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M E M O R A N D U M

DRAFT

March 5, 1981

TO: John Spencer

FROM: John Stetson JHS
Gerry Anderson GHA
Harry Tanaka H.T.

SUBJECT: Cathcart Landfill Special Report

Attached is the report on the Cathcart Landfill that you originally requested in your January 13 memo. While the main part of the report discusses the issues in some detail, the recommendation section summarizes results of our work in brief statements.

If you would like to discuss any of these issues or recommendations please let us know.

JS:GA:HT:sbh

Attachment

cc: Glen Fiedler, w/o attachment
Norm Glenn, w/o attachment

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NORTHWEST REGION

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CATHCART LANDFILL

SNOHOMISH COUNTY

A SPECIAL REPORT

RECEIVED
MAR 18 1981
DEPARTMENT OF ECOLOGY
NORTHWEST REGION

DRAFT

John Stetson, P.E.
Gerry Anderson, P.E.
Harry Tanaka, Geologist
March 6, 1981

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I. PURPOSE

The purpose of this report is to analyze the problems associated with the Cathcart Landfill and recommend alternative courses of action that could rectify or minimize those problems as well as prevent future problems.

II. SCOPE

The scope of this report was somewhat limited due to resource constraints. Our analysis was limited to the evaluation of existing information only and was focused mainly on water quality impacts resulting from existing conditions as well as suspected impacts from proposed plans for future stages. A brief discussion on the leachate treatment/disposal problem was also included. This investigation required discussion with the solid waste staff and the Northwest Regional Office staff of the Department of Ecology, as well as a site visit and discussions with the Snohomish County Public Works Department, and the Snohomish County Health Department.

III. PROJECT DESCRIPTION AND ANALYSIS

A. General

The Cathcart Landfill in Snohomish County is located approximately 10 miles southeast of the City of Everett (see foldout map at back of report, Appendix A), Approximately 200 acres has been dedicated to the site with about 50 acres dedicated to the actual disposal of garbage. After several years of planning and construction, the site started operation in June 1980. In late September, early October, the analysis of water samples indicated that leachate was apparently getting into the 18-inch storm water piping system. Subsequent sampling continued to give results that indicated leachate was indeed getting into the storm water piping system. This pipe was designed to carry storm water runoff generated on site as well as surfacing ground water, both of which were to be uncontaminated by leachate, underneath the landfill and out and to the existing streambed and away from the site.

B. Geology and Ground Water

The landfill site is constructed in the center of a shallow creek valley underlain by sandstone at varying depths. The glacial till overlying the sandstone is less than one foot to over 40-feet thick and generally of low permeability. In places, gravel and sandy streaks within the till provide enough permeability to conduct small amounts of water downward and laterally to form a shallow saturated zone above the impermeable sandstone. Recharge to this saturated zone is from precipitaiton within the drainage basin. Precipitation in the vicinity is about 45 inches per year, and nearly two-thirds of the yearly total occurs between late fall and winter when losses by evapotranspiration are small. Before

the landfill was constructed, the recharged water moved downgradient and eventually seeped into the drainage channel to move out of the site principally by evapotranspiration in the summer months and surface flow during the winter months.

In order to prepare a smooth-sloped surface for the landfill site, generally the east and west edges of the site were cut and the middle was filled. This changed the thickness of the material overlying the sandstone, but did not significantly change the hydraulic continuity or the original ground water flow pattern. During Phase I, perforated drain pipes (below the liner) were added to drain areas where ground water interfered with construction. Some of these drain pipes have been sealed with the result that there is no ground water outlet under the most of the Phase I area, except seepage beneath the north dike. The north dike was constructed by compacting successive layers of soil. The compaction reduced the soil permeability creating a partial barrier to ground water movement. Given enough time, the soil beneath the Phase I liner will become completely saturated because it is hydraulically connected with the ground water flow system of the drainage basin. If the liner is in tact, the hydrostatic head beneath the liner will increase until pressure is relieved by flow beneath the dike or by the water backing upgradient. If the liner is breached, the hydrostatic head will be relieved by upward flow of ground water through the breach into the leachate collecting system, and result in a much larger balance of leachate for treatment.

Because the integrity of the Phase I liner is questionable, computations based on rough but conservative information are made below to point out the magnitude of ground water inflow that could enter the landfill site, reaching the north dike beneath the liner, and eventually entering the leachate collecting system.

Ground water recharge = precipitation - (actual evapotranspiration and runoff).

1. Annual precipitation is 45 inches.

2. Actual evapotranspiration, based on 6 inches of available water capacity of soil, is about 22 inches at Monroe, WA. (U.S. Weather Bureau and Soil Conservation Service)

3. Runoff is less than 20 inches (USGS annual runoff map).

4. The drainage area south of the landfill site is 380 acres (Stevens, Thompson, and Runyan, Figure 4).

Ground water recharge = 45 - (22 + 20) = 3 inches/yr., a conservative estimate.

Ground water flow contributed by 380 acres is:

$$380 \text{ acres} \times \frac{3 \text{ ft}}{12 \text{ yr}} = \frac{95 \text{ acre ft}}{\text{yr}} \quad \text{or about 60 gpm}$$

Sixty (60) gpm is the overage inflow during the year. Significantly greater or lesser flow rates can be expected seasonally. Also, a part of the precipitation that falls directly on the landfill during its operation will infiltrate downward and be added to the leachate collection system.

Another potential source of ground water inflow into the landfill site is the channel that diverts the surface flow of the drainage basin around the west side of the site. The most likely place where channel leakage would contribute to ground water flow toward the landfill site is the southwest area where the road and channel curve to the north. Boreholes and test pits in this vicinity indicate about 10 feet of glacial till mixed with silty sand overlies the sandstone. If the bottom of the channel is above the sandstone, as it appears to be, leakage from the channel will be added to ground water and flow toward the center of the landfill site.

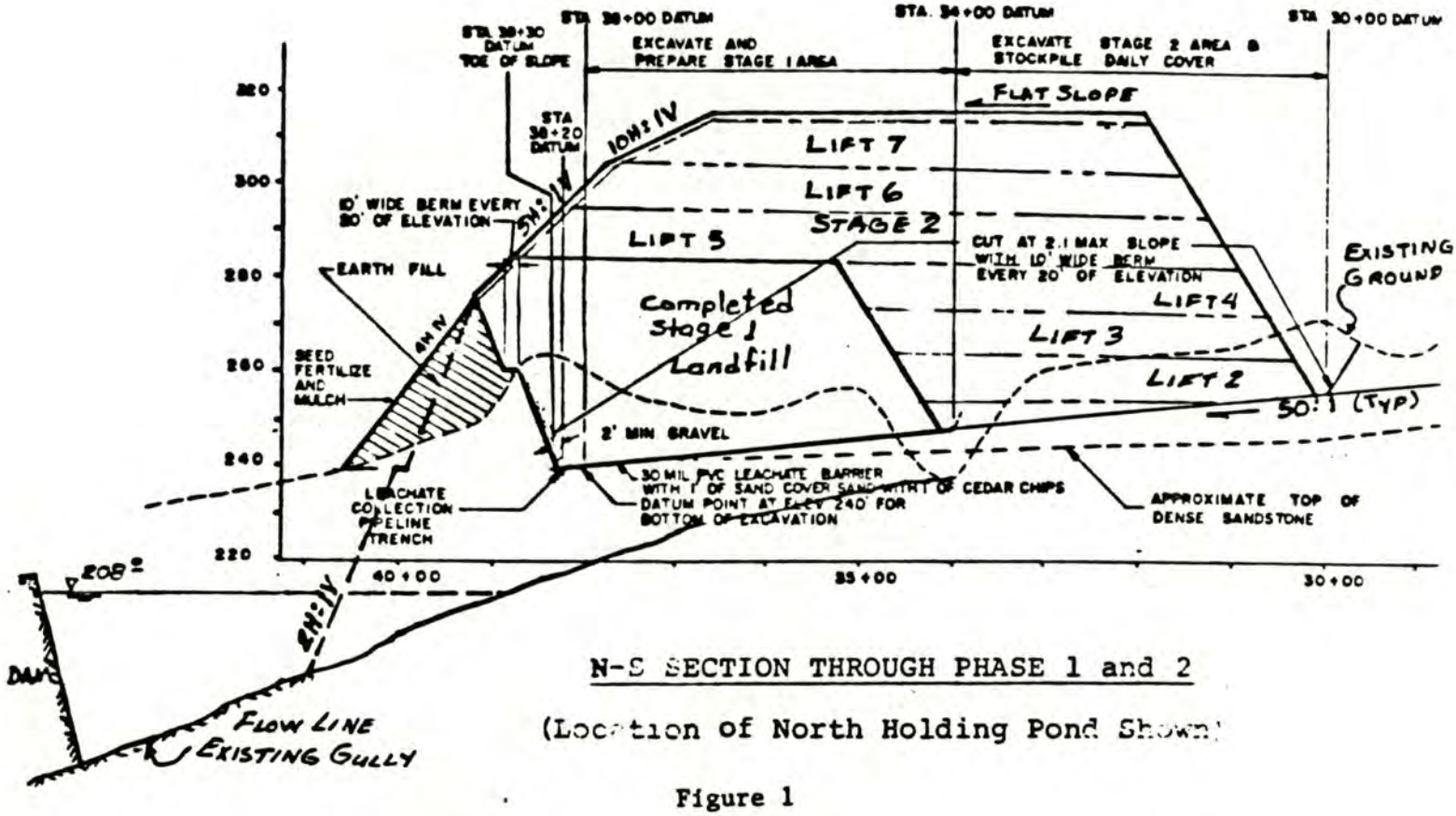
Furthermore, ground water could also enter the site down through the original water course (before diversion). The plans indicated that a cut-off trench was to be installed in the access road along the south side. However, based upon some conversations, this may not have been done. As a result, ground water may flow under this roadway section and into the site. Therefore, this potential contribution should be assessed and, if significant, some remedial actions should be taken such as installing a cut-off trench.

Ground water contamination outside of the landfill area proper has not been detected. Wells have been dry so no recent samples have been taken, but, nonetheless, it is probably too early to detect such potential contamination anyway. These wells, as well as nearby wells, should be sampled regularly. In addition, another well should be constructed in the vicinity of the road on the downstream side of the north dike down through the original stream channel bed to detect movement of leachate through this natural water passage area, to monitor the ground water head for berm stability purposes, and to sample the ground water quality for leachate detection purposes.

C. Development Plans

The overburden soils as well as some sandstone material was removed in order to carve out a flat area for the bottom of the landfill. The fill was to be constructed in several phases with Phase I (10 acres) being the northerly most phase and the one which is currently being used but rapidly approaching capacity. Phase II (7 acres) is now being developed.

This second phase consists of extending the construction (excavation, subgrade preparation, storm water, and leachate system installations, liner installations, etc.) another 400 feet to the south (see site map, Appendix B). As the landfill is continued the heighth of garbage will increase in Phase II until it reaches the final heighth of the Pase I area. At that time the landfill will be placed over the top of the Phase I area as well. See Figure 1.



N-S SECTION THROUGH PHASE 1 and 2

(Location of North Holding Pond Shown)

Figure 1

Each phase that extends the boundary in a southerly direction will be connected to the previous phase. The underdrain pipes will be joined to pass storm water from the south to the north underneath the fill, the liner and fabric will be joined and the leachate system will be connected so that when completed each of these individual systems for all the phases will act as a single system.

D. The Liner

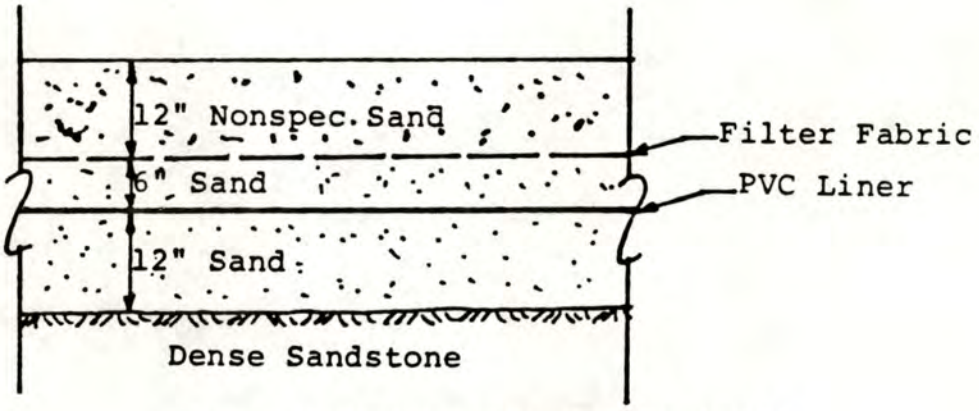
The one physical component most critical to the successful operation of this landfill or any landfill of this type, is the integrity of the liner. The purpose of the liner is to prevent water from moving from one side of it to the other. The polyvinyl chloride (PVC) liner in Phase I was not installed

as specified in the plans and specifications. The reasons are many and varied. Some relate to unanticipated site conditions, causing modifications to the plans, others result from failure of seams in the liner itself while some related to quality control problems.

To best understand how the plans for the installation of the liner evolved, one must review the soils report prepared for this project. The soils report indicated that the existing soils in the area would be adequate as a subbase for the liner (in fact, the dense sandstone was impermeable so as to impede the flow of water). The sandstone would deteriorate when exposed and graded by machine to form a smooth barrier for the liner. Therefore the contract plans showed the liner laid directly on the excavated ground.

Subgrade is one of the most important components common to all flexible liner systems. The subgrade serves as a support; therefore the quality and integrity must be assured if the liner is going to perform satisfactorily. Inadequate subgrade accounts for many of the failures of liner installations.

During construction of the excavated area for stage 1 and 2, it was determined that the sandstone should not be used as a subbase for the liner, therefore a change order was submitted to modify the liner/subbase configuration. See Figure 2.

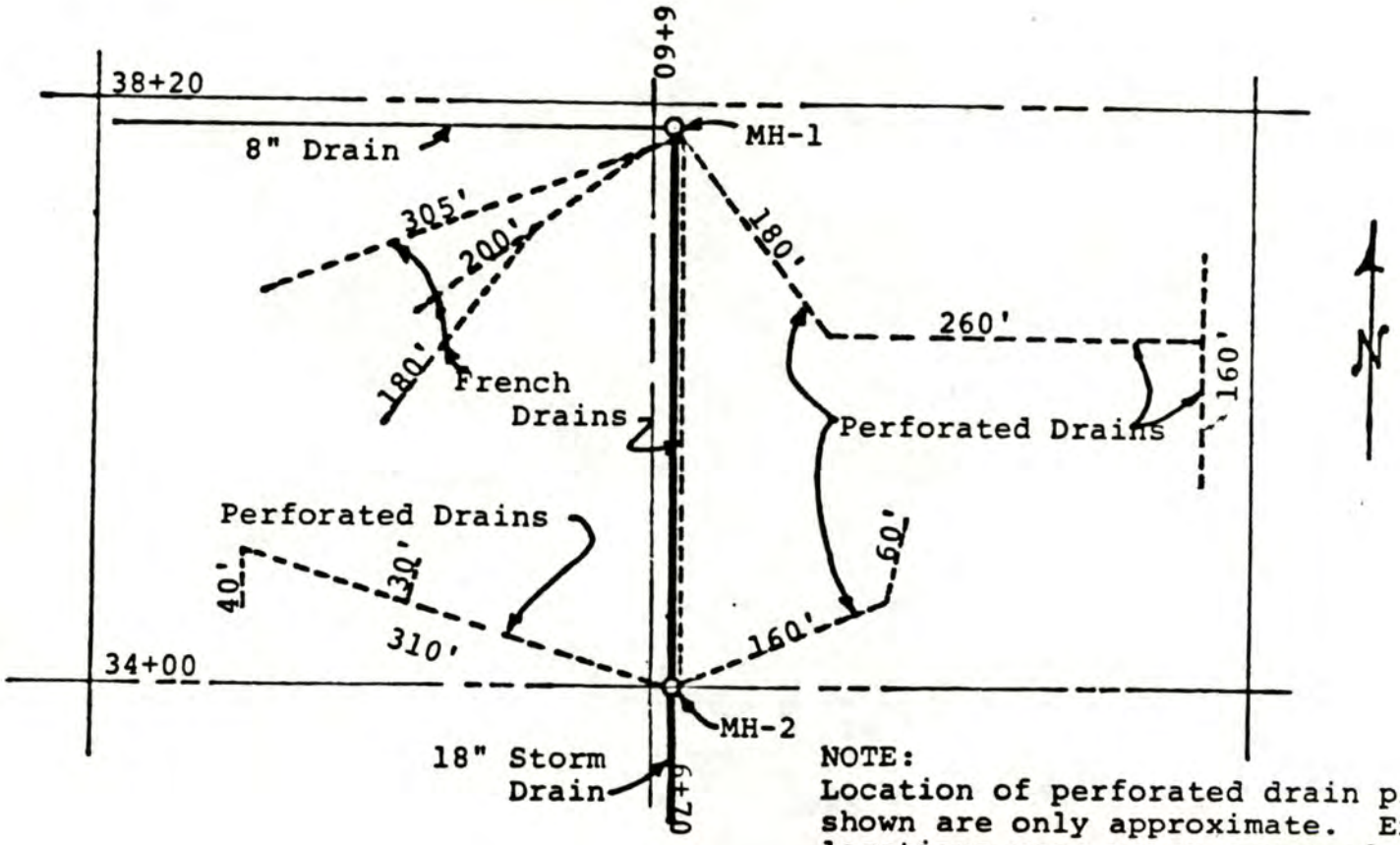


FIRST LINER-FABRIC CHANGE ORDER

Figure 2

Due to the problems with ground water and rain on the site, it was felt that sand placed under the liner would help keep the subgrade drained. The soils report showed the location of existing ground water elevation and indicated possible problems. However, the only underdrain proposed was used to convey storm water from up on the site, down through the 18-inch storm drain pipe, under the liner and off the site. Therefore, another change order was submitted to install perforated drain pipes to the wet areas and eliminate the sand layer between the PVC

liner a filter fabric. These perforated pipes were then connected to the 18-inch storm water piping system at manhole No. 1, located now under about 30 feet of garbage and at manhole No. 2, located near the south end of Phase I fill. See Figure 3.



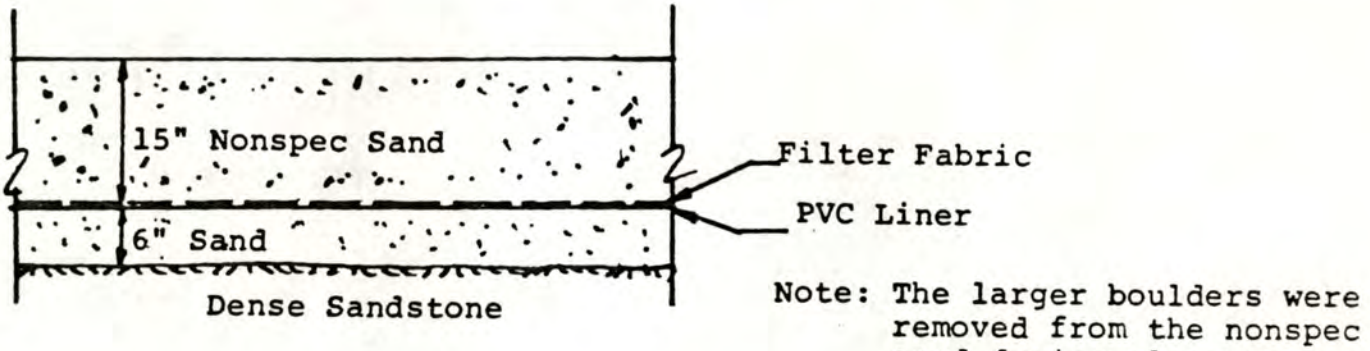
PHASE 1 UNDERDRAIN SYSTEM

Figure 3

Specifications for the fabrication and installation of the liner gave the general contractor the option to do the work with his own work force. The fabricator and the installer were not required to have any prior experience in the liner business.

It was reported by both the health district and the Department of Ecology inspectors on the site that some of the factory seams tested had failed to meet specifications because the conditions under which the seaming process took place were

less than ideal (i.e., temperatures below those recommended for proper bonding of seams etc.). Also, many of the field seams failed when tested. Since the liner was being installed under mostly adverse weather conditions, proper bonding of the seams was questionable. During the placing of the cover sand over the liner, many problems occurred. Heavy equipment along with adverse subgrade conditions created a rolling effect in the liner and sand layers. Due to this problem, the sand, liner, and fabric system was again altered. See Figure 4.



SECOND LINER-FABRIC CHANGE ORDER

Figure 4

During the fabrication and installation of the liner and cover sand, many concerns as to the adequacy of the seams were made. The county then hired a "liner expert" to review the construction records and actual field conditions and make a report with recommendations.

During this on-site inspection, many punctures in the liners and filter fabric as well as separated seams were located. Therefore, the main recommendation was to uncover and repair all field seams and liner punctures created by the liner and filter fabric being pushed up and run over by heavy equipment.

The second area of concern was the planned use of the PVC liner on the 2H:IV side slopes. The "expert" recommended the use of "Hypalon" (chlorosulfonated polyethylene) which is stronger and less likely to pull apart on the steeper side slopes, plus it is not as susceptible to ultraviolet and ozone deterioration when exposed.

At the time the "Hypalon" was installed on the side slopes, however, the liner ballooned out due to excessive water pressure behind the liner. To relieve this problem, three small pipes with one-way valves were installed in the liner and the ground water was allowed to drain out on to the top of the liner inside the future landfill area.

PVC liners are susceptible to organic chemicals, particularly hydrocarbons, solvents, and oils. The precise composition of leachate in the waste is site specific depending upon such variables as type of waste, amount of infiltrating water, and pH.

Municipal solid waste leachate can affect liners in different ways depending upon the concentrations in the specific liner materials. The components of leachate acting together can often have more of an effect on the liner than each component alone. These constituents can be damaging to rubber and plastic liners causing them to swell, become more permeable and softer, and more easily damaged. (i.e., lab testing has shown the average tensile strength for PVC liners was reduced after being immersed in landfill leachate; however, even though the PVC liner absorbed a smaller percentage of the leachate than the "Hypalon," the "Hypalon" increased in tensile strength during the same test period.)

Failure of liners include problems in the subgrade, the lining material itself, type of weather and aging, and problems imposed by the operating procedures used in conjunction with the existing site conditions. The problems in subgrades are related to compaction, differential settling, slope sluffing, build up of hydrostatic pressure and gas pressures. Failures may be induced by chemical and/or physical circumstances. Chemical compatibility failures are a function of the waste/liner combination, while physical failures are more often subgrade related. Several of these problems exist in the Cathcart Phase I area.

Due to the fact that the existing liner is covered with over 30 feet of compacted garbage now, the actual inspection of the liner integrity is nearly impossible. Samples of the storm drain water from underneath the landfill indicate that leachate was escaping from the landfill itself.

E. Leachate Collection System and Storm Water System

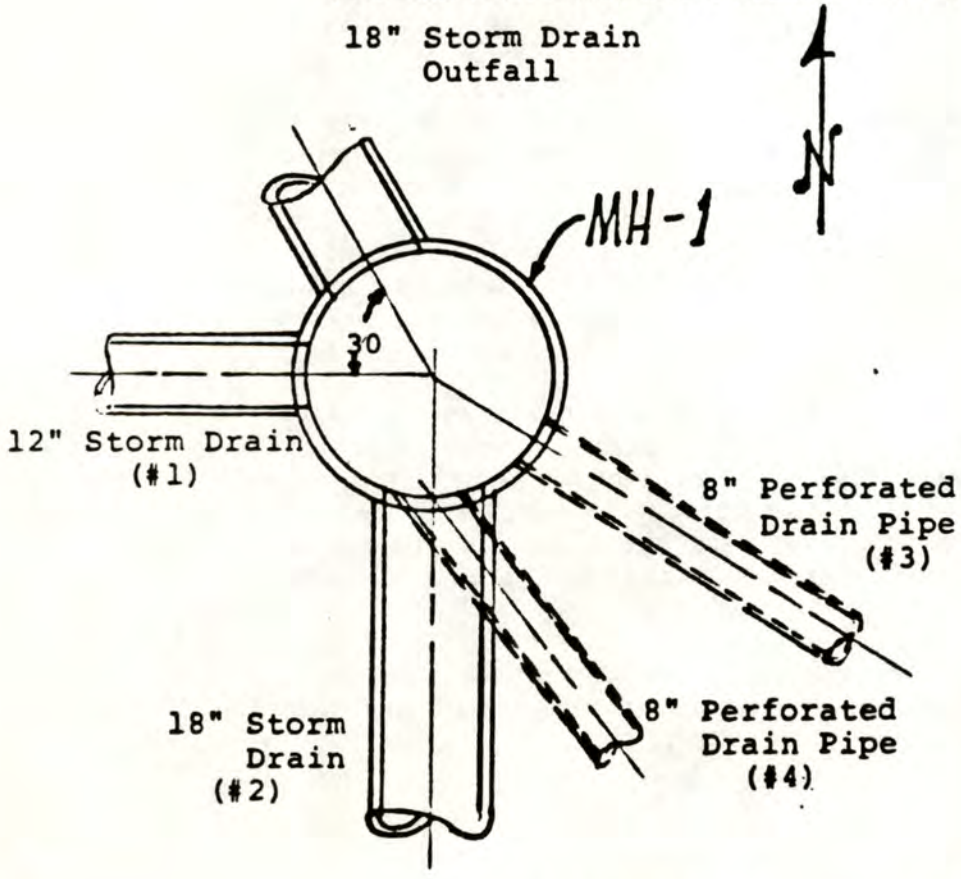
On top of this liner is the leachate collection system. The leachate collection system in Phase I area consists of a perforated pipe laid in a "T" fashion with the vertical leg down the center of the fill in a north-south direction and the horizontal leg is at the low "north" end of the fill running in an east-west direction. This pipe is directly above the PVC liner in the 15-inch sand layer. Leachate collects in these pipes and flows by gravity to a pumping station located outside the confines of the landfill. From there it is pumped to the leachate aeration pond and then eventually to treatment and disposal.

The leachate was allowed to collect in the landfill because the valve at the inlet to the pump station was closed. Just how much had accumulated was uncertain. Some of the public

works personnel say that 3 to 4 feet of leachate had accumulated above the liner and when it was drained out comprised about 60,000 to 70,000 gallons. Other reports indicate that the leachate level in the landfill was much higher - say 8 to 9 feet. The actual depth is not that important now - what is important is that the leachate level should not be allowed to build up in the landfill.

First, this procedure will minimize the contact time between the leachate and the garbage thereby minimizing the strength of leachate produced. Secondly, with no (or very little) hydrostatic pressure on top of the liner the probability for leachate to travel down through the liner should be minimized. In fact, the ground water pressure underneath the liner should tend to force leachate up through the liner and into the collection system instead, provided there is little or no leachate accumulated on top of the liner. One exception to this could arise if the ground water elevation lowers below the bottom of the landfill in which case leachate could travel downward through the liner.

It is probable, based on water quality sampling done to date, that the leachate traveled down through the liner. Manhole 1, located just inside the landfill at the north end of the 18-inch storm drain system, was uncovered by digging down through 30-plus feet of garbage. This was done to check the extent of leachate contamination by sampling the flows from the pipes that drained in to this manhole. The samples that were taken in storm water manhole 1 are shown on Figure 5.



Pipe No.	(2/2/81) Flow	Total Organic Carbon mg/L
1	No flow	1,500
2	800 GPM	13
3	No flow	4,300
4	0.5-5 GPM	1,000

MANHOLE NUMBER 1 Figure 5

As you can see, leachate of varying concentrations has appeared in the underdrain system. In addition, the lateral storm drain system connected to this manhole appeared to also have some leachate but its exact source is unknown. Whether it entered the pipe through cracks or came down through the pipe during construction is unknown. However, when the samples were taken in this lateral storm drain system, there was no flow. In pipe No. 4, a special underdrain, there was flow estimated from less than 0.5 gallon per minute (gpm) to greater than 5 gpm, depending upon the source of the information. Before resealing this manhole and refilling the hole with garbage, two special underdrain plugs were installed in lines No. 3 and No. 4. Due to the corrosive nature of the leachate present, the long-term integrity of these plugs may be questionable. However, with these drains now plugged, the accumulation of liquid in the lines will begin to build up some hydrostatic pressure, causing the liquid to flow upward to the liner, or down the old stream channel, depending on the path of least resistance. Keeping the leachate collection system always pumped down, increases the likelihood that the path of least resistance would be back into the landfill leachate collection system. This is good from the standpoint of preventing ground water contamination. It is bad from the standpoint of adding to the quantity of leachate needing treatment. Also, another unknown is the effect of leachate on the physical integrity of the storm water underdrain line itself.

In order to assess the continued impact of the leachate contamination problem, it would be desirable to measure the quantity and quality of leachate getting into the storm drainage system underneath the landfill.* Because no direct measurement is practicable now, one would need to sample the quality and measure the flows at manhole No. 1 (between the Phase I and Phase II areas) and at the 18-inch storm drainage pipe flowing out of the downstream dike into the downstream settling pond. Waster quality parameters such as specific conductivity, total organic carbon, etc., could be used. By having this information, one could then calculate the quantity and quality of leachate that enters the system in between those two sampling locations (i.e., the Phase I area).

If it shows unacceptable levels of contamination, additional abatement measure may be warranted; measures such as isolating the storm water of the Phase I area from additional phases and sending this water to the leachated treatment facility. This would mean that the flow entering the Phase I storm drainage system should be minimized by isolating the system as much as

* This is particularly true now since the recent tests of February 19 showed some evidence of continued contamination even though the sample was taken after the two plugs were inserted.

possible from the systems of future stages. This could possibly be done by inserting a smaller diameter pipe through this main storm drainage system to carry storm water from future stages through the affected area without it mixing with the Phase I storm water. Another alternative would be to insert a smaller diameter pipe from outside the berm on the downstream side of the landfill through the 18-inch storm drain, up to manhole No. 1 and connect it to the now plugged off lines. These alternatives would probably require access to manhole No. 1. A third alternative would be to install a pumping station at manhole No. 2 and pump the water entering manhole 2, hopefully uncontaminated, around the affected area. However, other abatement measures should be exhausted and a more accurate assessment of the origin of the contamination should be done (MH 1 vs MH 2) via the recommended monitoring proposal before any of these are instituted.

Leachate was also detected in manhole 2. Evidently its origin was the result of: (1) the large impoundment of leachate on top of the liner in the Phase I area (before it was drained off) causing a backup and overflow of leachate into manhole No. 2; (2) the surface runoff from the landfill itself being contaminated and running into manhole No. 2; or (3) the subsurface drainage from Phase I area entering manhole No. 2. In any case, it can be solved by proper design and operational techniques in the landfill (i.e., allow no leachate to build up on top of the liner, route all storm waters runoff from the landfill proper into the leachate collection system (not the storm water system) and seal Manhole No. 2 from any underdrains coming from under the affected Phase I area).

F. Phase I Cover

Because of the questionable integrity of the liner in the Phase I area, the Phase I area should be isolated as much as possible from the future phases. While current Phase II plans call for some isolation measures, additional measures may be warranted. Through proper design and construction, adequate isolation should be achieved.

Because differential settlement of the landfill may occur due to the decomposition and subsequent compaction of the garbage, stresses will develop in the "impermeable" cover material on top of the Phase I area. This could cause cracks to develop and allow rainwater and/or future leachate to enter the Phase I area. By increasing the depth of good cover material from the proposed 1 foot to between 2-3 feet, installing it during favorable weather conditions and compacting it properly in "6 inch lifts" maybe even using bentonite as an additive, future liquid pentration into this area Phase I area could be minimized. A temporary viscose cover could also be used as well as steepening the cover slope. All rainwater falling on the landfill area either during operation or after a phase

completion should be directed into the leachate system until tests indicated it is not leachate contaminated water.

In an attempt to isolate the Phase II leachate from the Phase I leachate, the plans call for the construction of a small leachate barrier berm on the floor of the landfill extending in an east-west direction at the border between the two phases. It may be beneficial to expand this concept by placing the Phase I cover material all the way down to the PVC liner on top of the barrier berm rather than just to the top of the sand cover surface above the liner. In the event that the barrier berm was not totally effective, this additional measure would tend to keep the Phase II leachate, which has accumulated on the bottom, out of the Phase I area. Also it would tend to keep Phase II leachate that percolates down the sloping southerly side of the Phase I covered area from getting into the Phase I system.

If these remedial construction operational measures are instituted, the environmental risk should be reduced to a reasonable level and therefore any future major liner repair in the Phase I area would not be worth the significant cost. The one exception to this is the southern edge of the Phase I liner particularly the southwest portion. Damage has been detected and should be repaired before joining it with the Phase II liner (the public works department indicated they plan to do this).

G. Phase II

For Phase II and future phases the lessons learned in Phase I should be utilized. The integrity of the liner with all its facets is probably the most important lesson. Quality control during the installation of the subgrade and liner will provide the confidence that the facility will be constructed as designed and will function as intended. There are three major specific areas of quality control in a flexible membrane liner project. They are the subgrade, the membrane and its seams, and the sealing of penetrations through the liner.

The quality control engineer should be required to assure that the contract's specifications are fully met and be familiar with the liner manufacturer's recommendations regarding all facets of the materials, use, and installation.

The quality control plan for the earth work portion of the project should specify the test frequency to assure accurate and reliable field density data and be tailored to the specific needs and requirements of the project. The general accepted practice is to take from one to ten tests per 2,000 square feet on each lift of soil placed.

Measurement of moisture and relative compaction are taken to insure that the subgrade has the desired firmness. Visual

observations of subgrade appearance, earthwork activities and workmanship, lack of vegetation, drain orientation and placement, curb and control of surface water, slope characteristics and preparation, should be noted on an, as-needed basis.

The special underdrain system designed for Phase II is apparently scheduled to be plugged once the landfill has progressed. There are advantages and disadvantages for plugging these lines, however, we believe the disadvantages outweigh the advantages (assuming Phase II liner does not leak). Plugging the lines would make future detection of leachate leakage difficult. Also, the back pressure that could build up underneath the liner would tend to force liquid up through the liner (if there were any holes), provided that the leachate is not allowed to build up on top of the liner. In addition, plugging these lines could tend to cause an increase in the ground water migrating into the Phase I area thereby increasing the ground water pressure. As a result, this could aggravate the underdrainage problems there, including increasing the potential for north dike stability problems. By not plugging the lines, the pressure underneath the liner would not be allowed to build up, getting better overall stability to the liner/subgrade system. It would also tend to keep ground water from migrating into the Phase I problem area reducing those adverse impacts. However, if there are leaks in this liner too, leachate could once again get into the storm water system.

The type of liner used should be reevaluted. Consideration should be given to using "fabric reinforced Hypalon" for the liner material instead of the PVC because of its apparent superior qualities. By doing so, it may be acceptable to eliminate the extra layer(s) of the filter fabric now planned to go on top of and underneath the PVC. In addition, field seaming is reported to be easier, faster and more reliable with the Hypalon material.

The success or failure of a liner installation will depend to a great extent upon the contractor's seam credibility. If the project is to contain liquids that are hazardous and/or will pollute ground water, the installer should have seamed 5 million square feet of liner as a minimum qualification. Job site factors which may influence the seaming operations include such things as: ambient temperature, relative humidity, wind velocity, moisture content, the subgrade supporting surface on which the seams are to be bonded, skill of the seaming crew, quality and consistency of the adhesive, cleanliness of the seam and liner temperature. All field seams should be 100 percent inspected as per specifications, by the installation contractor and/or the lining manufacturer's representative. The materials supplied under the specifications should be first quality products designed and manufactured specifically for the project and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes.

The manufacturer should have previously produced a minimum of 10 million square feet of similar liner for installation on such projects.

An authorized representative of the installation contractor should certify in writing that the surface on which the lining is to be placed is acceptable. No installation of lining should commence until this certification is furnished to the engineer. The initial sand cover on top of the liner should be spread from a pile with a light tracked dozer and kept at a minimum thickness of 18 inches. Extreme caution should be exercised to keep this vehicle off the liner itself.

Penetrations of the membrane liner are also of significant concern with respect to adequate sealing between the liner and those penetrations. When a penetration is round, stainless steel bands may be used. Screw-type clamps are well-suited for small penetrations (4 inches in diameter or less) while for larger pipes "band-it" type methods may be specified. An extra layer of liner material should be placed between the band and the liner to prevent cutting or abrasion. Flange-type connectors are the most secure type of seal between the liner and pipe penetration. Flanges should be set in concrete with anchor blocks tack welded to the back of the flange. Care must be taken to insure that the concrete is smooth finished with rounded edges. Additional layers of the liner may be place over the flange, extending to the full edge of the concrete in order to form a gasket and also to prevent abrasion between the concrete and the liner. Once the liner is placed over the flange, an additional layer should be placed on top to form the other half of the gasket seal.

H. Leachate Treatment and Disposal

The leachate aeration pond is currently full. As a result, the valve on the leachate line from the landfill has been closed again. Immediate measures should be taken to open the valve and keep it open. This would require an emergency plan to reduce the level of the pond, most probably by trucking the leachate to a nearby treatment lagoon (possibly Everett). Adequate monitoring of both quantity and quality of leachate generated should be done for determining future expected flows. Volume in the lagoon and/or to and from the lagoon, plus analysis of leachate to, from, and in the lagoon should be performed.

The ultimate leachate treatment/disposal plan has yet to be constucted because the county felt that it would take over a year to fill up the aeration lagoon. Now, after eight months the pond is full. Therefore an emergency program to identify and implement the most cost-effective, long-term solution should be started. This could take the form of a simplified type facility plan (expanded engineering report) to determine the objectives, requirements, alternatives, cost, impacts,

etc., and then to identify the most cost-effective solution, particularly now, after so many changes have occurred since the original plan (i.e., design flow changes, disposal location changes, etc.).

The current plan, however, is to build a physical-chemical treatment plant on the site with disposal to some municipal sewerage system. The plans for this leachate treatment facility are currently being reviewed by the Snohomish County Health District and the Northwest Regional Office of the department.

The treatment facility consists of two-stage chemical precipitation followed by carbon adsorbers, pressure filters, and chlorination. Because many of the factors that are needed for the design are not well defined, parameters such as leachate quantity and quality, its treatability, etc., plus the questions involving process reliability, operability, maintainability and the ultimate disposal methodology, these plans should be reviewed very critically.

Our brief review of the proposed treatment system has raised several questions and concerns. An estimated 26,000 gallons per day of sludge needs to be disposed. Plans call for a sludge holding tank with no discussion of where the sludge goes from there. The ultimate fate of this sludge is unknown but likely would be in the landfill. This sludge may be classed as hazardous because of its heavy metals or toxic components and as such require special disposal techniques. The fate of heavy metals through the treatment processes was not adequately addressed (i.e., no mass balances). The chlorination facilities do not appear to meet standard requirements, particulary for safety. The pressure filter operational design seems marginal. With high suspended solids loadings, it may be under designed plus it appears to require manual operation. They should probably be designed for automatic backwashing based upon an allowable differential pressure setting. The carbon adsorption system design is not well documented. No proof has been provided that indicates this process will perform adequately. Additionally, since spent carbon will need to be wasted, this material could also be categorized as hazardous and require special disposal techniques.

The pH adjustment, first raising and then lowering, appears to be for heavy metals removal. Yet no design criteria was found. This extreme adjustment may be unnecessary, since normally only a slightly basic solution is needed for metal removal. To date, the sampling of the untreated leachate indicates heavy metals (except zinc) are within the pretreatment requirements for the City of Everett. While these levels generally tend to increase with landfill age, they may not, in this instance, and therefore their removal may be unnecessary, particularly at this time. The biochemical oxygen demand (BOD) and total suspended solids (TSS) balances across the

lagoon as well as the flow rates* are purely theoretical and therefore, subject to significant error. With a nominal error in these assumptions, the treatment plant operational performance could be jeopardized. Normally, some bench scale or jar tests are run on the wastes before design and constructed of treament plants like this, particularly on wastes that are so site specific as landfill leachate. This would aid it setting the design parameters, as well as operating techniques. To our knowledge those tests have not been done.

This physical chemical treatment plant is a complex plant. Its successful operation will depend upon the accuracy of the design assumptions and upon the performance of the operator. Both have a high degree of risk. This $1 million package-type treatment plant could turn out to be much less than expected and much less than required. In addition, the effluent from this facility is slated to go to some municipal sewage treatment facility anyway.

It may make more sense to get this leachate (with some pretreatment but not to the extent planned) into a local sewage treatment facility provided several conditions are met. First, compatibility with the treatment process must be assured as well as assuring compliance with NPDES requirements. (An additional allowance may be given for this added waste.) Secondly, the actual leachate discharge location into the collection system should be carefully scrutinized so as to obtain as low a leachate/sewage ratio as possible in order to prevent problems such as corrosion and gas buildup in the sewer lines. The desired dilution ratio would have to be determined and, of course, would be a function of the allowable concentration of each portion of the flow, but it would probably be in the order of 1:50 to 1:100. Additionally, flushing the leachate line that flows into the sewage collection line may be necessary. Thirdly, an evaluation must be done to assess the overflow points that exist in that collection system where the combined leachate/sewage could bypass directly to the receiving water without treatment. And finally, the requirements of the owner of the system, collection, and treatment must be satisfied, or some special conditional variance may be needed.

The most logical alternative would be to discharge (pumping or trucking) into the Snohomish treatment lagoon or Everett lagoon either directly or indirectly. The Snohomish treatment facility is presently overloaded, constrained by size because of floodplain requirements and hampered by not having available grant money for its resolution. However, it may be possible to upgrade that plant by raising the existing dikes (not

* Potential volumes due to ground water flow up through the liner may significantly increase expected flows to a point where the treatment capacity is exceeded (see Section III. b.).

encroaching upon the floodplains any more than already exists), adding extra aeration capacity (mechanical or otherwise), over and above that needed to satisfy the requirements for the town by itself and improving chlorination etc. A separate leachate line (4 miles) to the lagoon would probably be needed.

The Everett alternative consists essentially of three subalternatives: (1) pumping directly to the lagoon (11 miles); (2) pumping to the proposed south end interceptor (9 miles); or (3) pumping to the Fircrest system (2 miles) which eventually flows to the Everett system. There are advantages and disadvantages to each of these subalternatives. The Fircrest system flows through much of the Everett collection system so a detailed evaluation would need to be done to determine acceptable dilution ratios in that system, and to assess the combined sewer overflows (CSOs) that occur in that system particularly during wet weather. It is of course, during wet weather or shortly thereafter the large leachate flows would need to be pumped. It may be possible to provide some storage at the site (not in the landfill) for the leachate so that it could be metered into the Fircrest system during nonstorm events. However, some maximum allowable leachate/sewage ratio should be established.

The southend interceptor alternative would also have to be looked at carefully in that there are CSOs to the river in that system too, as well as, some scheduling or timing problems. The solution to this leachate disposal problem is an immediate need while the funding and construction of the southend interceptor would take substantial time to complete. However, there would be more sewage in the southend interceptor to dilute the leachate but again because of CSOs the leachate would probably have to be metered into the interceptor. The other alternative is the direct long line to the Everett Lagoon itself (or very close to it). In addition to being rather expensive because of length of the line and because of its probable path through developed areas, this line may need some additional and/or special flushing measures. However, this alternative would avoid the CSO problem and also experience the least dilution ratio problems of all the alternatives.

I. North Dike

The north dike was constructed in the typical fashion for a homogeneous earthfill dam embankment. The ground was cleared and grubbed and all unsuitable material was removed before the embankment fill was constructed in compacted layers.

The only change from the construction plans was to alter the slope of the north slope of the dike. The plans indicated a 4H:1V slope; however, the toe of the fill in the area of the existing stream gully would have extended into the holding pond area and thereby reducing its required volume for sedimentation. Therefore, the slope was steepened to 2H:1V in the gully area but changing back to the original 4H:1V at the east and west ends of the dike.

The south slope of that dike is covered with the "Hypalon" liner which is seamed to the PVC liner near the base. Due to this impermeable liner and the leachate being drained off, the build-up of the ground water under the berm could create a stability problem; therefore, the piezometric surface should be monitored.

The seepage at the toe of the dike should be continually monitored to detect any changes. Underseepage as the result of soil piping is a problem in earthfilled dams. Depending on the type, permeability, and compaction of the fill material, seepage may cause dispersive piping and eventual tunnelling all of the way through the dike. Therefore, the downstream slope in the gully area should be inspected frequently for signs of seepage. If sluffing develops or excessive exfiltation appears, a toe drain should be installed to prevent damage to the embankment.

Erosion as a result of runoff from the northside of the dike particularly after completing Phase II should be controlled to insure that it does not erode the bank. This could be accomplished by constructing interceptor ditches horizontally along the dike (top) to route storm drainage in protected channels back down into the sediment pond below the site.

J. All Weather Access

Another general comment in regard to minimizing leachate generation is the ability to continually operate the site under any weather conditions. This mandates that an all-weather road be constructed and maintained on a continuous basis for use by not only the garbage vehicles, but by vehicles hauling cover material. Use of native soil for cover material should be reevaluated for its adequacy. Cover material should be properly stored (maybe covered) and then hauled on a daily basis so that daily cover can be properly and effectively placed at all times.

K. Off-Site Drainage Holding Pond (Rentention Pond)

The retention weir at the south end of the site is currently being used to monitor background conditions for use in the NPDES permit. Because of the advserse weather conditions and work in the nearby area, runoff with significant amounts of sediment and turbidity appears to be draining from the roadway into this detention pond thereby artifically increasing the turbidity level measured at the weir. This results in an abnormally high background level of turbidity. Since the NPDES permit allows 5 NTU over background turbidity levels, this results in an artifically large allowance for the site. Current operating procedures should be modified to prevent this turbidity/sediment contamination, possibly by constructing a small type berm along the edge of the roadway and sloping the roadway in a northerly direction away from the pond and

bypass channel. Also the background station could be changed to some place upstream, or outside the influence or potential influence of the site activities.

IV. RECOMMENDATIONS

A. Phase I Landfill Area

1. LEACHATE SHOULD NOT PURPOSELY BE ALLOWED TO IMPOUND ON TOP OF THE LINER.

   This will minimize the possibility of leachate travelling down through the liner into the ground water and will increase the likelihood that contaminated water underneath the liner will be forced back up through the liner and into the leachate collection system. Also see Section IV. C. 5. a. for immediate requirement.

2. NO ADDITIONAL LINER REPAIR IN PHASE I AREA IS PRACTICABLE.

   Because of the magnitude of any such repair work and because the recommended measures here will tend to minimize leachate passage down through the liner no repair work is recommended. (NOTE: the exception is the southern side of the liner where it will joint the Phase II liner and where it has been damaged.)

3. CONSTRUCT AN ALL-WEATHER ROAD AND MAINTAIN AN ALL-WEATHER ROAD THROUGH THE LANDFILL AREA.

   This would allow garbage vehicles, and vehicles hauling the daily cover to have continuous access to the site.

4. MAINTAIN AND PLACE ADEQUATE COVER MATERIAL.

   This would necessitate having a stockpile adequately protected from the weather so as to be able to, under all weather conditions, deliver, and place cover material in an acceptable manner.

5. ISOLATE PHASE I AREA.

   This will minimize the amount of leachate in the Phase I problem area. It can be accomplished by special cover design and installation requirements as well as runoff routing requirements previously discussed.

6. SEAL MANHOLE NO. 2 FROM ANY SPECIAL STORM WATER UNDERDRAINS COMING FROM THE PHASE I AREA (ONLY).

   This will help to minimize Phase I leachate from getting into the storm water system.

7. ROUTE SURFACE RUNOFF FROM FILL TO LEACHATE COLLECTION SYSTEM.

This would reduce contamination of storm water system. Once tests reveal no contamination use of the storm water system can begin.

B. Phase II Landfill Area (and Future Phases)

1. SPECIAL UNDERDRAINS SHOULD NOT BE PLUGGED.

This will allow for better liner/subgrade stability and reduce the potential for increased ground water flows into the Phase I problem area (assumes liner is truly impervious). These subdrains should be inspected to insure that they are still functional (not silted in).

2. SPECIAL LINER MANUFACTURER-FABRICATOR-INSTALLER REQUIREMENTS.

In order to insure that the integrity of the liner once operational, special requirements should be placed on those activities involved with the liner. These could include experience and expertise requirements as well as detailed and well written specificaitons along with special quality control requirements.

3. ROUTE SURFACE RUNOFF FROM FILL TO LEACHATE COLLECTION SYSTEM.

This would reduce contamination of storm water system. Once tests reveal no contamination, use of storm water system can begin.

4. CONSIDER USE OF HYPALON THROUGHOUT AREA.

Because Hypalon (fabric reinforced type) appears to possess superior strength to the normal PVC, plus less deterioration rates due to leachate, etc., serious consideration should be given to substitute this material for the PVC liner.

5. MAINTAIN AND PLACE ADEQUATE COVER MATERIAL.

In order to insure the integrity of the cover material once in place, the native material should be reevaluated to determine its suitability and the acceptability as cover material. It should be adequately protected from the weather to insure its continuous effective use as an impervious properly placed cover material.

6. PLACEMENT OF LINER COVER MATERIAL.

Extreme care should be taken when placing the sand layer on top of the liner to insure that the liner is not damaged. Restrict the type of vehicles used and maintain a minimum 18-inch sand cover.

C. General

1. MONITOR SURFACE WATERS.

In order to keep a continuing assessment of the water quality impact on surface waters, the existing monitoring program should be expanded and/or modified. The background station should be moved to either eliminate the on-site influences or eliminate those influences or both. Also, the monitoring should be expanded to assess the continuing impact of the Phase I area on the 18-inch storm water line by monitoring above and below that area. If unacceptable levels of leachate appear in the 18-inch storm water line after these recommended remedial measures are implemented, then some method to collect and treat the contaminated storm water should be constructed (i.e., one of the methods discussed in Section III. E.).

2. MONITOR GROUND WATERS

In order to keep a continuing assessment of the impact on ground water, the existing wells on-site as well as off-site should continue to be sampled. In addition, one additional well located above the original stream bed on the downstream side of the north dike, in the vicinity of the road, should be constructed to monitor water quality and ground water surface elevations. Additionally, seepage at the toe of the north dike should be monitored and if it appears that the gound water is moving through the lower dike area to the extent of posing a potential threat to the dike stability, a toe drain should be constructed.

In order to minimize water entering the overall site, it would be desirable to determine the significance of ground water entering the site, particularly at two suspect locations. First, the bypass channel may leak and contribute ground water into the landfill area. If this is significant, it could be reduced by lining parts or all of the channel. Second, the natural drainage on the south side of the landfill may contribute ground water underneath the roadway and into the landfill area. If this is significant, a back hoe dug trench filled with an impervious material could be constructed along the access roadway near the retention pond.

3. COMPLY WITH GOOD SANITARY LANDFILL PRACTICES.

Even though our evaluation was mainly limited to water quality related issues, other issues are also important. The operation should comply with the Minimum Function Standards (WAC 173-301) etc. These should include taking the appropriate measures relating to such things as aesthetics, sea gull activity, security (fences), sightlessness, noise, odors, etc.

4. INTERCEPT THROUGH DITCHES OR OTHER MEANS STORM WATER RUNOFF PRESENTLY AND POTENTIALLY ON THE DOWNSTREAM FACE OF THE NORTH DIKE.

This would prevent erosion of the north dike and help to insure its structural integrity.

5. IMMEDIATE NEED FOR LEACHATE TREATMENT DISPOSAL.

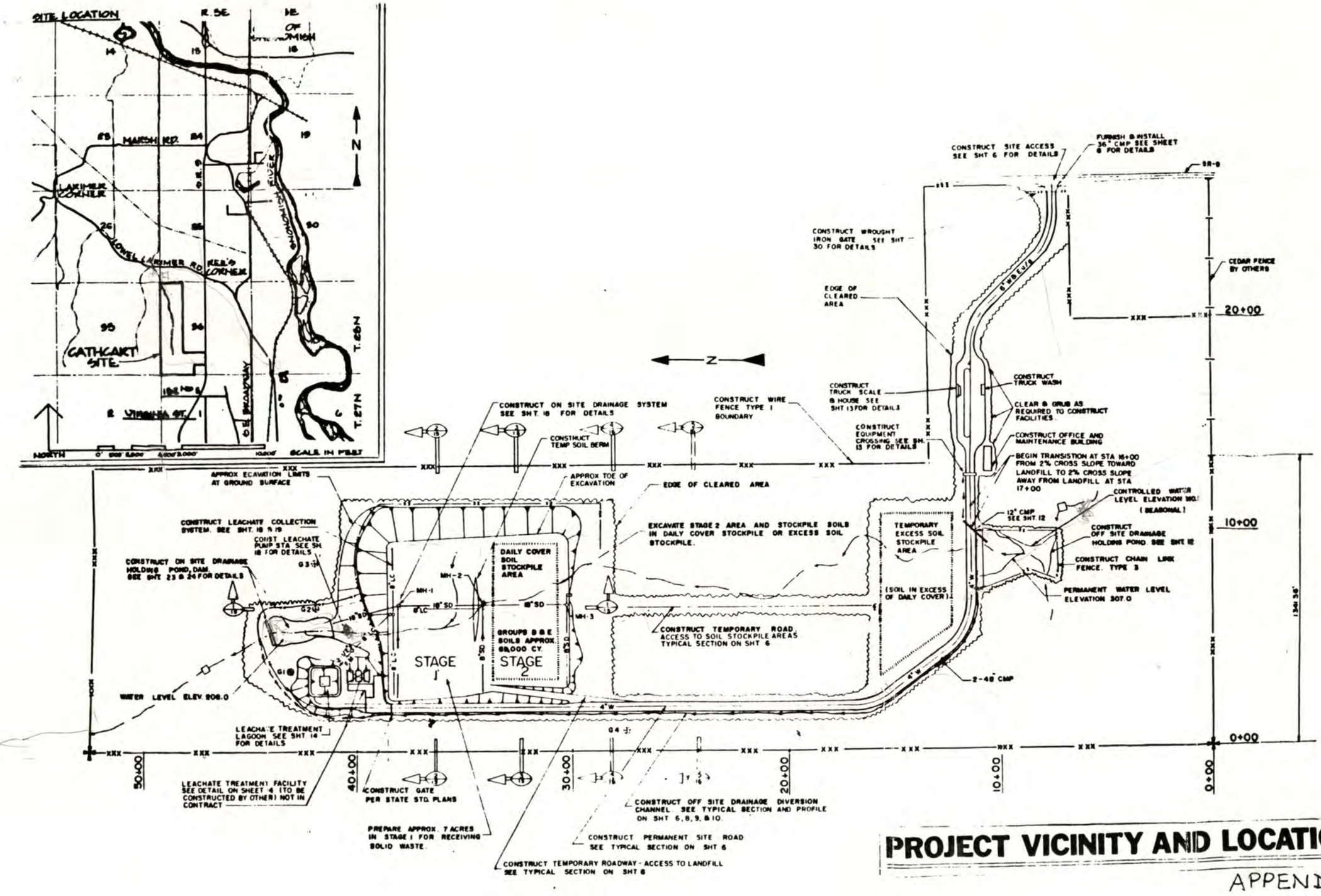
Immediately reduce the liquid level in aeration lagoon. This will allow the valve to be reopened and the leachate to be drained off the top of the liner. The leachate would probably need to be trucked to an existing treatment system (maybe Everett). This practice should be continued until a permanent disposal system can be built.

6. PERMANENT LEACHATE TREATMENT/DISPOSAL FACILITY.

Immediately begin a simplified type facility plan report to determine the proper permanent system to install. The treatment scheme was evidently designed when the disposal alternative was directed to state waters (Snohomish River or tributary thereto). Now this disposal alternative has evidently changed. When added to the many other changes and unknowns, a reevaluation of the entire treatment/disposal system for its cost-effectiveness seems necessary. Two possible alternatives are briefly outlined in Section III. H. These and possibly others should be studied, otherwise, the $1 million treatment plant now proposed may end up undersized, or inoperable, or both.

APPENDICES

GEOLOGICAL SURVEY
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
WASHINGTON
15 MINUTE SERIES
Central Snohomish
South Snohomish
Marshland Sch.
Murphys Corner
Osborn Corner
Ross Corner
Pleasant View Ranch
Davis Butte
Lake Brecker
Kennard Corner
Thrashers Corner
Turner Corner
Maltby
Cathcart
Bothell
CATHCART LANDFILL
APPENDIX A



PROJECT VICINITY AND LOCATION

APPENDIX B