McCollum Park File

FINAL CLEANUP ACTION PLAN
McCOLLUM PARK/EMANDER LANDFILL
SNOHOMISH COUNTY, WASHINGTON

Prepared for:

Washington Department of Ecology
Toxic Cleanup Program
3190 160th Avenue S.E.
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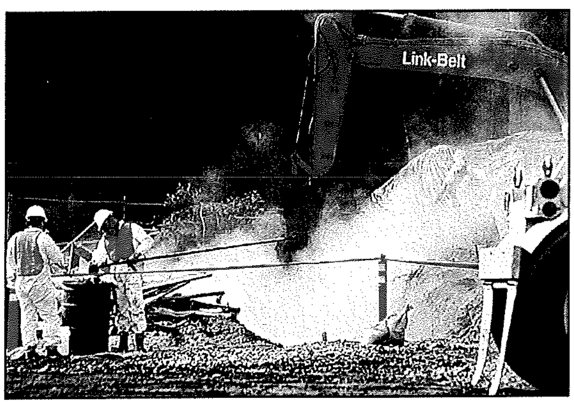

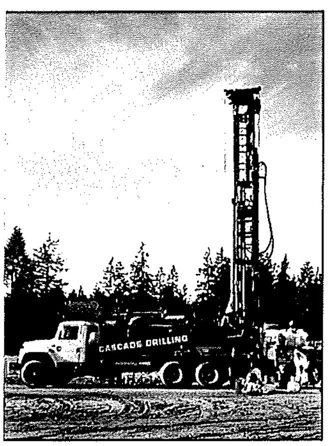

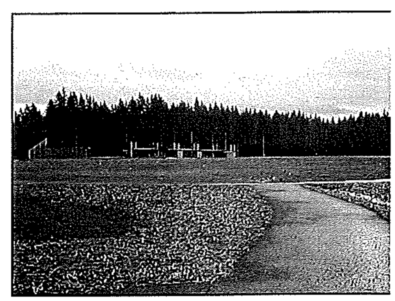

April 1996

AGI Project No. 15,512.279

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AGI TECHNOLOGIES

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LIST OF ACRONYMS

AGI	AGI Technologies
ARAR	applicable or relevant and appropriate requirement
ASIL	Acceptable Source Impact Level
BETX	benzene, ethylbenzene, toluene, and total xylenes
CAP	Cleanup Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/s	centimeters per second
COC	chemicals of concern
COPC	chemicals of potential concern
County	Snohomish County Public Works
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
GRA	General Response Action
HCR	hydrocarbon-contaminated refuse
HDPE	high-density polyethylene
landfill	McCollum Park/Emander Landfill
μg/L	micrograms per liter
mg/kg	milligrams per kilogram
MTCA	Model Toxics Control Act
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PQL	practical quantitation limit
psi	pounds per square inch
QA	quality assurance
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objectives
RI/FS	Remedial Investigation/Feasibility Study
S/S	solidification/stabilization
SHD	Snohomish Health District
SVOC	semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TPH	total petroleum hydrocarbons
VOC	volatile organic compound
UCS	unconfined compressive strength
WAC	Washington Administrative Code
WSU	Washington State University

CLEANUP ACTION PLAN

1.0 INTRODUCTION

This Cleanup Action Plan (CAP) presents the selected cleanup actions for the McCollum Park/Emander Landfill (landfill) in Snohomish County, Washington. This document was prepared by AGI Technologies (AGI) and reviewed by Washington Department of Ecology (Ecology). These cleanup actions incorporate the U.S. Environmental Protection Agency's (EPA) Presumptive Remedy for CERCLA Municipal Landfill Sites (Presumptive Remedy) (Directive No. 9355.0-49FS, EPA 540-F-93-035, September 1993), and are based on the results of AGI's Remedial Investigation/Feasibility Study (RI/FS). AGI performed the RI/FS on behalf of Snohomish County Public Works (County) in accordance with MTCA Remedial Investigation/Feasibility Study (RI/FS) requirements.

The RI evaluated the nature, extent, and potential for migration of landfill-related contaminants through data collection and analysis. The RI results were used to assess current or potential future risks posed by landfill-related contaminants to human health and the environment. Cleanup levels for contaminants of concern were calculated. This information was used in the FS to evaluate potential cleanup action alternatives for the landfill, including those specified as part of the Presumptive Remedy.

The CAP summarizes preferred cleanup methods, including cleanup design and compliance monitoring of cleanup actions. The CAP follows the Washington State Model Toxics Control Act (MTCA) regulations (Washington Administrative Code [WAC] 173-340) for cleanup actions, WAC 173-340-400. Applicable portions of the regulation are addressed in this document and/or the following documents, incorporated by reference:

- *Draft Final Report, Remedial Investigation, McCollum Park and Former Emander Landfill;* AGI Technologies, January 1996.
- *Draft Final Report, Feasibility Study, McCollum Park and Emander Landfill;* AGI Technologies, February 1996.
- *Work Plan, McCollum Park;* AGI Technologies, October 13, 1995.
- *McCollum Park Air Sampling;* AGI Technologies, December 19, 1994.
- *Hydrocarbon-Contaminated Refuse, Dangerous Waste Designation, McCollum Park;* AGI Technologies, August 10, 1995.
- *McCollum Park Sludge Assessment;* AGI Technologies, February 10, 1995.
- 128th St. S.E./Dumas Road Park & Ride, C.R.P. #91-951, T.I.B. #9P-031 (004)-2, McCollum Park Redevelopment - Phase 2, Northwest Streams Center, C.R.P. #94-411; Perteet Engineering, Inc.

The above-referenced documents do not represent all documents prepared for this site, only those required by WAC 173-340-400.

2.0 BACKGROUND

This section summarizes background information pertinent to the proposed cleanup action.

2.1 NATURE OF THE PROBLEM

The County is currently improving McCollum Park as part of the County's Master Plan implementation. An Environmental Impact Statement (EIS), issued in April 1993, identified potential environmental impacts from landfill gas and landfill contents encountered in the landfill during previous environmental investigations. The EIS established mitigation measures, including additional fill soil over the landfill, a partial synthetic cover, a limited landfill gas management system, and long-term groundwater monitoring.

A wet, sludge-like material (sludge) rose to ground surface in November 1994 during fill placement and grading near the middle of the landfill. Chemical analysis of the sludge revealed elevated concentrations of petroleum hydrocarbons, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and metals. In April and June 1995, sludge emerged at two additional locations near the first emergence.

The Washington State Department of Ecology (Ecology) completed a Site Hazard Assessment in January 1995 and placed the landfill on the Washington State Hazardous Sites List. The County originally undertook the RI/FS as an independent cleanup action. In April 1995, the County entered into negotiations with Ecology for an Agreed Order. While negotiations proceeded, the County and Ecology entered into a Prepayment Agreement. This allowed Ecology to review and comment regarding the ongoing remedial investigation. This was done for two reasons: to allow park construction to proceed on schedule, and to ensure the independent action taken by the County was in concurrence with the Order being negotiated.

Revised draft reports of the RI and FS were issued in November and October, 1995, respectively, after Ecology's review of the first draft reports. The County Executive signed the Agreed Order on October 25, 1995.

2.2 STUDY AREA LOCATION AND DESCRIPTION

McCollum Park is located approximately 1/2 mile east of Interstate 5 on 128th Street SE in Snohomish County, Washington. **Figure 1** shows the park location. The Emander Landfill (landfill) comprises most of the northern half of the 78-acre park. The landfill extends beneath 128th Street SE to the north, across Dumas Road to the east, and is bordered by North Creek to the west and wooded parkland to the south. The RI considered the landfill and a larger "study area," which encompassed the Park, portions of the landfill that extend into public right-of-way, areas in which groundwater and surface water monitoring stations have been installed, residences along Heatherwood Drive (located south of the landfill), and a trailer park located north of the landfill across 128th Street SE. McCollum Park and the study area are shown on **Figure 2.**

As of February 1995 (prior to the 1995 construction season), surface elevations varied across the landfill from approximately 383 to 405 feet above Mean Sea Level. The ground surface currently slopes gently downward from the northern portion of the landfill to the east, west, and south. Most of the landfill surface was stripped of vegetation and partially filled/graded in preparation for McCollum Park Master Plan improvements. A swimming pool, park ranger's residence, maintenance buildings, and parking lot are located near the landfill's western edge, and a newly realigned segment of Dumas Road crosses the landfill's eastern portion. Two County Parks and Recreation buildings leased by Washington State University (WSU) Extension Services are located immediately southeast of the landfill.

Principal study area surface water features include: North Creek and its tributaries; a pond on the golf driving range (driving range pond) north of the landfill; a seep on the adjacent property south of the landfill (seep); and stormwater retention ponds east and south of the landfill. Study Area surface water features are shown on **Figure 3.**

Light residential development borders the park to the east, west, and south, and the golf driving range is located to the north. Several trailer homes are located across 128th Street SE, northeast of McCollum Park.

North Creek provides spawning and rearing habitat for numerous resident and anadromous fish species (fish that ascend rivers from the sea to breed); however, the number of anadromous fish using the creek has declined considerably over the past two decades and the creek habitat within McCollum Park is typically limited by low flows during the summer.

The Silver Lake and Alderwood Water Districts serve McCollum Park and most of the surrounding area. Six residences on Heatherwood Drive, south of the landfill, are supplied drinking water by domestic wells (see **Figure 2**).

2.3 SITE HISTORY AND CONTAMINANT SOURCES

The landfill occupies property acquired by the County beginning in 1922. Gravel mining operations commenced in 1929. The gravel pit was used by the County for refuse disposal from about 1947 to 1967, and was known as the Emander Landfill during and following landfill operations. Landfilling operations were substantially completed by 1967, and a soil cover was installed. The site was subsequently turned over to the Snohomish County Parks and Recreation Department for development as McCollum Park.

Little documentation is available regarding disposal operations at the landfill; however, pre-RI investigations and AGI's 1995 RI encountered refuse typical of municipal solid waste landfills, including glass, plastic, paper, wood, metal, and concrete demolition debris. This refuse is mixed with soil in varying percentages throughout the landfill, and contains petroleum hydrocarbons in several areas. Former truck drivers indicate fuel storage tank bottoms were disposed of at the approximate location where the sludge was encountered. In addition, anecdotal information suggests septic tank contents and ship bilge water were also disposed of at the landfill.

Several landfill gas vents/flares were installed in the 1970s and 1980s to mitigate landfill gas generation. Environmental and geotechnical investigations undertaken by the County as a part of the Master Plan between 1985 and January 20, 1995 (pre-RI investigations) identified the extent and thickness of landfill contents, and assessed the landfill's impacts on groundwater, surface water, and air quality. The results of these pre-RI investigations are summarized as follows:

- *Landfill Contents*: Refuse thickness ranged from approximately 3 to 19 feet. Prior to the 1995 construction season, refuse was overlain by a 1- to 6-foot soil cover (the cover was mixed with minor amounts of domestic refuse in the southern portion of the landfill). Refuse within parts of the landfill was found to be impacted with petroleum hydrocarbons. Black, sludge-like liquid was encountered in the landfill's south-central portion. Landfill sludge samples revealed concentrations of volatile and semivolatile organic compounds (VOC, SVOC) ranging from 2.3 to 690 milligrams per kilogram (mg/kg), metals ranging from 4.4 to 6,800 mg/kg, and petroleum hydrocarbons ranging from 580 mg/kg (gasoline) to 230,000 mg/kg (oil).

- *Groundwater*: VOCs and metals were detected in groundwater. Groundwater sampled from monitoring wells downgradient of the landfill exceeded state groundwater quality standards (WAC 173-200) and/or MTCA Method A cleanup levels for benzene, vinyl chloride, 1,2-dichloroethane, trichloroethene, arsenic, chromium, and lead.

- *Surface Water*: North Creek water samples were analyzed for various water quality parameters as part of a larger study of surface water quality in southern Snohomish County. Results indicated exceedances of several ambient water quality criteria; however, these exceedances were not attributed to landfill impacts.

- *Air Quality*: VOCs were detected in soil gas samples; concentrations were below state Acceptable Source Impact Levels (ASIL) for all compounds. ASILs for benzene, ethylbenzene, toluene, and xylenes (BETX), TPH diesel and hydrogen sulfide were exceeded in an air sample collected directly above exposed sludge.

3.0 REMEDIAL INVESTIGATION RESULTS

3.1 SITE GEOLOGY AND HYDROGEOLOGY

The landfill is located on the Intercity Plateau of the Puget Lowland, a north-south-trending structural and topographic depression bordered on the west by the Olympic Mountains and on the east by the Cascade Mountains. The lowland is underlain by Tertiary volcanic and sedimentary bedrock and is filled to the present-day land surface with Quaternary glacial and nonglacial sediments. Depth to bedrock in the study area is approximately 300 feet.

Geologic and hydrogeologic conditions in the study area were investigated during the RI by drilling 39 borings and excavating 18 test pits within the landfill, and installing 13 new groundwater monitoring wells outside the landfill (see **Figures 4 and 5**). The thirteen new wells (three shallow, one intermediate, and nine deep) augment five shallow wells installed outside the landfill during a pre-RI investigation.

Drilling data, stratigraphic correlations between boreholes, and review of pertinent geologic literature identified three geologically distinct deposits near or underlying the landfill:

Advance Outwash occurs at land surface except in the landfill and other filled areas. Advance Outwash is typically a very dense sandy gravel with a varying silt content, occasional cobbles, and sand lenses; thin surficial lenses of silty sand were noted bordering North Creek. Advance Outwash thickness ranges from approximately 13 to 65 feet, tending to thicken to the north and east

Esperance Sand underlies Advance Outwash. Esperance Sand is a dense to very dense, fine-grained sand with occasional gravel lenses and thin silt interbeds. The Esperance Sand ranges in thickness from approximately 47 to 89 feet.

Lawton Clay underlies Esperance Sand. Lawton Clay consists of a laminated, hard, brown, brittle silt. The unit was not fully penetrated during RI drilling and the thickness was not determined.

Figure 6 shows a hydrogeologic cross section of the landfill; **Figure 5** shows the location of the cross section.

A single aquifer, occurring in the Advance Outwash and Esperance Sand, was identified during drilling of the RI deep monitoring wells and review of available domestic water supply well logs for residences along Heatherwood Drive. For purposes of the RI, this aquifer was termed the Outwash Aquifer. Outwash Aquifer groundwater occurs under water table (unconfined) conditions. The base of the landfill intersects the water table in some locations. In March 1995, depth to groundwater in monitoring wells ranged from approximately 2 to 24 feet; aquifer saturated thickness ranged from approximately 90 to 98 feet.

The Outwash Aquifer comprises two portions, upper and lower, based on lithologic differences and differing groundwater flow regimes. Recharge to the aquifer, in both the upper and lower portions, occurs primarily by direct infiltration of precipitation and lateral groundwater flow from the north.

Most precipitation occurs between October and April. During the dry season (May through September), the reach of North Creek adjacent to the landfill and north of 128th Street SE dries out and groundwater discharge south of the WSU Extension buildings forms the creek's extreme northern headwaters. The lower portion of the aquifer is not influenced by North Creek.

Groundwater flow beneath the landfill, in both the upper and lower portions of the aquifer, is predominantly to the south with a small western component (see **Figures 7 and 8**). The groundwater recharge area for the Heatherwood Drive domestic water supply wells is east of the landfill and northeast of Heatherwood Drive. The primary component of groundwater discharge from the study area is by lateral flow toward the south. Less significant groundwater discharge pathways include evapotranspiration in the forested wetland south of the landfill during the summer months and vertical leakage through the Lawton Clay. Groundwater discharge to surface water will be discussed below.

Outwash Aquifer horizontal hydraulic conductivity estimates range from $1x10^{-4}$ to $1x10^{-2}$ centimeters per second (cm/s) for the upper portion of the aquifer, and $1x10^{-3}$ to $1x10^{-2}$ cm/s for the lower portion. Vertical gradients within the aquifer are very low, indicating primarily horizontal flow through the aquifer. Estimated horizontal flow velocities range from 1.7 to 72 feet per year.

North Creek is the primary surface water feature in the Study Area. The McGill Street retention pond, located about 2.5 miles north of the landfill, comprises North Creek's headwaters. During the wet season, this retention basin and others upstream of the landfill are replenished by precipitation and provide the reach of North Creek adjacent to the landfill with a base flow on the order of one to two cubic feet per second. As these upstream retention basins drain in the late spring and summer, North Creek is typically dry (the exception being storm events) along the reach north of the WSU Extension buildings. Along the reach south of the WSU Extension buildings, the aquifer discharges to North Creek. This groundwater discharge forms the extreme headwaters of North Creek during the dry season. Groundwater downgradient of the landfill also discharges at a seep on the property adjacent to McCollum Park.

3.2 NATURE AND EXTENT OF CONTAMINATION

The RI evaluated the nature and extent of landfill sludge and potential landfill-related impacts to groundwater, surface water, and sediment.

3.2.1 Landfill Sludge and Hydrocarbon-Contaminated Refuse

The landfill was investigated with borings and test pits as shown on **Figure 4**. Sludge samples and hydrocarbon-contaminated refuse (HCR) samples were analyzed for VOCs, SVOCs (including PAHs), organochlorine pesticides and polychlorinated biphenyls (PCB), metals, and petroleum hydrocarbons.

Two classes of VOCs (BETX and chlorinated hydrocarbons) were detected in sludge and refuse samples. BETX compounds were more prevalent, with higher concentrations occurring in sludge than in HCR. Several SVOCs, including a variety of PAHs, were detected in sludge and refuse samples; concentrations were higher in sludge than in HCR. A single PCB compound was detected in two HCR samples collected in the base of a stormwater pond excavation in the southern portion of the landfill. No PCBs were detected in sludge. Various organochlorine pesticides were detected in several sludge and HCR samples at concentrations <1 mg/kg. Elevated trace metal concentrations (arsenic, barium, copper, lead, and zinc) were detected in sludge and HCR samples, generally at higher concentrations in sludge. Detected fuel hydrocarbons extended from gasoline to heavier oils, with widely varying concentrations (4,700 to 160,000 mg/kg).

The total volume of sludge is approximately 4,100 cubic yards. HCR overlies and surrounds the sludge. Deeper portions of the sludge are below the water table year-round; HCR encountered during the RI was above the water table. Cross sections through the sludge emergences are shown on **Figures 10** and **11**; cross section locations are shown on **Figure 9**.

3.2.2 *Groundwater*

Two rounds of groundwater samples (February and March 1995) were collected from eight shallow monitoring wells completed in the upper portion of the aquifer and five deep wells completed in the lower portion of the aquifer. The RI also incorporated Snohomish Health District (SHD) groundwater sampling data from two residential supply wells on Heatherwood Drive. For the third groundwater sampling round (August 1995), four deep monitoring wells, one intermediate monitoring well, and one Heatherwood Drive residential supply well were sampled in addition to the wells sampled in the first and second rounds. Monitoring well samples were analyzed for VOCs, SVOCs (including PAHs), PCBs, metals, fuel hydrocarbons, and general water quality parameters. Pre-RI residential well samples were analyzed for VOCs, SVOCs, and metals by SHD; in the third round the residential well was sampled and analyzed using the same methods as the monitoring wells.

Shallow Well Results : Various fuel-related and chlorinated VOCs were detected, primarily in wells downgradient of the landfill (BH-5, -6, -7, and MW9). Concentrations ranged from 0.2 μg/L (various compounds) to 5.8 μg/L (chlorobenzene). Bis(2-ethylhexyl)phthalate was detected at 5.0 and 9.0 ug/L in BH-7 in Rounds 1 and 2 only; trace levels of the PAHs acenaphthylene, fluorene, or both were detected in BH-5, -6, and -7. No PCBs were detected. Eighteen metals were detected; downgradient (BH-5, BH-6, BH-7, and/or MW9) concentrations of arsenic, barium, chromium, manganese, and nickel were significantly elevated compared to their respective upgradient concentrations (BH-8 and MW10). Gasoline- and diesel-range fuel hydrocarbons were detected at concentrations near their respective detection limits in BH-5, -6, and -7 during the first sampling round, diesel range hydrocarbons were detected in BH-5 and BH-7 in Rounds 2 and 3; and gasoline range hydrocarbons were detected in BH-6 in Round 2. General water quality indicators (chloride, chemical oxygen demand [COD], ammonia, sulfate, and total organic carbon [TOC]) were generally elevated in BH-5, -6, and -7 compared to upgradient concentrations.

Deep Well Results : Vinyl chloride was detected in MW16 and MW18 (sampled in Round 3 only); concentrations ranged from 14 to 45 μg/L. No SVOCs, PAHs, or PCBs were detected. The metals detected in shallow well samples were also detected in deep well samples, generally at lower concentrations. Significant elevations of arsenic, manganese, and nickel were noted in downgradient wells (MW12, MW16, MW18, MW19, and/or MW20) when compared to upgradient wells (MW13 and MW14). Diesel- and oil-range hydrocarbons were detected at concentrations just above their respective detection limits in the first round sample from MW14; no fuel hydrocarbons were detected in second or third round samples. Downgradient water quality parameters were significantly elevated in MW18 compared to upgradient parameters.

Residential Well Results : A residential well on Heatherwood Drive was sampled during the third round of groundwater sampling (see **Figure 2**). No VOCs, SVOCs, PAHs, PCBs, or fuel hydrocarbons were detected. Copper, lead, and zinc were detected at μg/L concentrations significantly exceeding concentrations both upgradient and downgradient of the landfill. Concentrations are well within drinking water standards. It is likely these compounds are being introduced into the sample via the well casing, pump column, or distribution piping. These results are consistent with pre-RI groundwater sampling data collected by the Snohomish Health District (SHD) from this and another Heatherwood Drive residential well (see **Figure 2**).

3.2.3 *Surface Water*

Two rounds of surface water samples (February and March 1995) were collected from North Creek and two creek tributaries. **Figure 12** shows surface water sample locations. Samples were analyzed for VOCs, SVOCs, PCBs, metals, and fuel hydrocarbons. North Creek was dry during the third round (August, 1995).

No VOCs, SVOCs, or PCBs were detected. Aluminum, barium, calcium, iron, lead, magnesium, manganese, potassium, sodium, and zinc were each detected in at least one sample (lead was only detected once, near its detection limit in the second round SW4 sample). Concentrations showed no significant differences between upstream (SW1), downstream (SW3, SW5), and tributary (SW2, SW4) samples. The source of the vast majority of North Creek surface water in the Study Area is stormwater detention basins upstream or feeding tributaries.

Surface water samples were collected from the seep in March and August 1995. Elevated major cation concentrations indicate groundwater flowing from the seep is impacted by the landfill. No VOCs were detected at the seep and metals concentrations were similar to those found in shallow groundwater monitoring wells upgradient of the landfill.

3.2.4 *Sediment*

RI sediment samples were collected in March and August 1995 from North Creek, two creek tributaries, and the seep. **Figure 13** shows sediment sample locations. Samples were analyzed for SVOCs, PCBs, metals, and TOC. Micro- and macroorganisms were also evaluated.

The SVOCs benzyl alcohol, benzoic acid, carbazole, and various PAHs were detected in upstream (SD1, -8, and -9) and downstream (SD3, -5, and -6) North Creek samples. Concentrations were higher in the upstream samples. The tributary samples contained only bis(2-ethylhexyl)phthalate and fluoranthene, at concentrations lower than the North Creek samples. PCB (Aroclor 1254) was detected in downstream North Creek and seep samples at 23 to 140 μg/kg; no other PCBs were detected. Metals concentrations were generally highest in the upstream North Creek samples. The type and distribution of SVOCs/PAHs and metals indicates the source of this contamination observed in North Creek sediment is stormwater runoff draining into North Creek upstream of the Study Area. The source of PCB 1254 is likely surface water runoff during historical operations. Micro- and macroorganisms were present in North Creek and its tributaries with little difference between upstream and downstream locations.

3.2.5 *Landfill Gas*

The landfill is still actively generating landfill gas. Landfill gas samples from the site contain methane, hydrogen sulfide, and various halogenated and nonhalogenated VOCs, including benzene, trichloroethene, and vinyl chloride.

3.2.6 *Contaminant Release, Transport, and Receptors*

Three sources of groundwater contamination were identified during the RI: sludge, HCR, and domestic refuse. Contaminants from all three of these sources migrate to groundwater via the infiltration of precipitation. Sludge and domestic refuse are also beneath the groundwater in some locations, allowing contaminants to directly leach into groundwater. The landfill impacts groundwater in the upper portion of the aquifer south/southwest of the landfill; contaminants include low concentrations of VOCs (aromatic hydrocarbons and chlorinated ethenes), PAHs, fuel hydrocarbons, and metals. The lower portion of the aquifer south/southwest of the landfill generally shows less impact than the upper portion, with one exception. MW16 and MW18 contain vinyl chloride one to two orders of magnitude greater than the shallow well detections.

Surface water data do not indicate landfill impact on North Creek during the wet season. North Creek was dry and no groundwater was observed discharging to it during the third round of sampling (August 1995). Sediment data indicate landfill impact on the creek is minimal. The seep does not appear to be impacted by the landfill, and is recharged by surface water runoff from nearby roadways.

The landfill is generating landfill gas, including methane and VOCs, below state ASILs.

4.0 DEVELOPMENT OF CLEANUP LEVELS

Cleanup levels were developed using a combination of the approaches taken in EPA's Presumptive Remedy, MTCA (Methods A and B), and *Risk Assessment Guidance for Superfund* (RAGS). The Presumptive Remedy incorporates experience gained from previous Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) landfill investigations and cleanups. Presumptive Remedy components for McCollum Park include grading for surface water control, a landfill cap, a landfill gas management system, and long-term groundwater and surface water monitoring.

Development of most cleanup levels was based on the MTCA Method B criteria and initially involved compilation of available data, identification of contaminants of potential concern (COPC), and identification of primary receptors and pathways assuming implementation of the Presumptive Remedy. Chemicals of concern (COCs) were then selected from the COPCs based on potential exposure, available toxicity information, and comparison to background (upgradient or upstream) concentrations. Cleanup levels were determined for most COCs by calculating each chemical's carcinogenic risk using MTCA risk assessment guidance (WAC 173-340-708) and/or identifying its most stringent applicable or relevant and appropriate requirement (ARAR). The more stringent of these values (as applicable) was selected as the cleanup level unless the practical quantitation limit (PQL) was greater than this value, in which case the PQL was selected due to technical limitations. The cleanup level for petroleum hydrocarbons was based on MTCA Method A, as required by current Ecology policy. COC concentrations detected during the RI were then compared to cleanup levels to identify exceedances requiring cleanup actions.

5.0 FEASIBILITY STUDY

Feasibility Study tasks, as described in the following sections, included:

- Remedial technology identification and screening
- Comparative evaluation of process options
- Selecting the preferred cleanup option

5.1 REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING

Following development of cleanup levels, Remedial Action Objectives (RAOs) were developed for protection of human health and the environment based on the COCs exceeding the established cleanup levels. RAOs represent the expected result of a cleanup action with respect to human health and the environment, and help define the general types of remedial technologies that may be appropriate for the remedial action. Groundwater was the only environmental medium considered during the development of RAOs because achieving cleanup levels in groundwater would protect other media such as surface water and sediment.

General Response Actions (GRAs) were then developed that included the Presumptive Remedy plus other remedial actions necessary to achieve RAOs (e.g. institutional controls, treatment, and containment). GRAs were used to define specific remedial technologies, such as capping and groundwater treatment, which were screened based on technical implementability. Remedial technologies surviving initial screening were further evaluated using three criteria: effectiveness and permanence, implementability, and order-of-magnitude cost. Specific process options for each surviving remedial technology were then comparatively evaluated using the MTCA criteria (WAC 173-340-360).

5.2 COMPARATIVE EVALUATION OF PROCESS OPTIONS

The process options were evaluated comparatively with respect to MTCA criteria to assess their relative merits and shortcomings. Although MTCA describes cleanup requirements and technology evaluation criteria, it does not establish a specific process for evaluating and selecting process options. Consequently, some of the cleanup requirements were combined with some of the technology evaluation criteria to create process option evaluation criteria, which are listed below:

- Overall protection of human health and the environment
- Compliance with cleanup levels
- Compliance with state and federal laws
- Compliance monitoring
- Restoration time frame
- Long-term effectiveness
- Short-term effectiveness
- Reduction of toxicity, mobility, and volume
- Implementability
- Cost
- Community concerns

5.3 THE PREFERRED CLEANUP ACTION

Based on the comparative evaluation of process options, the following preferred cleanup action was selected for McCollum Park and the Emander Landfill:

- In situ sludge solidification/stabilization
- Grading and surface water controls
- Dust control and revegetation
- Impermeable landfill cap
- Active landfill gas collection and thermal treatment
- Groundwater compliance monitoring
- Groundwater use restrictions

6.0 SLUDGE SOLIDIFICATION/STABILIZATION STUDIES

6.1 INITIAL SLUDGE ASSESSMENT/TREATABILITY STUDY

AGI initially conducted a bench-scale treatability study to evaluate feasible alternatives for sludge solidification/stabilization (S/S). Sludge was characterized as containing elevated concentrations of barium, lead, and TPH, and low concentrations of SVOCs (PAHs) and VOCs. Treatability study results indicated barium, lead, TPH, and PAHs can be solidified/stabilized with cement and sand. The solidified sludge is physically competent to support planned construction and chemically stabilized such that Toxicity Characteristic Leaching Procedure (TCLP) leachate does not exceed regulatory standards.

6.2 SLUDGE SOLIDIFICATION/STABILIZATION OPTIMIZATION STUDY

AGI evaluated specific solidification reagents to optimize the volume addition and cost while maintaining a chemically stable and structurally sound material (Sludge Solidification/Stabilization Optimization Study, July 17, 1995). The optimal reagent was determined to be Type I/II Portland cement, which was added at a rate of 30 percent by weight (e.g., 30 lbs of cement was added for every 100 lbs of sludge).

7.0 CLEANUP ACTIONS

Proposed cleanup actions incorporate several Presumptive Remedy components common to landfill cleanup actions, including grading, landfill capping, gas management, and compliance monitoring. In situ solidification/stabilization of the sludge is also included.

Each individual component of the CAP is summarized in the following sections. More specific details, as outlined in WAC 173-340-400, are contained in the appended design drawings or work plans referenced in each section, and/or are referenced in additional site documents.

7.1 IN SITU SLUDGE SOLIDIFICATION/STABILIZATION

Sludge will be treated in situ using solidification/stabilization. Solidification encapsulates the sludge into a solid material of sufficient structural integrity to allow construction on top of the solidified material. Stabilization will convert the sludge contaminants into a less mobile and less leachable form. The solidification/stabilization plan is further described in **Appendix A.**

7.2 GRADING, SURFACE WATER CONTROL, DUST CONTROL, AND REVEGETATION

The landfill area surface will be graded to direct surface water runoff from the landfill surface prior to cap placement. The grading plans are included as **Appendix B**. Grading will include minor excavation and filling to reach design landfill cap grade.

Dust control will be implemented as necessary during excavation and grading. It includes wetting the work areas to minimize wind entrainment of dust generated during site activities. Dust control plans are included by reference in **Appendix B**.

Revegetation will establish vegetative growth over graded areas or areas exposed as a result of cleanup activities. Revegetation helps to mitigate surface erosion. Revegetation plans are included by reference in **Appendix B.**

7.3 IMPERMEABLE LANDFILL CAP

The landfill area will be capped to minimize stormwater infiltration and landfill leachate production. The landfill cap design is specified in **Appendix C**, and includes a leveling course, 60-mil textured high-density polyethylene (HDPE) liner, a protection/drainage soil layer, and a topsoil layer (see **Plate C1**).

7.4 ACTIVE LANDFILL GAS COLLECTION AND THERMAL TREATMENT

The landfill gas management system will consist of two separate piping systems: a perimeter system and a system covering the interior landfill area. Off-gases will exhaust to a fenced remote flare pad and will be treated by thermal oxidation before discharge to the atmosphere. Details of the gas management system are included in **Appendix D.**

7.5 COMPLIANCE MONITORING

Compliance monitoring of groundwater, surface water, and sediment will be accomplished after other cleanup actions are completed. The compliance monitoring plan is presented in **Appendix E**. Compliance monitoring is being performed to confirm the cleanup action attains cleanup standards.

7.6 GROUNDWATER USE RESTRICTIONS

Groundwater extraction within the park may cause accelerated migration of contaminants. Accordingly, the County should file a petition to restrict groundwater use within Park property. These restrictions will be periodically reviewed by Ecology. If monitoring results indicate contaminants decrease to acceptable levels, restrictions could be removed.

8.0 CONCLUSION

Compliance with this CAP and associated appendices will confirm that cleanup has been designed, constructed, and implemented in a manner consistent with accepted engineering practices and MTCA cleanup requirements and technology evaluation criteria prescribed in WAC 173-340-360.

DISTRIBUTION

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