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PROPOSED DESIGN AND OPERATION OF A LAND APPLICATION (SPRAY IRRIGATION) SYSTEM AS A CONTINGENT TREATMENT OF PKCA WASTE WATER

JERICHO PROJECT

Submitted to:

Tahera Diamond Corporation
Toronto, Ontario

Submitted by:

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Burnaby, BC

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VE51295.600

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1.0 INTRODUCTION

A land application (spray irrigation) system was presented in the Jericho Project EIS as a contingent treatment method to remove ammonia and other contaminants from the discharge from the Processed Kimberlite Containment Area (PKCA). This report is intended to provide an update for the design criteria, predicted performance and operating plan for the proposed spray irrigation system to be installed and operated at the Jericho Project site.

The proposed use of a spray irrigation system at the Jericho Project site was previously discussed in the following documents:

- The Suitability of Wetland/Overland Flow Treatment and Spray Irrigation for Mine Water for the Jericho Project – Phase 1, prepared for Tahera Corporation by Dr. Andre Sobolewski of Microbial Technologies, Inc., dated October 2000.
- *Jericho Project Land Treatment Pilot Trials: Summer 2001 Final Report* and addendum, prepared for Tahera Corporation by Corporation by Dr. Andre Sobolewski of Microbial Technologies, Inc., dated December 2001.
- *Addendum to Proposed Jericho Project Land Application (Spray Irrigation) Treatment System*, prepared for Tahera Corporation by Dr. Andre Sobolewski of Microbial Technologies, Inc., dated September 2003.

It should be stressed that the proposed spray irrigation system is intended to be a contingent treatment method to be used in the event that water quality from the PKCA facility does not meet the anticipated Water License criteria.

The water and contaminant load balance developed for the Jericho Mine (Technical Memorandum G to the Final EIS) indicated that the concentrations of Total Ammonia-N, Total Copper, Nickel and Zinc in the PKCA pond and in the settling pond downstream of the PKCA, might become marginally elevated above CCME Guidelines. The predicted maximum Total Ammonia-N concentrations for the PKCA pond during operations is in the order of 2.2 mg/L. Similarly, the predicted maximum concentrations of Total Cu, Ni and Zn are 0.0206, 0.0695 and 0.0335 mg/L respectively. Land application, also referred to as spray irrigation, has been identified as the preferred method of discharging excess water should the Ammonia-N concentration exceed levels acceptable for direct discharge. Previous work conducted by Microbial Technologies indicates that Cu, Ni and Zn will be suitably reduced through land application.[1]

[1] Sobolewski, A. 2001. Jericho Project Land Treatment Pilot Trials: Summer 2001 Final Report and subsequent December 2001 addendum.

2.0 WHAT IS A LAND APPLICATION (SPRAY IRRIGATION) SYSTEM?

Use of land Application or spray irrigation systems to remove ammonia and other contaminants relies upon the ability of plants and the underlying soils to convert, adsorb, and/or uptake most of the ammonia and other contaminants contained in the wastewater that is applied to the land. The mechanisms involved are complex and involve bacterial conversion of ammonia to nitrate. This process has been applied successfully at other

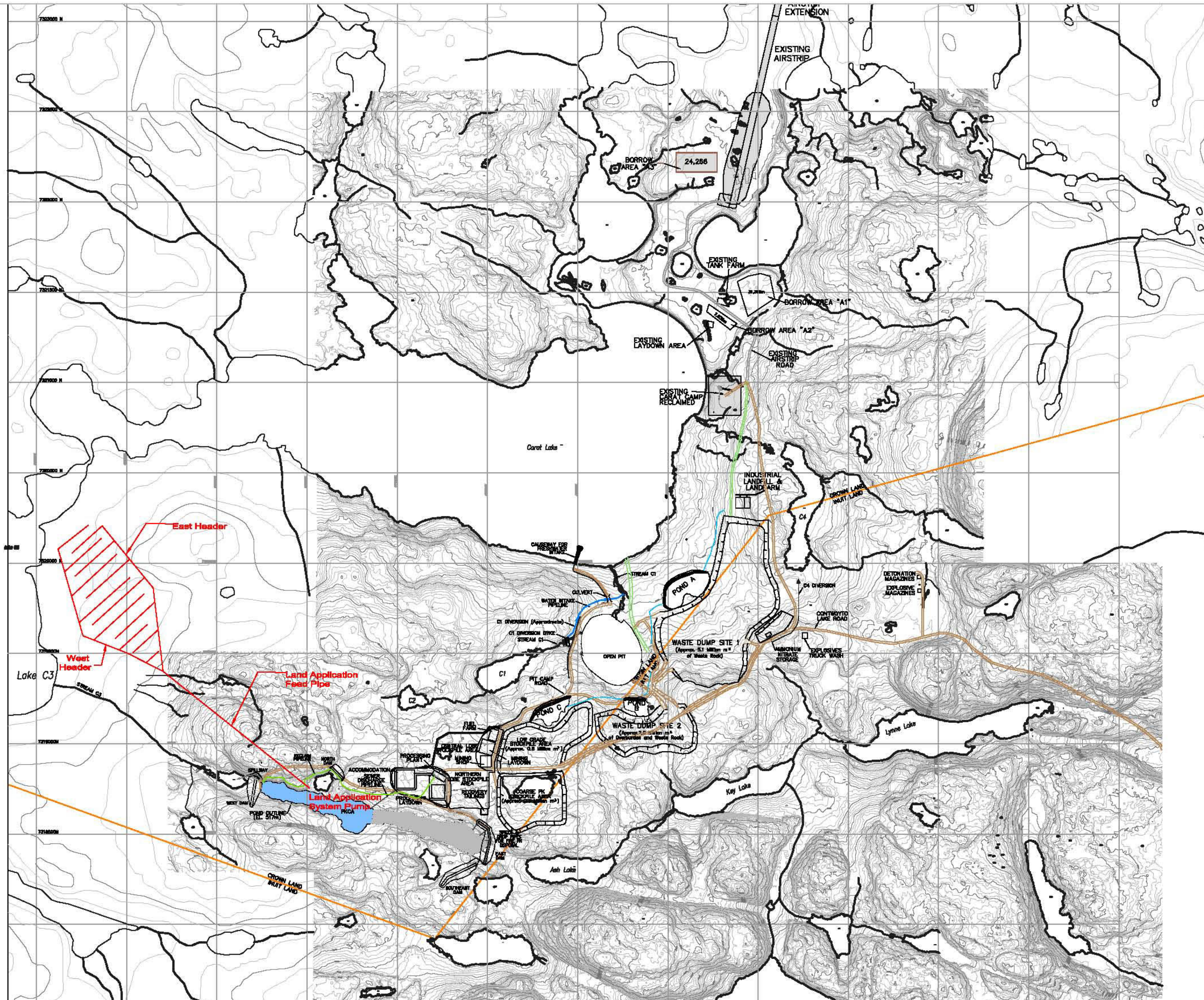
locations to remove ammonia and other nitrogen compounds from both sewage treatment system waste waters and from mine water.

The system as proposed would involve the pumping of wastewater from the PKCA pond through a piping system to a designated land application area to be located south of the west end of Carat Lake and immediately east of the lake designated as Lake C3 (see Figure 2.1).

The system would only be operated in the summer months when the surface ground temperatures are above freezing. An operational season of 100 days per year has been assumed (during the 4 month period of June through September).

A network of plastic spray piping would be laid out in parallel lines over the surface of the designated spray irrigation area connected to two feed header pipes, one along the west side and the other along the east side of the land application area. At periodic intervals along each parallel spray pipe, spray nozzles would be installed. These spray nozzles would release wastewater into the air, allowing for some loss of water through evaporation with most of the water falling onto the surrounding land. The spacing of the spray nozzles would be set to create full coverage over the land surface while minimizing the overlap of the circular spray pattern from the adjoining sprinkler nozzles. The rate of flow would be set to allow the soils in the spray irrigation area to reach near saturation levels but to prevent overland flow. The piping delivery system would be set up to allow flow to be switched from one area to another within the spray irrigation system using manually operated valves. The delivery pump would be set to operate on a timer so that the system is switched on and off at a pre-determined cycle (nominally 3 hours on, 3 hours off) so that over each operating day each sprinkler would only see flow over 12 hours out of every 24 hours. In this way the soil and plants are given the rest time needed to adsorb the wastewater applied without supersaturating the underlying ground.

A small amount of the wastewater applied through the spray irrigation system would be lost to the air through evaporation. The remainder of the water would land on the surface of the spray irrigation area wetting both the soils and plants in the area. Some additional water will be lost to the air through evapotranspiration (evaporation through the plants and their root systems). The remaining water will drain downwards into the soil wetting the underlying soil and plant rooting systems. Biological action within the soils and plants will both convert ammonia into nitrate and adsorb (take up) the nitrate as a nutrient for plant growth. The water not lost to the air through evaporation and evapotranspiration will over time drain into the shallow groundwater in the



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Client: TEHARA CORPORATION

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CHK'D BY: BO
APP.: BO
SCALE: As Shown

Figure 2-1 Site Location

DATE: July 2004
PROJECT NO: VE51295-700
REV. NO.: -
FIGURE No. FIGURE 1

*PLOT 1:1=D D:\NTITLES\ AMEC-A3L-IMP-BBY.dwg Wed. Oct. 31 9:30am 2001 Model SMIot active layer on top of the permafrost and drain towards the lake designated as C3. Over time, the treated wastewater would drain through the ground entering the C3 Lake watershed, which in turn drains into Carat Lake.

The proposed spray irrigation system is predicted to sufficiently remove/convert ammonia-N concentrations in the PKCA wastewater so that the water quality entering the groundwater below the spray irrigation meets the expected criteria for direct discharge. These predictions are based on the data obtained through the field trials run at the Jericho Project site during the summer of 2001. The proposed land application area has been sized to provide some conservative nature in these predictions as discussed in more detail in the following sections.

3.0 HOW MUCH WATER WILL HAVE TO BE LAND APPLIED?

The predicted water balance for the Jericho Project site was revised as one of the key follow up elements coming from the review of the Jericho Project Final EIS. The maximum monthly discharge from the PKCA pond is predicted to be 250,000 m^3 from June to September, regardless of low/average/high scenarios considered, for a total annual discharge of 1,000,000 m^3. This volume is a peak, not an annual norm and is expected to be reached during the first two years of the operation. For design purposes, the expected volume of water that would be treated through the land application system was set at this peak value of 1,000,000 m^3 per year or 10,000 m^3 per day based on a 100 day long land application operational period (within the period of June thru September).

4.0 WHAT IS THE EXPECTED WATER QUALITY IN THE WASTEWATER TO BE LAND APPLIED?

Predicted loadings and concentrations of selected contaminants within the PKCA were revised accordingly and are presented in Table 4.1. These values represent the highest concentration expected within the PKCA pond and PKCA Settling Pond expected over the mine life. In most cases these predictions represent expected concentrations from later in the mine life that reflect the expected delay in the movement of contaminants from the waste rock dumps. The waste rock dumps will grow in size over the mine life and it will take time for precipitation to wash contaminants from these dumps to be collected and transferred into the PKCA.

Table 4.1: Predicted Concentrations of Selected Contaminants

Predicted Concentrations of Selected Contaminants	**PKCA Pond**	**Diavik WL Limits**
Total Ammonia (NH_4-N) (mg/L)	**2.9**	2.0[2]
Nitrate (NO_3-N) (mg/L)	7.28	N/A
Phosphorous (P) (mg/L)	0.0831	0.2
Total Dissolved Solids (TDS) (mg/L)	1558	N/A
Total Aluminium (mg/L)	1.0401	1.5
Total Copper (mg/L)	**0.0206**	0.02
Total Iron (mg/L)	1.0149	N/A
Total Nickel (mg/L)	**0.0695**	0.05
Total Lead (mg/L)	0.0042	0.01
Total Uranium (mg/L)	0.6802	N/A
Total Zinc (mg/L)	**0.0335**	0.30

The revised balance for the Jericho Project predicts that some contaminants may exceed expected direct discharge limits, specifically Total Ammonia-N, Copper, Nickel and Zinc within the PKCA pond as indicated by the bolded values in Table 4.1. The Diavik water license direct discharge limits are presented here as a point of reference.

The values presented in Table 4.1 have been applied as the predicted concentrations expected to report to the spray irrigation system. The area required for spray irrigation has been calculated using these concentrations as described in Section 7.0.

5.0 HOW MUCH WATER CAN BE LAND APPLIED BEFORE SATURATING THE GROUND?

The field trials conducted in the summer of 2001 suggest that the maximum application rate of wastewater that can be applied before the ground becomes too saturated to accept further water thus causing surface flow should be set at 5 m^3 per m^2 of application area per day. This became a ceiling that was not to be exceeded in sizing the land application area required.

[2] The Diavik water license has recently been amended to increase the allowable Total Ammonia-N concentration to be increased to 20 mg/L with appropriate precautionary monitoring requirements.

6.0 HOW MUCH WATER WILL BE LOST THROUGH EVAPORATION AND/OR EVAPOTRANSPIRATION?

Microbial Technologies, Inc. previously reported on evaporative losses from agricultural sprinkler irrigation systems:

In general the 'above the canopy spray evaporation loss' (or ACSEL) is determined by equipment-related factors and weather conditions. Evaporative losses are enhanced by generating smaller droplets traveling greater distances, higher winds, higher water/air temperature ratio, and higher air vapour pressure deficit. All these factors can be manipulated in the engineering design of the sprinkler system by adjusting the sprinkler type, water pressure, nozzle design and size, and the water application schedule.

The reviewed studies, which were designed to conserve water and were conducted in various climatic conditions, and used several low-pressure agricultural sprinkler irrigation systems, reported evaporative losses reaching 30 to 50%. Although true site-specific evaporative losses need to be field evaluated (generally, the site has constant gentle breezes and low relative humidity, factors that favour evaporative losses), it is expected that ordinary agricultural sprinkling equipment can be selected and adjusted to result in 40% reduction of water volumes due to evaporation.[3]

Precipitation at the Jericho site is limited and averages about 300 mm per year, approximately half rain and half snow (rainfall equivalent). Various estimates of evaporation put it at approximately 250 mm per year with evaporation taking place almost entirely during the four snow-free months of the year. It is recognized that reconciling this estimate of evaporation loss (which is for standing water such as lakes) with the higher losses predicted from agricultural sprinkling equipment is difficult as the two evaporative mechanisms are quite different. Intuitively losses from the sprinklers would be expected to be significantly higher than lake evaporation losses but the difficulty is in determining by how much.

For design purposes of the spray irrigation system for use at the Jericho Project site, it was decided to use an evaporation loss of 20%, half the value recommended by Microbial Technologies based on their literature search. This was an arbitrary choice designed to provide a conservative approach to estimating the size of the land application area required. This selection of an evaporative loss value will be evaluated by Tahera as part of a proposed field trial of the land application contingent technique run at 10% of the full scale system design flow rate. This field trial is discussed further in Section 10.0.

An evaporative loss of 20% means that for a feed rate of 1,000,000 m^3 of wastewater applied to the land, 200,000 m^3 will be lost to the air through evaporation and evapotranspiration, leaving

[3] Sobolewski, A. 2000. The Suitability of Wetland/Overland Flow Treatment and Spray Irrigation for Mine Water for the Jericho Project – Phase 1.

800,000 m^3 to enter the shallow groundwater flow. On a daily basis this values translates over the proposed 100 day application period to the following:

- Average daily application rate: 10,000 m3/day
- Loss to evaporation/evapotranspiration: 2,000 m3/day
- Flow into groundwater: 8,000 m^3/day

While the literature indicates that some ammonia may be lost to the atmosphere through spray irrigation through volatilization, for design purposes, it has been assumed that no ammonia will be lost to the air through evaporation. In other words, it has been assumed for design purposes that the concentrations of ammonia and other contaminants will be concentrated through spray irrigation (i.e., the mass loading of ammonia and other contaminants reaching the plants and ground at the land application area remains constant despite the evaporation loss).

7.0 HOW LARGE AN AREA IS REQUIRED FOR THE LAND APPLICATION SYSTEM?

The size of the required land application area is a function of the following factors:

- The amount of wastewater that has to be land applied;
- The time available when weather conditions are suitable for operation of the land application system;
- The ability or rate at which the ground can soak up or adsorb the wastewater applied through the land application system without causing overland flow;
- The concentration of contaminant(s) in the wastewater applied;
- The ability or amount of contaminant that can be adsorbed, taken up or converted by the soils and plants in the land application area; and
- The targeted acceptable contaminant(s) concentrations in the wastewater reaching the groundwater under the land application area.

For the Jericho Project it has been established that the land application system should be designed to treat 1,000,000 m^3/year over a 100-day application period. The previously measured hydraulic adsorption constraint of the soils in the land application area was set at 5.0 m^3/m^2/day.

The parameters of concern, (i.e., those that must be reduced through the land application system) identified in the predictive site water balance were Total Ammonia-N, Total Copper and Total Nickel. The concentrations of Total Ammonia-N, Total Copper and Total Nickel in the feed to the land application area are predicted to be 2.9 mg/L, 0.0206 mg/L and 0.0695 mg/L respectively. Using an evaporative loss of 20%, the concentration of these contaminants reaching the ground is predicted to be 3.6 mg/L, 0.026 mg/L and 0.087 mg/L respectively.

For design purposes the Diavik water License limits of 2.0 mg/L for Total Ammonia-N (see footnote #2); 0.02 mg/L for Total Copper and 0.05 mg/L for Total Nickel were referenced as expected direct discharge limits. However for sizing of the required land application area these values were reduced by 50% for target values to be achieved in the wastewater reaching the groundwater below the land application area. Consequently the targeted acceptable limits for contaminant concentrations in the wastewater reaching the groundwater below the land application area were set at 1.0 mg/L Total Ammonia-N, 0.01 mg/L for Total Copper and 0.025 mg/L for Total Nickel. These were the targeted values used to size the required land application area.

On this basis the estimated contaminant loads in the wastewater to be land applied and the amount of each contaminant that must be removed to achieve the targeted groundwater concentrations were calculated to be as follows:

	Load in Wastewater To be Land Applied	Load to be Removed by Land Application
Total Ammonia	2,900 kg/year	2,100 kg/year
Total Copper	21 kg/year	13 Kg/year
Total Nickel	70 Kg/Year	50 Kg/Year

Microbial Technologies previously presented information on expected removal rates of Total Ammonia, Total Copper and Total Zinc[4]. Based on this review Microbial Technologies recommended use of the following predicted removal rates:

Total Ammonia:	6.0 kg/ha/day	(reported range of 2.8 to 9.8 kg/ha/day);
Total Copper:	0.2 kg/ha/day	(reported range of 0.2 to 8.0 kg/ha/day);
Total Nickel:	0.085 kg/ha/day	(reported value of 0.17 kg/ha/day).

To ensure use of conservative removal values in sizing the required land application areas, the following removal rates were applied in calculating the required land application area:

Total Ammonia:	2.0 kg/ha/day
Total Copper:	0.2 kg/ha/day
Total Nickel:	0.085 kg/ha/day

The required land application area was then independently calculated for each of these three contaminant parameters with the following results, where the required land application area in

[4] Sobolewski, A. 2003. Addendum to Proposed Jericho Project Land Application (Spray Irrigation) Treatment System.

hectares is equal to the total load in Kg per year of the contaminant to be removed divided by the selected removal rate in Kg/ha/day times 100 days:

Required Land Application Area Based on:

Total Ammonia-N removal:	10.5 ha
Total Copper removal:	0.6 ha
Total Nickel removal:	5.8 ha

Consequently the minimum required area is estimated to be 10.5 ha and is controlled by the rate of Total Ammonia-N removal. The calculation of this minimum required land application areas is presented in Table 7.1.

Table 7.1: Calculation of Minimum Required Land Application Area

Calculated Area Required for Spray Irrigation	Full Scale	Proposed Field Trial
Based on Nickel Removal		
Estimated Starting Concentration (mg/L Total Nickel)	0.0695	0.0695
Annual Loading in Effluent to Land Application (kg Total Nickel)	70	7
Assumed Allowable Discharge Limit (mg/L Total Nickel)	0.05	0.05
Assumed Allowable Loading in Discharge to Groundwater (kg Total Nickel)	40	4
Design Target Loading in Discharge to Groundwater (kg Total Nickel)	20	2
Estimated Concentration After Allowing for 20% Evaporation (mg/L Total Nickel)	0.0869	0.0869
Nickel to be Removed by Land Application Adsorption (kg)	50	3
Target Residual Concentration in Groundwater after Adsorption (mg/L Total Nickel)	0.025	0.025
Design Nickel Removal Rate (Based on wetland treatment in Manitoba) (kg/ha/day)	0.085	0.085
Nickel to be Removed by Land Application Adsorption (kg/year)	50	3
Calculated Land Application Area Required (hectares)	5.8	0.3
Based on Ammonia Removal		
Estimated Starting Concentration (mg/L Total Ammonia)		
Estimated Concentration After Allowing for 20% Evaporation (mg/L Total Ammonia)	3.6	3.6
Assumed Allowable Discharge Limit (mg/L Total Ammonia)	2.0	2.0
Target Residual Concentration in Groundwater after Adsorption (mg/L Total Ammonia)	1.0	1.0

Calculated Area Required for Spray Irrigation	**Full Scale**	**Proposed Field Trial**
Annual Loading in Effluent to Land Application (kg Total Ammonia)	2,900	290
Assumed Allowable Loading in Discharge (kg Total Ammonia)	1,600	160
Design Target Loading in Discharge to Groundwater (kg Total Ammonia)	800	80
Ammonia to be Removed by Land Application Adsorption (kg)	2,100	210
Design Ammonia Removal Rate (Based on Star Lake/Jasper wetland treatment) (kg/ha/day)	6.0	6.0
Ammonia to be Removed by Land Application Adsorption (kg/year)	2,100	210
Calculated Land Application Area Required (hectares)	3.5	0.4
Conservative Ammonia Removal Rate (kg/ha/day)	2.0	2.0
Ammonia to be Removed by Land Application Adsorption (kg/year)	2,100	210
Area Required (hectares)	10.5	1.1
Based on Copper Removal		
Estimated Starting Concentration (mg/L Total Copper)	0.0206	0.0206
Estimated Concentration After Allowing for 20% Evaporation (mg/L Total Copper)	0.0258	0.0258
Assumed Allowable Discharge Limit (mg/L Total Copper)	0.02	0.02
Target Residual Concentration in Groundwater after Adsorption (mg/L Total Copper)	0.010	0.01
Annual Loading in Effluent to Land Application (kg Total Copper)	21	2
Assumed Allowable Loading in Discharge to Groundwater (kg Total Copper)	16	2
Design Target Loading in Discharge to Groundwater (kg Total Copper)	8	1
Copper to be Removed by Land Application Adsorption (kg)	13	0.5
Design Copper Removal Rate (Based on wetland treatment in Manitoba) (kg/ha/day)	0.200	0.200
Copper to be Removed by Land Application Adsorption (kg/year)	13	0.5
Calculated Land Application Area Required (hectares)	0.6	0.02

Before finalizing the selected land application sizing, it is necessary to compare the projected or design wastewater application rate (m^3/m^2/day) for the selected land application area size (10.5 ha) against the previously measured hydraulic adsorption constraint of the soils in the land application area set at 5.0 m^3/m^2/day, i.e. the ability of the soil to adsorb the water applied.

Based on use of a land application area of 10.5 ha, a total of 800,000 m^3 per year to be adsorbed into the ground (1,000,000 m^3 – 200,000 m^3 in evaporation loss), a 100 day treatment system operating 24 hours per day, the resultant soil infiltration rate would be 32 m^3 per hour.

To be conservative, an operating factor of 50% was assumed, i.e., the sprinklers would only operate on average 12 hours per day. On this basis the infiltration rate would be 63 m^3 per hour. Using this value the predicted required infiltration rate would translate into a value of 0.08 m^3 per m^2 per day that is well under the previously measured hydraulic constraint of 5.0 m^3/m^2/day (Table 7.2). In other words the soil should be capable under normal operating conditions of soaking up the water applied without resulting in overland surface flow.

Table 7.2: Determination of the Land Application Infiltration Rate

	Full Scale Design	**Field Trial Design**
Selected Design Land Application Area (ha)	10.5	1.1
Selected Design Land Application Area (m^2)	105,000	11,000
Minimum Infiltration Rate (m^3/hr over Design Application Area) – 24 hr day	32	32
Maximum Infiltration Rate (m^3/hr over Design Application area) - 12 hr day	63	63
Design Land Application Rate (m^3/m^2/day)	0.08	0.08
Previously Measured Hydraulic Constraint (m^3/m^2/day)	5.0	5.0

Consequently, the size of the required land application area should be set at a minimum of 10.5 ha. The size of the area is controlled by the expected ammonia removal rates.

8.0 WHAT WILL THE LAND APPLICATION (SPRAY IRRIGATION) SYSTEM LOOK LIKE?

The full-scale land application system will consist of the following major components:

- A wastewater pump and pipe delivery system;
- The spray irrigation piping network, control valves and the irrigation sprinklers; and
- Performance monitoring wells (lysimeters).

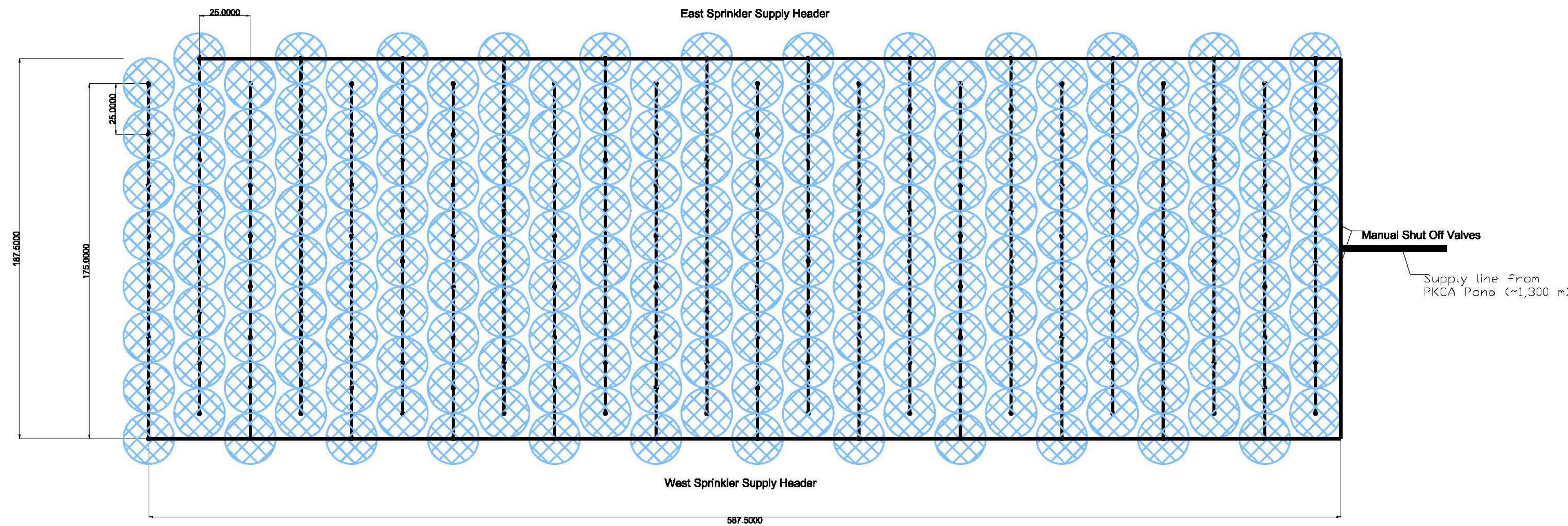
The wastewater pump and delivery system will consist of a floating barge mounted vertical pump installed in the PKCA pond capable of delivering 75 m^3/hr to the proposed land application area. The pump will be electrically operated and designed to run 24 hours per day over a 100-day period in June through September. The pump would be tied to an electrical timer that would allow the delivery system to be automatically turned on and off based on a pre-determined irrigation cycle (nominally a 3 hour on – 3 hour off cycle). A check valve will be installed to prevent the pump loosing its prime through the alternating pumping cycles. A flow meter and totallizer will be installed on the discharge pipeline from the delivery pump to measure and record the total volume of wastewater delivered to the spray irrigation system.

The pump and barge would be removed at the end of each operating season and placed in storage until the start of the following operating season. An HDPE pipeline would deliver the wastewater to the proposed land application area, a distance of approximately 1.3 km. The pipeline would be laid across the tundra. At the end of each operating season the pipeline would be drained by breaking the line at flanged connections allowing the solution to drain onto the surrounding tundra. At the beginning of each season the pipeline would be reconnected and then joined to the delivery pumping system.

The required land application area is 105,000 square meters. The actual layout of the land application area would be field fitted but would generally consist of an area approximately 600 m in length by 175 m in width.

The spray irrigation system at the land application area would consist of two main delivery headers (each approximately 600 m in length). From the delivery pipeline, one header would wye off and run along the east side of the land application area, while the second header wyes off to run along the west side of the land application header. From each of the two headers, parallel spray pipes would tee off from the header and run towards the opposite header pipe (see layout in Figure 8.1). Each of the parallel lines would be approximately 175 m in length. The spacing between the parallel spray pipes would be set by the diameter of the circular spray pattern from the irrigation nozzles, adjusted so that the wetted spray patterns just overlapped. The spacing between the parallel spray lines would be set so that two lines come off the west header and go completely across the land application area, followed by the next two lines coming off the east header. Along each parallel spray pipe, nozzles would be set into the pipeline with the distance between nozzles set by the diameter of the circular spray pattern, adjusted so that the wetted spray patterns just overlap. A shutoff valve would be installed at the head end of both the east and west header pipe allowing each header to be shut off. Typically, the positions of these valves would be left open however this system could be used to allow alternating cycles of dry and wet over the full land application area as an alternative to the timer on the pump.

The design envisions use of conventional Rainbird style sprinkler heads operating at a delivery pressure of around 100 psi. They would be set to operate in a circular wetted spray pattern with a diameter of approximately 25 meters. Consequently, the parallel spray pipelines would be set at intervals of 25 meters with a spacing between spray nozzles of 25 meters. The total number of parallel spray lines would be 25, 13 from the west header, and 12 from the east header. The total number of sprinkler nozzles would be 175, each set at a nominal spacing of 25 meters along the parallel spray lines.



Legend:

- Supply Header
- Sprinkler Line
- Sprinkler Head
- Spray Area
- Manual Shut Off Valve

Total Wetted Area is approximately 115,000 square metres (612.5 mx 187.5 m)

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Jericho Project - Contingent Water Treatment Land Application System

Schematic Layout of Proposed Full Scale Spray Irrigation System

DATE:	JULY 2004
PROJECT NO:	VE51295-600
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FIGURE No.	FIGURE 8.1

Total piping requirements will be as follows:

Main Delivery Pipeline:	1,300 m
East and West Header Pipes:	1,200 m
25 Parallel Spray Pipelines:	4,375 m
Spray Nozzles:	175

9.0 HOW WILL THE PERFORMANCE OF THE LAND APPLICATION SYSTEM BE MONITORED?

Monitoring of the performance of the land application system will consist of two forms:

- Operational Monitoring; and
- Environmental Monitoring.

The operational monitoring will consist of the following elements:

- The operation of the PKCA barge mounted delivery pump will be monitored through a link to the process plant control room, allowing monitoring of the alternating pump cycle through the plant's digital control system and allowing the flow rate pumped to the system to be monitored.
- Once per 12-hour shift during the operating season, an operator will travel to the land application area to inspect the operation of the spray nozzles and adjust header pressure as required and to inspect the delivery pipeline and PKCA barge pump. The operator will also look for evidence of channeling, surface flow, erosion resulting from saturation of the underlying ground and take appropriate action to turn off one or both headers to allow the ground to rest until infiltration, evaporation and evapotranspiration have caught up. Typically, some maintenance of spray nozzles will be required on a daily basis (plugging with dirt and other debris).
- Once per day the flow meter totallizer reading will be recorded.

The environmental monitoring will consist of the following elements:

- Water sampling – the following points will be sampled weekly and submitted for analysis of pH, alkalinity, conductivity, Nutrients (Total Ammonia-N, Nitrate-N and Nitrite-N), ortho-Phosphorous and metals (including Cu, Ni, and U):
    - The PKCA pond (the source wastewater);
    - One upstream shallow groundwater well (or suction lysimeter) to measure groundwater quality up gradient of the land application area;

  - Two shallow groundwater wells (or suction lysimeters) installed within the land application area to measure groundwater quality under the land application area;
  - Two shallow groundwater wells (or suction lysimeters) immediately down gradient of the land application area; and
  - One sample point within Lake C3.
- Soil Sampling – Bi-monthly soil sampling at 4 field sites within the land application area and 1 control point outside the land application area, with each sample being analyzed for pH, conductivity, chemistry (N & P, cations, metals, including Cu, Ni, U), temperature profile at depth and populations of nitrifying and denitrifying bacteria;
- Annual plant survey at 4 permanent field plots within the land application area and 1 control plot outside the land application area with a determination of the plant community composition, density and health within the test plot area and analysis of plant tissue for Nitrogen compounds, Phosphorous, metals (including Cu, Ni and U), chlorophyll content in leaves, and ash content;
- Annual small mammal survey of both irrigated and non-irrigated land. Suggest using a species such as red back voles (*Clethrionomys gapperi*) as red voles are widely prevalent, easy to trap and are browsers like caribou, although they do have a different diet; and
- Fish tissue sampling in Lake C3 every 5 years with fish tissue analyzed for tissue metal concentrations [Fish tissue will be sampled every 5 years as part of the AEMP; the fish populations in Lake C3 and Carat Lake cannot sustain sampling at a shorter frequency].

The proposed sampling program will be adaptive and will be adjusted in frequency or type of monitoring to adjust to the operation and performance of the spray irrigation system and the variability in measured water chemistry.

The spray irrigation or land application area may have to be adjusted (increased in size or moved) as a consequence of:

- Breakthrough of Ammonia-N or other nitrogen compounds into Lake C3;
- Evidence of surface channeling, ponding;
- Signs of impaired plant health (though not changes in plant species composition);
- Salt build-up in soil; and
- Significant change in depth of active layer.

The spray irrigation system is inherently flexible and allows for easy and rapid redeployment of pumps, lines, and spray nozzles.

10.0 WHEN WILL TAHERA CARRY OUT A FIELD TRIAL OF THE PROPOSED LAND APPLICATION SYSTEM? HOW WILL THIS FIELD TRIAL BE CONDUCTED?

Tahera is committed to carrying out a demonstration field trial of the proposed land application system early in the mine life to verify the projected performance predictions and design parameters used to size the spray irrigation system. The proposed field trial would be constructed and operated at 10% of the full-scale system. In other words the field trial would involve land application over an area of approximately 1.4 hectares (14,900 m^2) at an average application rate of approximately 1,000 m^3 per day.

During the first full year of mine operations it is projected that water quality within the PKCA will not likely be very representative of later conditions. The water quality is likely to be better than the projections used to design the spray irrigation system as the initial water within the PKCA pond will dilute first year inputs from the process plant, open pit and waste dumps. In addition the waste dumps will be new and unlikely to be generating seepage containing levels of ammonia characteristic of that expected later in the mine life. Testing the land application system under these early drainage conditions is not likely to provide useful data representative of the design conditions.

Consequently Tahera proposes that this field trial not be conducted before the second summer of full operations to ensure that the system is tested under more representative conditions. In this way the data obtained is likely to be more representative of expected site drainage conditions.

The field trial would be set up and monitored to obtain sufficient data to verify the following design and operating parameters:

- Field estimation of evaporation rates through the spray irrigation system. This will be difficult to measure because of the difficulty in accurately determining the amount of groundwater exiting the area. However, by measuring the volume of wastewater land applied, the actual site precipitation and pan evaporation during the field trial, and groundwater flow rates upstream and downstream of the field trial through groundwater monitoring wells an estimate of evaporation will be made.
- Actual contaminant removal rates in the field trial area of both the contaminants used to size the land application area (Total Ammonia-N, Total Cu and Ni) and of other nutrients and metals of concern at the Jericho Project site. These removal rates will be estimated by monitoring the loadings applied to the land application area (i.e., by regular measurement of the volumes of wastewater applied and sampling and assaying of the wastewater quality to determine the concentrations of contaminants land applied) and by measuring the concentration of the same parameters in the shallow groundwater down gradient of the land application area through the use of shallow wells and lysimeters. Shallow groundwater wells and suction lysimeters will be installed both up gradient and down gradient of the field trial area but in close proximity given the lag time involved in

groundwater movement through soils. Shallow suction lysimeters will also be used to obtain groundwater samples from within the field trial area.

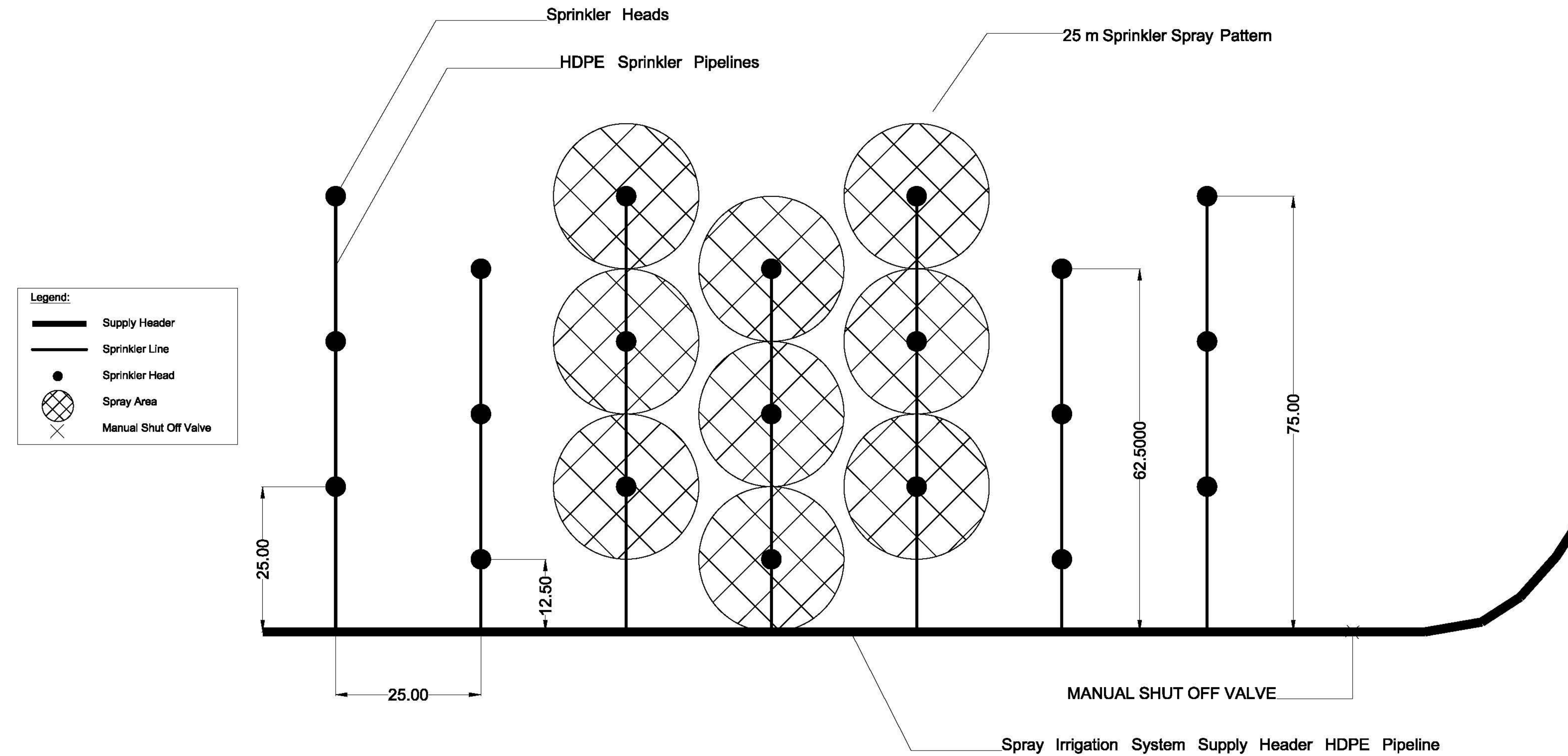
The field trial will consist of one main HDPE pipe header of 150 m in length. From this header seven parallel spray lines will be teed off, with four of the headers being 75 m in length with the alternating three headers being 62.5 m in length. Spray nozzles would be placed at distances of 25 m, 50 and 75 m along the four 75 m long spray lines and at distances of 12.5, 37.5, and 62.5 m along the alternating 62.5 m long spray lines (see layout in Figure 10.1).

A submersible pump would be installed in the PKCA pond to deliver 2,000 m^3 per day (1,000 m^3 per day at an operating factor of 50%) through a 1.3 km pipeline to the field trial location. The trial would be operated for 100 days. The pump would be set up on a timer to operate on a nominal 3 hour on – 3 hour off cycle. The flow to the land application field trial would be measured using a flow meter and totallizer.

Monitoring during the field trial would be similar to that previously described for the full-scale land application system, specifically consisting of the following elements:

The operational monitoring will consist of the following elements:

- The operation of the PKCA submersible pump will be monitored through a link to the process plant control room, allowing monitoring of the alternating pump cycle through the plant’s digital control system and allowing the flow rate pumped to the system to be monitored.
- Once per 12-hour shift during the field trial, an operator will travel to the land application area to inspect the operation of the spray nozzles and adjust header pressure as required and to inspect the delivery pipeline and PKCA pump. The operator will also look for evidence of channelling, surface flow, erosion resulting from saturation of the underlying ground and take appropriate action to turn off the system to allow the ground to rest until infiltration, evaporation and evapotranspiration have caught up. Typically, some maintenance of spray nozzles will be required on a daily basis (plugging with dirt and other debris).
- Once per day the flow meter totallizer reading will be recorded.



Total Wetted Area is approximately 15,000 square metres (87.5 m x 175 m)

amec	AMEC Earth & Environmental 2227 Douglas Road Burnaby, B.C. V5C 5A9 Tel. 294-3811 Fax. 294-4664	DWN BY: TAC CHK'D BY: LC APP. LC	Jericho Project - Contingent Water Treatment Land Application System Schematic Layout of Proposed Pilot Scale Spray Irrigation System	DATE: JULY, 2004 PROJECT NO: VE51295-600 REV. NO.: -
Client	TEHARA CORPORATION	SCALE AS SHOWN		FIGURE No. FIGURE 10.1

The environmental monitoring will consist of the following elements:

- Water sampling – the following points will be sampled weekly and submitted for analysis of pH, alkalinity, conductivity, Nutrients (Total Ammonia-N, Nitrate-N and Nitrite-N), ortho-Phosphorous and metals (including Cu, Ni, and U):
    - The PKCA pond (the source wastewater);
    - One upstream shallow groundwater well (or suction lysimeter) to measure groundwater quality up gradient of the land applications area;
    - Two shallow groundwater wells (or suction lysimeters) installed within the land application area to measure groundwater quality under the land application area;
    - Two shallow groundwater wells (or suction lysimeters) immediately down gradient of the land application area; and
    - One sample point within Lake C3.
- Soil Sampling – Bi-monthly soil sampling at 4 field sites within the land application area and 1 control point outside the land application area, with each sample being analyzed for soil OM, pH, conductivity, chemistry (N & P, cations, metals, including Cu, Ni, U), temperature profile at depth and populations of nitrifying and denitrifying bacteria;
- Annual plant survey at 4 permanent field plots within the land application area and 1 control plot outside the land application area with a determination of the plant community composition, density and health within the test plot area and analysis of plant tissue for Nitrogen compounds, Phosphorous, metals (including Cu, Ni and U), chlorophyll content in leaves, and ash content;
- Annual small mammal survey of both irrigated and non-irrigated land, suggest using a species such as red back voles or suitable alternative as red back voles are widely prevalent, easy to trap and are browsers like caribou, although they do have a different diet; and
- Periodic fish tissue sampling in Lake C3 with fish tissue analyzed for tissue metal concentrations (once per 5 years as laid out in the AEMP).