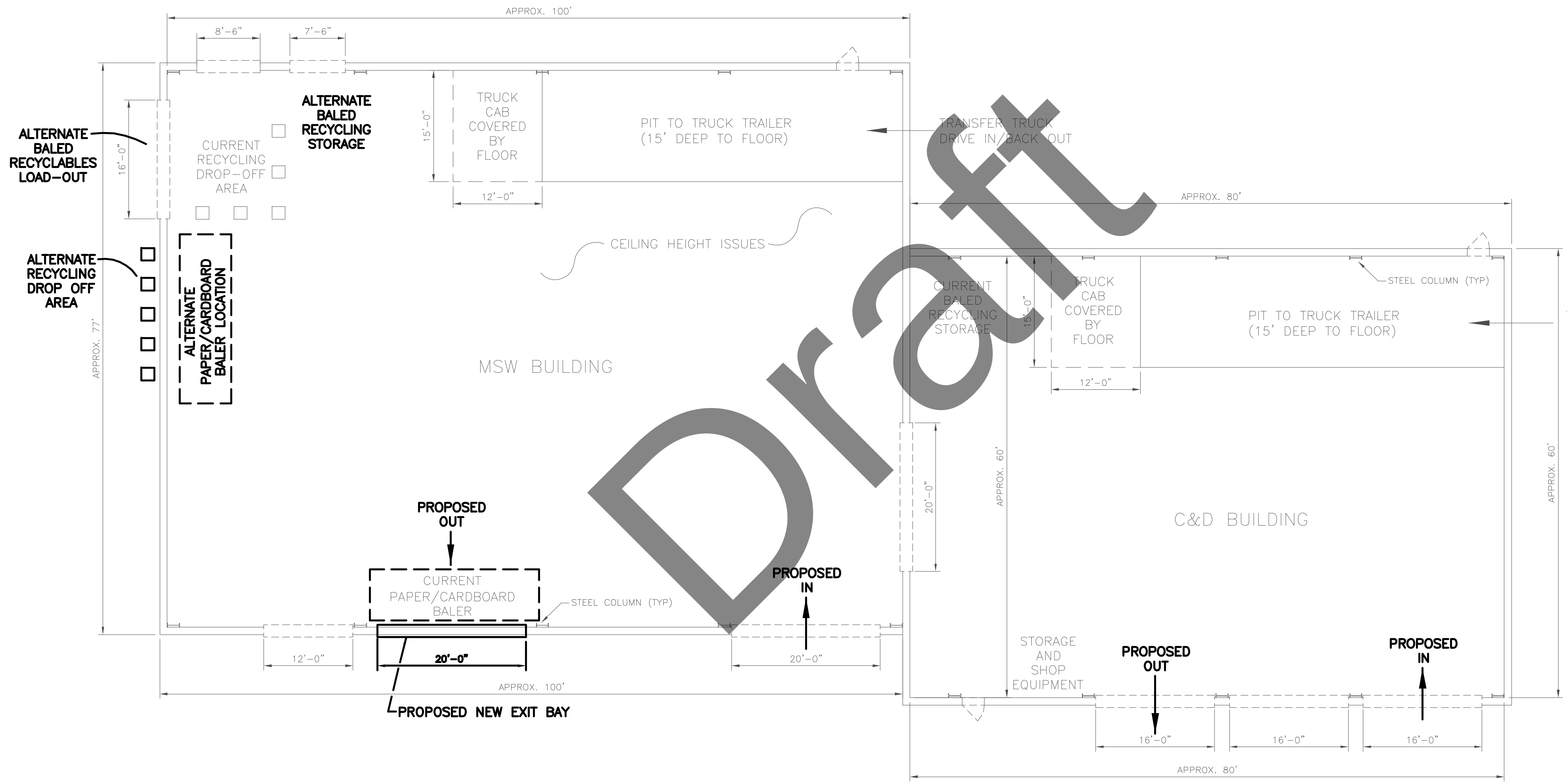


FIGURE NO.

3

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

ATTACHMENT A - YANKTON TRANSFER STATION ASSESSMENT



0 4' 8' 16'

NOTES:

THE BUILDING DIMENSIONS SHOWN WERE MEASURED IN THE FIELD WITH A TAPE MEASURE. THEY ARE NOT INTENDED FOR CONSTRUCTION DESIGN.

Draft

YANKTON

EXISTING TRANSFER STATION

DESIGNED BY:MJE
DRAWN BY: RAC
CHECKED BY:TJY
REVISIONS:

ACAD FILE:/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011

CITY OF YANKTON

SOLID WASTE AND RECYCLING
1200 WEST 23RD STREET, YANKTON, SD 57078

FIGURE NO.

A

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

YANKTON

YANKTON TRANSFER STATION

DESIGNED BY:MJE
DRAWN BY: RAC
CHECKED BY:TJY
ACAD FILE:H/SURVEY/INSURVEY/VERMILLION LANDFILL
DATE:4-27-2011
REVISIONS:
BY: DATE:
BY: DATE:

CITY OF YANKTON
SOLID WASTE COLLECTION
416 WALNUT STREET, YANKTON, SD
PHONE:(605)668-5251

PLANS BY:
HDR, INC.
SIOUX FALLS, S.D.

FIGURE NO.
1

Technical Memorandum

To:	Vermillion/Yankton Joint Integrated Solid Waste Management System		
From:	HDR Engineering, Inc.	Project:	Phase I Strategic Planning Study
CC:			
Date:	November 17, 2011	Job No:	HDR – 00000164381

Re: "In-Town" Multi-Purpose Solid Waste Facility Assessment

DRAFT

Introduction

Currently, the City of Vermillion has an "in-town" recycling building located at 840 North Crawford Road. This facility receives recyclable material and bales the material for transport. Figure 1, below, shows and aerial view of the recycling building location, with an overlay showing the internal components of the building. The recycling building has approximate dimensions 200'x100' (20,000 sq.ft.) and is described in more detail in the Recycling technical memorandum. This facility currently does not accept municipal solid waste (MSW) or construction and demolition (C&D) waste.

Figure 1: Existing Recycling Building

Separately, the City of Vermillion operates the Vermillion Landfill at 31426 Bluff Road. The landfill accepts MSW and C&D waste as well as recyclables. The MSW is currently baled in the baling building on site, prior to landfilling. The landfill baler building is near the scale house, with approximate dimensions 130'x80' (10,400 sq.ft.), and is shown on Figure 2, below.

I. Assessment

HDR is tasked with a general analysis of the advantages and disadvantages associated with combining these two baling facilities into one larger facility that would be located at a central location "in-town." HDR staff visited both facilities and reviewed the layout, traffic flow, and overall operation of the facility. In order to assess this alternative mode of operation, the following issues are considered:

Figure 1: Existing Recycling Building

A. Building Size

Based on combining the operations of the two existing facilities, a preliminary estimation of required building size for the new facility would be combined total area. This yields approximately 30,400 square feet as the minimum required area. This would be a minimum size requirement, and could be increased depending on specific operations and/or office space required.

B. Building Cost

Typical costs for similar facilities can range from $105 - $125 per square foot. Therefore, the proposed square footage yields a range of capital costs of approximately $3.2 million - $3.8 million. Note that this is a conceptual construction cost estimate for the building only, and does NOT include the following:

- Land purchase
- Baling equipment (assumed to be moved from existing locations)
- General site work (cut and fill)
- Ingress/egress road and driveway work
- Landscaping/fencing
- Stormwater/drainage features
- Electrical/water/sanitary sewer tie-in to existing, or extension of utilities to the site
- Site lighting and security

C. Building Location

The "in-town" site must be large enough to accommodate the building, ancillary access and parking. Similar to a MSW transfer station, the site would need to have the space to handle incoming waste haulers, accommodate transfer trailer turning radii, and provide space for queing. In essence, location considerations similar to the construction of a transfer station would be required. These include (but are not limited to): neighbors/zoning, odors, drainage, roadway access, etc.

D. Other Operational Concerns

The most noticeable operational change associated with combining the recycling and MSW collection and baling would arguably be the segregation of MSW baling operations from the landfill. Currently, MSW is brought the landfill and baled on-site, then landfilled. There is dedicated equipment for loading, transporting, and unloading the bales. Any unacceptable MSW, prohibited waste, or hot loads can be segregated and either landfilled separately, or sent back to the generator.

All of these processes can happen with the MSW baler located off-site, however, actual operation may be more difficult. More coordination (and possibly more equipment) would be required to transport the baled waste to the landfill. This waste would need to be hauled on a street-licensed vehicle. In addition, storage space would have to be managed to allow for bales, incoming MSW, prohibited wastes, and C&D waste without the luxury of "unlimited" space enjoyed at the landfill site. Similar to a transfer station, odors would need to be managed by use of enclosures, operational techniques, and other means.

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E. Permitting

Permitting for a facility of this nature would generally follow the permitting applicability of a transfer station. As mentioned, siting, transportation, odor, waste acceptance, waste flow, drainage, and other considerations would be reviewed as part of the permit application process.

II. Recommendations

Based on this initial assessment, the initial capital cost and operational restrictions regarding baling of the incoming MSW to be landfilled would not support the creation of an “in town” multi-purpose solid waste facility at this time.

DRAFT

Technical Memorandum

To:	Vermillion/Yankton Joint Integrated Solid Waste Management System		
From:	HDR Engineering, Inc.	Project:	Phase I Strategic Planning Study
CC:			
Date:	November 17, 2011	Job No:	HDR – 00000164381

Re: Yard Waste Handling and Processing

The purpose of this technical memorandum is to discuss current yard waste handling and processing operations in Vermillion and Yankton and recommend improvements to the yard waste handling facilities and overall operations. Consideration of drop-off centers for leaf and vegetation will also be discussed.

Vermillion and Yankton each operate their yard waste programs separately. Yard waste is banned from landfill disposal in South Dakota. Yard waste must be separated from other solid waste so that it can be diverted. Yard waste is either managed by residents in their own yards (i.e. grass clippings left on lawn or backyard composting) or hauled to the communities' yard waste drop-off location(s) for composting.

Existing program enhancements and program options are summarized below as candidates for further consideration in the second phase of the Solid Waste Strategic Planning Study. A detailed technical and economic evaluation of alternatives was not conducted.

I. Current Yard Waste Programs and Facilities

Vermillion and Yankton both accept yard waste and wood waste at their respective solid waste facilities. Each operates their own composting and wood chipping program. Yard waste drop-off by households is not charged a fee at either of the two facilities, and the resulting compost is not sold. As such, the yard waste programs are primarily subsidized through other solid waste program/disposal fees. The following discusses the yard waste programs and facilities for each community.

A. Vermillion

Vermillion currently operates the following yard waste handling and processing program:

- Public brings yard waste to either the drop-off center at the Recycling Center or the Vermillion Landfill
    - o Receipt of yard waste at both sites is during normal operating hours of the facilities; this provides a level of supervision and monitoring of customer activities
    - o Yard waste and shrubbery is received free of charge from households at Recycling Center from April through October

    - When yard waste roll-offs at Recycling Center become full, the City transports them to the Vermillion Landfill for further processing. This is done approximately two times per week.
- The Vermillion Landfill also serves as a drop-off site for tree branches and yard waste from residential, commercial and industrial customers.
    - Branches and yard waste drop-off are free from households
    - Commercial customers must pay a fee at the Landfill for tipping yard waste and trees.
- Yard waste is composted using the windrow method at the Vermillion Landfill.
    - The graded compost pad is approximately 100' x 300'
    - Windrows are created and turned with a loader
    - Typically it takes approximately two years for the yard waste to decompose into compost
- Yard waste is composted and used on site at the Vermillion Landfill. It is not sold or distributed to the public due to South Dakota requirements for registration with the Department of Agriculture and testing requirements.

Wood chip waste is received at the Recycling Center from commercial customers. Wood chips are stored outside the building and sold for $5 a bucket load (bucket approximately ½ cubic yard to ¾ cubic yard). Wood waste received at the Landfill is stored onsite and sold to Mueller Pallets.

B. Yankton

Yankton currently operates the following yard waste handling and processing program:
- Public can bring yard waste to the Yankton Transfer Station for composting at no cost.
- Tree branches are accepted at the Transfer Station for a tip fee.
- Yard waste collected at the Transfer Station is composted using the windrow method. A WildCat CT 515 windrow turner machine is used in the process.

II. Yard Waste Handling and Operations Improvements

Based on facility observations and the program descriptions above, the following facility and program improvements are recommended for consideration by each community.

A. Vermillion Yard Waste Program Enhancements

The City of Vermillion offers two drop-off locations for public drop-off. These are located at:
- Vermillion Landfill – 31426 Bluff Road
- Recycling Center – 840 N. Crawford Road

The drop-off at the Vermillion Landfill is immediately adjacent to the windrows. The front-end loader then pushes the material to continue the formation of the windrow. The City plans to relocate the yard waste/tree branches drop-off and compost pad immediately east of the scalehouse and baling facility. Improvements to consider with the relocation include:
- Provide new compost pad area of minimum 54,000 SF (e.g., 300' x 180' or 360' x 150') to include maneuvering areas and short-term stockpiles of wood waste and curing compost

- Grade new compost pad area with approximate 1% slope to one end for management of stormwater run-off from the composting pad to a lagoon approximately 2,200 SF to 2,500 SF in surface area
- Provide space between windrows for loader access to turn windrows
- Orientate windrows to facilitate customer unloading directly at end of current windrow

The Recycling Center drop-off provides a convenience to residents, however the City does incur a cost to handle and haul the roll-offs to the Landfill. Continued operation of this yard waste drop-off is a policy decision for the City, since approximately 80% of the annual yard waste is estimated to be received at this drop-off. Some enhancements for the City to consider for this drop-off site include:

- Increasing the size of the roll-off box to reduce the number of loads hauled to the landfill
- Provide information pamphlet to customers about backyard composting and "Don't Bag It" source reduction programs

The City already limits yard waste drop-off at the Recycling Center from April through October for households only (no commercial accounts).

In order to better track diversion from landfill disposal, it is recommended that all yard waste loads to the Landfill are weighed, both direct-haul and roll-offs from the Recycling Center. Such records could be used in the future to evaluate the benefit of the Recycling Center drop-off and track data trends/differences between household quantities and commercial customers.

B. Yankton Yard Waste Program Enhancements

The City of Yankton offers yard waste drop-off at their Transfer Station free of charge. Their compost facility is also located at the Transfer Station site. Within the last year, the City constructed the new compost pad with storm water lagoon on the west end of the site. From visual observations conducted during a site visit on June 27, 2011, the following operational improvements are recommended for consideration:

- Consider relocating customer drop-off of yard waste adjacent to the compost pad. This may not reduce the double handling since windrows are formed through the material unloading from the dump truck; however haul distance would be reduced.
- Composting was in its initial stages, thus no finished compost has been produced yet. If not already identified, it is recommended that an area be designated for finished compost stockpile. If compost will be made available for public pick-up, then locate in area that facilitates customer access without interference with other operations.
- As composting facility operations mature, monitor adequacy of area for quantity of yard waste received. Some options to alleviate crowding include:
    - Encourage residents to implement source reduction measures such as backyard composting and "Don't Bag It"
    - Increase frequency of turning windrows to accelerate the composting process
    - Consider moving the large soil stockpile adjacent to the current compost pad to provide expansion capabilities

In order to better track diversion from landfill disposal, it is recommended that the yard waste loads are weighed and recorded for data collection.

III. Program Options

Besides the specific program improvements for the existing facilities, the following options may be considered by Vermillion and Yankton as part of the final Solid Waste Master Plan development. These options include both physical facilities and public education to encourage greater source reduction.

- Enhance public education by promoting "Don't Bag It" yard waste programs to reduce the amount of yard waste received at the existing drop-off centers.
- Consider adding drop-off centers for residential yard waste at location(s) more convenient to residents who reside further away from the existing drop-off locations.

The consideration of yard waste drop-off centers was identified in the scope of the feasibility study. Such drop-off centers provide a convenience to residents, however there are additional costs to initiate and operate such drop-offs and the potential exists for large quantities of yard waste being dropped off by for-profit landscape maintenance firms to avoid the tip fees at the Vermillion Landfill and Yankton Transfer Station. For a typical unstaffed drop-off center on existing property with one roll-off (and one spare), a capital cost of approximately $22,000 could be expected with a haul cost of $90 per load for a 10-mile one-way haul. These costs would increase further if enforcement mechanisms are required to prevent use by for-profit landscape maintenance firms.

Due to observed relatively low quantities of yard waste received from the public free of charge at the existing drop-off locations, curbside collection of yard waste is not recommended for the communities. A certain amount of yard waste appears to be managed by residents at the source, thus never entering the facilities. The cost and fee of curbside collection could be perceived as too great compared to the convenience.

Technical Memorandum

To:	Vermillion/Yankton Joint Integrated Solid Waste Management System		
From:	HDR Engineering, Inc.	Project:	Phase I Strategic Planning Study
CC:			
Date:	November 17, 2011	Job No:	HDR – 00000164381

Re: Cost of Service

The convention used by most public utilities to establish their revenue requirements is called the "cash basis" approach of setting rates. As the name implies, a public utility aggregates its cash expenditures for a period of time to determine its required revenues from user rates and other forms of income. This methodology conforms nicely to most public utility budgetary requirements and is very straightforward and easily understood calculation. Operation and maintenance expenses are added to any applicable transfer payments to determine total operating expenses. Capital costs are calculated by adding any debt service payments (principal and interest) to capital outlays financed with operating rate revenues. Depreciation expense is sometimes included in lieu of this latter item to stabilize annual revenue requirements. Under the "cash basis" of accounting, the sum of the capital and operating expense equals the utility's revenue requirement during any period of time. It should be noted that the two portions of the capital expense component (debt service and capital improvements financed from rates) are necessary under the "cash basis" approach because utilities generally cannot finance all of their capital facilities with long-term debt. The table below may be helpful in summarizing the "cash basis" methodology.

Overview of the "Cash Basis" Methodology

+ O&M Expense
+ Taxes/Transfer Payments
+ Capital Outlay Financed with Rates (>= Depreciation Exp.)
+ Debt Service (P+I)

= Total Revenue Requirements

As part of this cost of service study, Joint Powers expenses were allocated to seven different cost centers. These cost centers are:

- Vermillion Landfill
- Vermillion Baler Building
- Vermillion Compost Operation
- Vermillion Recycling Center
- Yankton Transfer Station
- Yankton Recycling (Transfer Station related expenses)
- Yankton Rubble Pit

Included in Attachment A is a Summary of the Revenue Requirements for each of these cost centers. Tables presenting the allocation of expenses for each of these cost centers are also included in Attachment A.

It is recommended that the results of this cost of service study be used as a basis for a future rate study. The rate study should take into account the costs identified in the cost of service study, the probable costs of future projects (as determined by the results of the Phase 1 Strategic Planning Study), the variability in the recycling market, and the projected growth in waste from the communities. The rate study should also develop a plan that has a strategy going forward that covers costs and limits loans. Ultimately, the rates developed should be equitable for the customer classes and stabilized by considering future capital allocations over the period identified in the rate study.

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JOINT POWERS - REVENUE REQUIREMENT SUMMARY
November 8, 2011

	Vermillion			
Cost Type	Landfill	Landfill Baler Bldg	Compost Operation	Recycling Bldg
Personnel	$ 129,230	$ 143,763	$ 5,710	$ 174,865
Operating	$ 210,965	$ 183,465	$ 2,977	$ 97,318
Capital	$ 292,901	$ 96,937	$ 2,276	$ 30,223
Debt	$ 43,261	$ 20,543	$ 134	$ -
Reserves	$ 11,139	$ -	$ -	$ -
Total	$ 687,496	$ 444,707	$ 11,096	$ 302,406

2010 Vermillion Landfill Tonnage	36,400
Landfill Cost per Ton	$ 18.89
Landfill Baler Cost per Ton	$ 12.22
Landfill and Baler Cost per Ton	**$ 31.10**

	Yankton		
Cost Type	Transfer Station	Recycling (Transfer Station)	Rubble Pit
Personnel	$ 203,923	$ 55,188	$ 2,926
Operating	$ 184,573	$ 35,706	$ 8,943
Capital	$ 79,110	$ 25,975	$ 2,269
Debt	$ -	$ 36,291	$ -
Reserves	$ -	$ -	$ -
Total	$ 467,606	$ 153,160	$ 14,138

2010 Yankton Transfer Station Tonnage	21,137
Transfer Station Cost per Ton	**$ 22.12**

VERMILLION LANDFILL BALER BUILDING

PERSONNEL SERVICES

WAGES	$	95,671
OVERTIME	$	11,989
FICA	$	7,851
RETIREMENT	$	6,137
WORKMEN'S COMPENSATION	$	6,903
INSURANCE	$	15,211
SUBTOTAL	$	143,763

OPERATING EXPENSES

INSURANCE POLICIES	$	2,230
PROFESSIONAL-LEGAL	$	1,207
MOTOR VEHICLE REPAIR & MAINT.	$	868
EQUIPMENT REPAIR & MAINTENANCE	$	23,329
BUILDING REPAIR & MAINTENANCE	$	732
OFFICE SUPPLIES	$	766
OPERATING SUPPLIES & MATERIALS	$	114,255
MOTOR VEHICLE FUEL & SUPPLIES	$	17,332
COPY SUPPLIES	$	55
POSTAGE	$	52
UNIFORMS	$	1,306
TRAVEL & TRAINING	$	1,926
ELECTRICITY	$	9,141
WATER	$	208
HEATING FUEL-GAS	$	9,229
TELEPHONE	$	828
SUBTOTAL	$	183,465

CAPITAL OUTLAY

FURNITURE & MINOR EQUIPMENT	$	617
MACHINERY & AUTO	$	96,319
SUBTOTAL	$	96,937

DEBT SERVICE

PRINCIPAL	$	16,929
INTEREST EXPENSE	$	3,614
SUBTOTAL	$	20,543

VERMILLION BALER BUILDING	**$**	**444,707**

VERMILLION COMPOST OPERATION

PERSONNEL SERVICES

WAGES	$	3,800
OVERTIME	$	476
FICA	$	312
RETIREMENT	$	244
WORKMEN'S COMPENSATION	$	274
INSURANCE	$	604
SUBTOTAL	$	5,710

OPERATING EXPENSES

INSURANCE POLICIES	$	82
PROFESSIONAL-LEGAL	$	44
PUBLISHING & ADVERTISING	$	791
MOTOR VEHICLE REPAIR & MAINT.	$	20
EQUIPMENT REPAIR & MAINTENANCE	$	545
BUILDING REPAIR & MAINTENANCE	$	27
OFFICE SUPPLIES	$	30
OPERATING SUPPLIES & MATERIALS	$	522
MOTOR VEHICLE FUEL & SUPPLIES	$	405
COPY SUPPLIES	$	2
POSTAGE	$	2
UNIFORMS	$	52
TRAVEL & TRAINING	$	76
WATER	$	8
HEATING FUEL-GAS	$	338
TELEPHONE	$	33
SUBTOTAL	$	2,977

CAPITAL OUTLAY

FURNITURE & MINOR EQUIPMENT	$	25
MACHINERY & AUTO	$	2,252
SUBTOTAL	$	2,276

DEBT SERVICE

PRINCIPAL	$	116
INTEREST EXPENSE	$	18
SUBTOTAL	$	134

VERMILLION COMPOST OPERATION $ 11,096

VERMILLION LANDFILL

PERSONNEL SERVICES

WAGES	$	86,000
OVERTIME	$	10,777
FICA	$	7,058
RETIREMENT	$	5,516
WORKMEN'S COMPENSATION	$	6,205
INSURANCE	$	13,673
SUBTOTAL	$	129,230

OPERATING EXPENSES

INSURANCE POLICIES	$	2,381
PROFESSIONAL SERVICES & FEES	$	44,470
STATE FEES	$	36,488
PROFESSIONAL-LEGAL	$	1,289
PROCESSING- REDUCTION	$	10,000
PUBLISHING & ADVERTISING	$	791
MOTOR VEHICLE REPAIR & MAINT.	$	1,549
EQUIPMENT REPAIR & MAINTENANCE	$	41,642
BUILDING REPAIR & MAINTENANCE	$	782
FACILITY REPAIRS & MAINTENANCE	$	10,419
OFFICE SUPPLIES	$	689
OPERATING SUPPLIES & MATERIALS	$	15,223
MOTOR VEHICLE FUEL & SUPPLIES	$	30,938
COPY SUPPLIES	$	50
POSTAGE	$	46
UNIFORMS	$	1,174
TRAVEL & TRAINING	$	1,731
ELECTRICITY	$	481
WATER	$	222
HEATING FUEL-GAS	$	9,855
TELEPHONE	$	745
SUBTOTAL	$	210,965

CAPITAL OUTLAY

FURNITURE & MINOR EQUIPMENT	$	555
MACHINERY & AUTO	$	171,927
LANDFILL DEVELOPMENT	$	120,419
SUBTOTAL	$	292,901

DEBT SERVICE

PRINCIPAL	$	38,382
INTEREST EXPENSE	$	4,879
SUBTOTAL	$	43,261

RESERVES

CLOSURE POSTCLOSURE RESERVES	$	11,139
SUBTOTAL	$	11,139

VERMILLION LANDFILL TOTAL **$** **687,496**

VERMILLION RECYCLING

PERSONNEL SERVICES

WAGES	$	128,685
OVERTIME	$	5,209
FICA	$	9,221
RETIREMENT	$	7,400
WORKMEN'S COMPENSATION	$	5,739
INSURANCE	$	18,611
SUBTOTAL	$	174,865

OPERATING EXPENSES

INSURANCE POLICIES	$	3,408
PROFESSIONAL SERVICES & FEES	$	2,953
HAZARDOUS WASTE COLLECTION	$	20,000
PUBLISHING & ADVERTISING	$	2,278
MOTOR VEHICLE REPAIR & MAINT.	$	540
EQUIPMENT REPAIR & MAINTENANCE	$	7,632
BUILDING REPAIR & MAINTENANCE	$	6,606
OFFICE SUPPLIES	$	1,333
OPERATING SUPPLIES	$	5,666
MOTOR VEHICLE FUEL & SUPPLIES	$	8,000
COPY SUPPLIES	$	106
POSTAGE	$	38
FREIGHT	$	1,550
UNIFORMS	$	313
MATERIALS PURCHASED	$	8,374
REVENUE SHARING MATERIALS	$	15,000
TRAVEL & TRAINING	$	2,249
ELECTRICITY	$	5,707
WATER	$	430
SEWER	$	851
HEATING FUEL-GAS	$	3,367
TELEPHONE	$	917
SUBTOTAL	$	97,318

CAPITAL OUTLAY

BUILDING & STRUCTURES	$	10,076
FURNITURE & MINOR EQUIPMENT	$	2,912
MACHINERY & AUTO	$	17,236
SUBTOTAL	$	30,223

RECYCLING TOTAL **$ 302,406**

YANKTON RECYCLING (TRANSFER STATION)

PERSONNEL EXPENSES

WAGES	$	37,692
TEMPORARY WAGES	$	733
OVERTIME	$	2,642
OASI	$	3,071
RETIREMENT	$	2,420
WORKERS COMPENSATION	$	376
INSURANCE	$	6,982
UNEMPLOYMENT INSURANCE	$	188
OPEB EXPENSE	$	1,082
SUBTOTAL	$	55,188

OPERATING EXPENSES

INSURANCE POLICIES	$	1,611
PROFESSIONAL SERVICES & FE	$	11,314
PUBLISHING & ADVERTISING	$	4,356
LABOR, EQUIP & MAT'L CHARG	$	774
EQUIPMENT REPAIR & MAINT.	$	928
MOTOR VEHICLE REPAIR & MAI	$	300
BUILDING REPAIR & MAINT.	$	429
MOTOR VEHICLE FUEL & SUPPL	$	9,217
POSTAGE	$	59
OFFICE SUPPLIES	$	483
COPY SUPPLIES	$	3
OPERATING SUPPLIES & MAT.	$	173
UNIFORMS	$	74
TELEPHONE	$	154
ELECTRICITY	$	387
HEATING FUEL-GAS	$	1,366
WATER	$	97
WW SERVICE	$	47
LANDFILL	$	20
TRANSPORTATION TO VERMILLI	$	3,825
PROCESSING RECYCLABLE	$	89
SUBTOTAL	$	35,706

CAPITAL OUTLAY

BUILDING & STRUCTURES	$	25,975
SUBTOTAL	$	25,975

DEBT SERVICE

BUILDING ADDITION INTEREST	$	11,215
BUILDING ADDITION PRINCIPA	$	25,076
SUBTOTAL	$	36,291

TOTAL **$ 153,160**

YANKTON RUBBLE PIT

PERSONNEL EXPENSES

WAGES	$	1,938
TEMPORARY WAGES	$	62
OVERTIME	$	159
FICA	$	161
RETIREMENT	$	126
WORKERS COMPENSATION	$	32
INSURANCE	$	347
UNEMPLOYMENT INSURANCE	$	10
OPEB EXPENSE	$	92
SUBTOTAL	$	2,926

OPERATING EXPENSES

INSURANCE POLICIES	$	304
PROFESSIONAL SERVICES & FE	$	331
PUBLISHING & ADVERTISING	$	7
LABOR, EQUIP & MAT'L CHARG	$	166
EQUIPMENT REPAIR & MAINT.	$	352
MOTOR VEHICLE REPAIR & MAI	$	242
BUILDING REPAIR & MAINT.	$	92
MOTOR VEHICLE FUEL & SUPPL	$	6,732
POSTAGE	$	5
OFFICE SUPPLIES	$	20
COPY SUPPLIES	$	0
OPERATING SUPPLIES & MAT.	$	37
UNIFORMS	$	2
TELEPHONE	$	13
ELECTRICITY	$	313
HEATING FUEL - GAS	$	293
WATER	$	21
WW SERVICE	$	10
LANDFILL	$	4
SUBTOTAL	$	8,943

CAPITAL OUTLAY

BUILDING & STRUCTURES	$	2,269
SUBTOTAL	$	2,269

TOTAL **$** **14,138**

YANKTON TRANSFER STATION

PERSONNEL EXPENSES

WAGES	$	135,046
TEMPORARY WAGES	$	4,349
OVERTIME	$	11,090
FICA	$	11,187
RETIREMENT	$	8,768
WORKERS COMPENSATION	$	2,233
INSURANCE	$	24,166
UNEMPLOYMENT INSURANCE	$	666
OPEB EXPENSE	$	6,419
SUBTOTAL	$	203,923

OPERATING EXPENSES

INSURANCE POLICIES	$	10,585
PROFESSIONAL SERVICES & FE	$	11,544
PUBLISHING & ADVERTISING	$	228
LABOR, EQUIP & MAT'L CHARG	$	5,788
EQUIPMENT REPAIR & MAINT.	$	6,352
MOTOR VEHICLE REPAIR & MAI	$	4,361
BUILDING REPAIR & MAINT.	$	3,203
MOTOR VEHICLE FUEL & SUPPL	$	121,341
POSTAGE	$	352
OFFICE SUPPLIES	$	1,367
COPY SUPPLIES	$	16
OPERATING SUPPLIES & MAT.	$	1,295
UNIFORMS	$	159
TELEPHONE	$	915
ELECTRICITY	$	5,638
HEATING FUEL - GAS	$	10,207
WATER	$	723
WW SERVICE	$	351
LANDFILL	$	149
SUBTOTAL	$	184,573

CAPITAL OUTLAY

BUILDING & STRUCTURES	$	79,110
SUBTOTAL	$	79,110

TOTAL	**$**	**467,606**