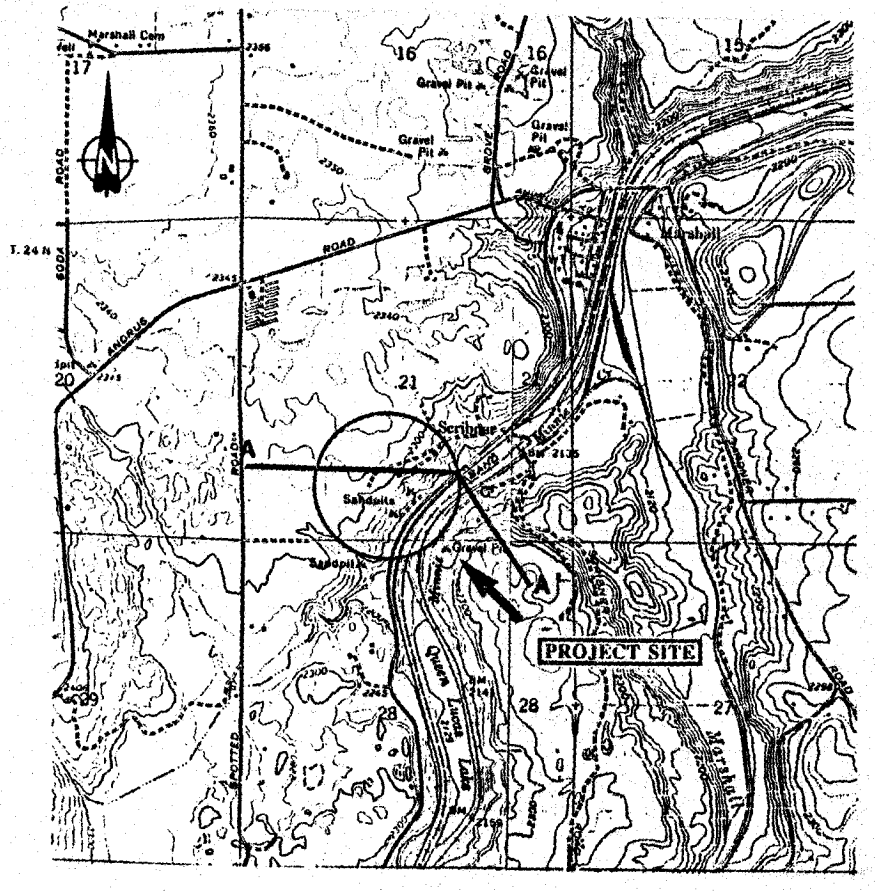
MARSHALL LANDFILL, INC.

VARIANCE REQUEST TO CONTINUE WASTE DISPOSAL THROUGH CLOSURE

WITH

SUPPORTING DOCUMENTATION



SEPTEMBER 1, 1989

RUSS FETROW ENGINEERING, INC.
GeoEnvironmental Branch
2546K PRAIRIE RD., EUGENE, OR 97402
(503) 689-6110

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PREFACE

The purpose of this document is to provide a comprehensive review of the Marshall Landfill in support of a variance request for continuation of waste disposal at the site concurrent with contouring and preparation of the landfill for final closure. The first section of this document contains the Washington State Department of Ecology Application for Disposal Site Permit and an Environmental Checklist. The second section contains the Permit Application Report which addresses site history, existing site hydrogeology, groundwater monitoring, conclusions, and recommendations. The third section contains the pertinent WAC 173-304 sections for a municipal landfill, followed by a statement of action for compliance for each section. Both the second and third sections provide information requested in the application, environmental checklist, and Minimal Functional Standards. The fourth and final section contains the Landfill Operational Manual and Closure Plans. Attached appendices contain supporting data, diagrams and plans which address landfill operation, closure, and post-closure maintenance.

VARIANCE APPLICATION

Russ Fetrow Engineering Inc.
GeoEnvironmental Division Office

2545K Prairie Road, Eugene, Oregon 97402
(503) 689-8110 Fax (503) 689-1524

December 11, 1989

Steve Holderby, R.S.
Solid Waste Program Coordinator
Spokane County Health District
Spokane, WA 99201

RE: MARSHALL LANDFILL
EXISTING LANDFILL CLOSURE
CLASS II VARIANCE REQUEST (Time Extension)

Dear Mr. Holderby:

Please consider this letter as a clarification of correspondence dated August 29, 1989 requesting a formal request for a Class II Variance (time extension) from the implementation dates and performance standards of WAC 173-304-400(3)(b). Marshall Landfill Inc. intended that this request ask for an extension of the final date for closure of the existing non-complying landfill from November 27, 1989 until October 1, 1991. This would, of course, require an initial one year extension, to November 27, 1990, and an additional one year extension request, to be submitted in August of 1990.

The majority of the closure work will be accomplished during the summer months of 1990, with the balance to be accomplished after achieving the final configuration on the presently active face.

If you have any questions or need additional information, please feel free to contact me.

Sincerely,

RUSS FETROW ENGINEERING, INC.

Shane Hughes, P.E.
Division Administrator

cc: Dennis Clayton, Marshall Landfill, Inc.
Mark Fuchs, Washington D.O.E.
Dale Wulffenstein, RFEI
Ralph Christensen, RFEI

Russ Fetrow Engineering Inc.
GeoEnvironmental Division Office

2545K Prairie Road, Eugene, Oregon 97402
(503) 689-8110 Fax (503) 689-1524

August 29, 1989

Steve Holderby, R.S.
Solid Waste Program Coordinator
Spokane County Health District
Spokane, WA 99201

RE: MARSHALL LANDFILL
EXISTING LANDFILL CLOSURE
CLASS II VARIANCE REQUEST (Time Extension)

Dear Mr. Holderby:

Please consider this letter and attachments as a formal request for a Class II Variance (time extension) from the implementation dates and performance standards of WAC 173-304-400(3)(b). This request is for an extension of the final date for closure of the existing non-complying landfill from November 27, 1989 until October 1, 1990. This time extension is necessary to allow or provide for the following:

1. Prepare plans and specifications for the proper closure of the existing landfill facility;

2. Bring the existing landfill to proper contours consistent with the above referenced plans and specifications;

3. Arrange and generate funding necessary to implement the approved closure plans; and

4. Fund, design and construct a new "state of the art" landfill to accept wastes currently being disposed of in the existing landfill.

We have reviewed the Washington Department of Ecology Technical Information Memorandum No. 88-1 and have addressed the applicable items in that document as follows:

1. This variance request is for a Class II (temporary) variance as noted above. In order to be considered we are including a time/compliance schedule (attachment A) and a copy of an executed contract (attachment B), between Russ Fetrow Engineering, Inc. (RFEI), and Marshall Landfill, Inc., authorizing engineering and geotechnical services for closure of the existing landfill and design of the proposed new landfill facility. These items demonstrate that this project has progressed beyond the "planning stage" as detailed in TIM 88-1, Section 5.2.

2. This request is consistent with solid waste management policies for closure of existing landfills that do not meet current Minimal Functional Standards. The Marshall Landfill was established long before today's stringent requirements were adopted. The work items which will be accomplished if this request is granted, will minimize the generation of leachate and provide for an orderly and environmentally sound closure of the site.

3. Granting of this variance should not conflict with the local comprehensive solid waste management plan.

5. Granting this variance request will provide the following potential benefits to the citizens of Washington:

   A. Currently there are no landfill operations in the Spokane area that meet the new Minimal Functional Standards. If the Marshall, and other landfills, are forced to close November 27, 1989, a significant hardship on the citizens of this area will be imposed.

   B. Allowing the additional time to properly close this site will also generate sufficient funding to allow design and construction of a new "state of the art" landfill facility for disposal of municipal solid wastes.

   Denying this variance request will create an unnecessary financial hardship on the applicant by eliminating the source of revenue necessary to properly close the site.

   No short or long term public benefits would be gained by a denial of this request.

6. Regular progress reports will be submitted to the Spokane County Health District as per any requirements included in the permit compliance schedule.

As discussed at our meeting of August 21, 1989, Russ Fetrow Engineering, Inc., will be submitting, next week, a single source document which includes site history, goetechnical reports, interim operation and maintenance plans, closure/post-closure plans, environmental checklists, and sections addressing applicable portions of WAC 173-304.

We apologize for the delay in submittal of the above document, however, there have been delays in assembling the necessary support data being provided by a number of different outside sources.

If you have any questions or need additional information, please feel free to contact me.

Sincerely,

RUSS FETROW ENGINEERING, INC.

Shane Hughes, P.E.
Division Administrator

cc: Dennis Clayton, Marshall Landfill, Inc.
Mark Fuchs, Washington D.O.E.
Dale Wulffenstein, RFEI
Ralph Christensen, RFEI

ATTACHMENT "A"

MARSHALL LANDFILL
Engineering Time Schedule

PROGRAM ELEMENT	TIME LINE
Task 1: Existing Landfill Closure	June 89 - Nov. 91
Engineering Work:	
Field Survey Complete	
Topographic Base Map	June 1 - July 10, 1989
Preliminary Layout	June 10 - July 21, 1989
Operation and Maintenance Plan	June 1 - Sept 1, 1989
Final Closure Plans/Specs	July 21 - Sept 1, 1989
GeoTech Work	June 1 - Aug 1, 1989
County/DOE Closure Approvals:	
Submit Variance Request	June 1 - Aug 1, 1989
Submit Closure/Post-Closure Plan	Aug 1 - Oct 1, 1989
Landfill Closure Work:	
Secure Top Cap Materials	June 1 - July 1, 1989
Site Closure	Sept 1, 1989 - Oct 1, 1991
Task 2: Environmental Impact Statement (on new landfill)	July 10, - Oct, 1990
Task 3: New Landfill Construction	Sept 1, 1990 - Oct, 1991
Engineering Plans/Specs	Sept 1 - Dec 1, 1990
Prepare/Submit Permit Application	Dec 1, 1990 - Mar 1, 1991
County/DOE Review and Approval	Mar 1 - May 1, 1991
Bid Process/Award Contracts	May 1 - July 1, 1991
Construction	July 1 - Oct 1, 1991
Site in Operation	Oct 1, 1991

SECTION 1

APPLICATION FOR DISPOSAL SITE PERMIT

AND

ENVIRONMENTAL CHECKLIST

TABLE OF CONTENTS

DEPARTMENT OF ECOLOGY

APPLICATION FOR DISPOSAL SITE PERMIT CLASS II VARIANCE

PART I (All Sites)

1. Name of Site MARSHALL LANDFILL, INC.

2. Address POST OFFICE BOX 67
MARSHALL, WA 99020

3. Owner of Record MARSHALL LANDFILL, INC.

4. Operator MARSHALL LANDFILL, INC.

5. Site Number | S | P | (County) | | | | (Serial)

6. Address POST OFFICE BOX 67
MARSHALL, WA 99020

7. Application Date | 8 | 9 | 0 | 9 | 0 | 1 | (Year Month Day)

8. Location | M | A | R | S | H | A | L | L | | W | A |

9. Check Type of Site:

X	Sanitary Landfill	___	Land Spreading	___	Shredding
___	Industrial Landfill	X	Drop Box	___	Baling
___	Transfer Station	___	Composting	___	Other
___	Incinerator	___	Resource Recovery		

Is this an existing site? X Yes ___ No

PART II Governmental Approval

A. Have any other permits or approvals been applied for from:

	Yes	No	N/A		Yes	No	N/A
1. Municipality Approval	___	___	X	6. a. Department of Ecology Discharge Permit	___	___	X
2. Planning Commission Approval	X	___	___	b. Department of Ecology Flood Control Permit	___	___	X
3. Shorelines Management, County Approval	___	___	X	7. Department of Natural Resources; Surface Mining Permit	___	___	X
4. Consistent with County Solid Waste Management Plan	___	___	X	8. Fire Department Approval	___	___	X
5. Department of Game/ Fisheries Hydraulic Permit	___	___	X	9. Other Spokane County Health Dept. (Specify)	X	___	___

(Local Health Department Use Only)

Local Approval Date | | | | | | | (Year Month Day)

Approved by: _____

ECY 030-28 10/80

AV/L6(82-16)

PART II - Governmental Approval (Continued)

B. Zoning

1. Classification of Site Area Ag, Mz

2. Enforcement Agency SPOKANE COUNTY HEALTH DISTRICT

3. Restrictions (If any)) CONDITIONS AS SET FORTH IN 1989 SOLID WASTE PERMIT

4. Use of Adjacent Properties within a Quarter Mile (Check Appropriate Box)

	North	East	South	West
a. Residential	X	X	X	X
b. Commercial				
c. Light Industrial		RAILROAD		
d. Heavy Industrial				
e. Agricultural	X		X	X
f. Mixed				
g. Other _____ (Specify)				

PART III - Solid Waste Characteristics

A. Type of Clientele Served: PRIVATE - COMMERCIAL Estimated Number: 53 DAILY

B. Source or Type:

	Description (If necessary)	Present Volume (Tons)	Projected Volume (Tons)
1. Garbage	MUNICIPAL SOLID WASTE	330,000	PRESENT TO CLOSURE 79,000
2. Rubbish			
3. Ashes			
4. Bulky wastes			
5. Abandoned vehicles			
6. Construction and demolition wastes		160,000	39,000

(Continued)

	Description (If necessary)	Present Volume (Tons)	Projected Volume (Ten Years) Tons
7. Industrial wastes	(MSW)		
8. Hazardous waste	NONE		
9. Sewage treatment residues	NONE		
10. Street refuse	(MSW)		
11. Litter	(MSW)		
12. Agricultural waste	NONE		
13. Mining wastes	NONE		
14. Other (Specify)	NONE		

C. Daily Waste Quantities:

	Volume	Weight
1. Estimated per customer daily waste quantities	Commercial-40 C.Y. Private-1/2 C.Y.	9 Tons 125 Tons
2. Total maximum daily volume or weight	1,600 C.Y.	360 Tons
3. Total average daily volume or weight	1,300 C.Y.	290 Tons

4. Additional comments _____

D. Daily Customer Traffic

	Number
1. Estimated number of transfer vehicles	7
2. Estimated number of municipal collection vehicles	0
3. Estimated number of private collection vehicles	22
4. Estimated commercial/industrial/special trucks	0-1
5. Estimated residential pickup trucks/station wagons daily	20
6. Estimated residential cars	3

7. Additional comments _____

PART IV - Soil and Geological Characteristics (All Sites)

A. Location:

Attach copy of USGS Topographical map to each copy of Application using 7.5 minute quadrangle map, if published.

1. Plot on topographical map the following on site or within one mile of outer perimeter of site:

	Checkoff
a. Wells, water	X
b. Springs	NONE
c. Swamps	NONE
d. Streams	X
e. Public water supplies	X
f. Other bodies of water	X
g. Underground or surface mines	NONE
h. Mining spoil piles	NONE
i. Irrigation canals	NONE
j. Irrigation pools	NONE
k. Mine pools and discharge points	NONE
l. Gas and oil wells	NONE
m. Other (specify)	NONE

2. Describe the Topographical Setting ROLLING HILLS

B. Flood Plains:

1. Is the facility in the 100-year flood plain? ___ Yes X No

2. Size of watershed above the landfill is 80 acres.

C. Soils:

1. List all soil series and phases within site and approximate thickness.
   Qt, HuC, HsB, HxC, MaC, VaD, We, Te, Uh
2. List all soil series and phases to be used as cover material.
   Qt, HuC, HsB, HxC, MaC, VaD, We, Te, Uh
3. A copy of soil map or references to site location and source of cover material on published soil survey must be included.
   See attached.

D. Geology:

1. Glacial geology or

a. Type(s) of deposit(s) Pleistocene age outwash sands and gravels

b. Texture of deposit(s) Medium to coarse, ranging from silty sand surficial deposits to deep clean sands and gravels.

c. Thickness of deposit(s) +200 Feet

2. Bedrock

a. Type(s) Metamorphosed granite and basalt flows

b. Depth to +200 Feet

c. Extent of weathering Upper metamorphic rocks are deeply weathered

d. Name and age of formation(s) Revett and Burke formations of precambria age and Columbia River Basalt Group - Miocene and Pliocene

E. Surface Water:

	Yes	No
1. Will there be a discharge of leachate to surface waters?	___	X
2. Will leachate collection and treatment facilities be constructed?	___	X
a. If yes, have you applied for Waste Discharge Permit?	N/A	___

3. Rainfall (in inches)

a. Annual value 17.8" *

b. Peak 24-hour value 1½"

c. Peak 1-hour value ½'

F. Ground Water

1. Depth to ground water 204 feet (MW-1A) and 30 feet (MW-4)

a. How determined Measurements at existing wells and monitoring wells

b. Seasonal variation May be as great as 30 feet (CRIS Tech. Ball No. 15)

* U.S. Weather Bureau, Spokane, Airport

F. Ground Water (Continued)

c. If depth to ground water cannot be determined, it is recommended that a boring or well be drilled outside of, but adjacent to, the solid waste disposal area. Additional information on construction type and materials may be obtained from the regional office of the Department of Ecology.

	Checkoff
(1) Locate well on site map	X
(2) Provide complete log (description of well)	X
(3) Indicate method of drilling	X

2. Direction(s) of ground water movement — East-Northeast

3. Discharge of ground water (indicate on topographical map) — X

a. Distance and direction of discharge point(s) — Approx. ½ mile Northeast

b. Name(s) of discharge point(s), i.e., springs, streams, etc. — Confluence of Minnie Creek and Marshall Creek

c. Area tributary to discharge point(s) — Minnie Creek, Marshall Creek

4. Subsurface information: (Detailed information is needed on subsurface conditions for proper analysis of the site. This information on soils, geology, and ground water may be determined from deep cuts, borings and wells, backhoe pits, strip mines, quarries, natural outcrops, or road or railroad cuts). Describe location, detailed description and findings, and locate on topographic map, logs.

See Landfill Permit Report - Hydrogeology

5. How was information determined? Examination of site, geologic work, review of previous investigations.

PART V - Disposal Sites - Design and Operation

Detailed Plans and Maps of Disposal Site:

Submit one copy of each set of plans with each set of application forms.

1. Property Line Map See Appendix F

   a. One map should indicate property lines of site, use of adjacent properties, all right of ways (fuel, power line, roads, etc.).

      (1) If right of way exists, name of owner Marshall Landfill, Inc.

      (2) Does owner/operator own mineral rights? X Yes ___ No

      (3) If not, name and address of owner of mineral rights.

      N/A

2. Detailed topographic maps of the site should include the following. More than one map may be used to show the required information on site and within 1/4 mile perimeter of site.

		Checkoff
a.	Scale 1":400' or larger	X
b.	Five-foot contour interval or less	X
c.	Location of access roads and roads on landfill	X
d.	Location of permanent fencing	X
e.	Location of weighing facilities/gate attendant	X
f.	Location of existing and proposed utilities (water, sewers, electricity, gas, telephone, etc.)	X
g.	Location of right of ways for power lines over 1 kv	X
h.	Location of discharge point of ground water	NONE
i.	Location and identity of monitoring wells	X
j.	Location and identity of other wells	X
k.	Direction of ground water flow (indicate all directions found)	X
l.	Fire protection facilities if beyond 1/4 mile, show on general topographic map	X
m.	Leachate collection and treatment facilities	NONE
n.	Employee facilities	NONE
o.	Equipment storage and repair buildings	X
p.	Salvaging facilities	X
q.	Buffer zone, plantings, etc.	X
r.	Location and identity of springs	X
s.	Location and identity of swamps	NONE
t.	Location and identity of streams	NONE
u.	Location and identity of fire hydrants	X
v.	Location and identity of fire ponds	NONE
w.	Diversion ditches and water control structures	NONE
x.	Lifts	X
y.	Cover stock piles	X
z.	Other (specify)	NONE

PART V - Disposal Sites - Design and Operation (Continued)

3. Design (landfill only)

	Checkoff
a. Total thickness of each lift	X
b. Working grade of each lift	X
c. Slope and width of working face	X
d. Approximate time interval between lifts	X
e. Sequence of lifts and cover usage in fill area	X
f. Final slope sequence	X
g. Cover supply sources	X
h. Drainage and water control devices	X
i. Other (specify)	

4. Plans for Finished Site (Check each item included)

a. Slope and contour	X
b. Buildings	X
c. Surface water management	X
d. Road construction	X
e. Revegetation procedure	X
f. Final site maintenance	X
g. Maps and a statement of fact recorded as part of deed with county auditor (WAC 173-301-310)	
h. Other (specify)	

5. Leachate Collection and Treatment - Required? ___ Yes X No
___ Not at this time

a. Location of collection and treatment facilities	
b. Cross sections and elevations of collection system	
c. Cross sections and elevations of treatment facilities	
d. Location of discharge points of treated leachate	
e. Comments: Not applicable to this site, existing landfill.	

6. Location of proposed ground water monitoring points

a. Number	5
b. Depth	50'-212'
c. Log of boring or well	5
d. Sampling method	Dedicated pump on bailer.
e. Sampling frequency	Quarterly
f. Comments	

PART V - Disposal Sites - Design and Operation (Continued)

B. General Plan of Operation. (Describe in addendum, check as completed.)

1.	Proposed landfill method	X	13.	Erosion control	X
2.	Schedule of filling	X	14.	Traffic control	N/A
3.	Site preparation	X	15.	Final cover	X
4.	Designation of unloading area	X	16.	Final slope	X
5.	Size of working face	X	17.	Revegetation procedure	X
6.	Cell construction	X	18.	Final site maintenance	X
7.	Compaction and cover practice	X	19.	Record system	X
8.	Blowing litter control	X	20.	Salvaging system	X
9.	Surface water management	X	21.	Noise control	X
10.	Dust control	X	22.	Employee facilities	X
11.	Gas venting provisions	X	23.	Vector control	X
12.	Road construction	X	24.	Other (specify)	

PART VI - Operational Support

		Yes	No
A.	Employee Facilities:		
	Are employee facilities provided in accordance with (WAC 248-62)?	X	
B.	Disease - Vectors:		
1.	Facility will apply daily cover.	X	
2.	Facility will practice other techniques.		X
	Explain _____		
3.	Control program for: Rodent, Fly, Bird? (circle)	Daily Cover	
C.	Disease - Sewage Sludge and Septic Tank Pumpings:		
1.	Are sewage sludge or septic tank pumpings to be applied to the land surface or incorporated into the soil?		X
2.	Are crops for human consumption to be planted within 18 months after application of waste?		X
3.	Will the waste be treated by a process to significantly reduce pathogens and is access controlled 12 months for the public, 1 month for grazing animals?		X
D.	Air Quality:		
	Will open burning of solid waste be practiced at the facility?		X
	Control program for odors?	Daily Cover	

E. Safety - Gas:

Will methane or other explosive gases be generated? X Yes ___ No

If generated, how will they be controlled? Because of the semi-arrid region, no significant quantites of gas will be generated. However, a passive gas discharge system will be installed in final cover process.

F. Safety - Fire Protection:

1. Fire Department (Name and Address - Telephone) Spokane County Fire District #3; 1321 - 2nd Street, Cheney, Washington 99004; (509) 235-6645

Distance from site 5 miles

2 Pond

a. Location Queen Lucas Lake - ¼ mile South

b. Volume of water Unavailable

c. Elevation 2129 Mean Sea Level

3. Soil Stockpile

a. Location Daily cover will be supplied from site sources. Final cover imported from the Wilcox borrow on Andrus Road.

b. Volume Daily cover 13,000 cubic yards, final cover 75,000 cubic yards compacted.

4. Water Under Pressure

a. Location On site well which will not deliver quanties required for fire control.

b. Owner N/A

c. Volume of water N/A

d. Pressure N/A

e. Distance to fire hydrant N/A

5. Comments N/A

PART VI - Operational Support (Continued)

G. Safety - Bird Hazards to Aircraft:

1. Will the disposal facility be within 5,000 feet from any airport runway used by piston-type aircraft or 10,000 feet from any airport runway used by turbojet aircraft? No

2. Does the facility receive putrescible wastes like food waste, sewage sludge, septic tank pumpings, animal manures, animal carcasses, etc.? Food waste only

H. Safety - Access:

1. Will access of unauthorized persons into the facility be controlled? Yes.

   How? Caretaker, fence and lockable gates.

2. Will authorized persons be controlled within the facility so as not to expose them to potential health and safety hazards? Yes

   How? With signs, barricades, cones and designated routing into and on the area.

I. Control Programs:

1. Dust control Gravel surfaces and remote location.
2. Odor control Daily and final cover.
3. Noise control Equipment will be kept properly maintained and remote area.
4. Other Monitoring wells - water quality.

J. Endangered Species:

Is the facility within a critical habitat or the range of an endangered or threatened species as listed pursuant to the Endangered Species Act of 1973 (16 U.S.C. 1530 ET. Seq. as amended) in 50 C.F.R. Part 17? ___ Yes X No

K. Public Utilities

	On site Yes or No	Off site Yes or No	Distance from Site	Date Available
1. Electricity	Yes	Yes	N/A	Present
2. Water	No	Yes	1 mile	Present
3. Sewage	No	No	N/A	Present
4. Telephone	Yes	Yes	N/A	Present
5. Other (explain)				

PART VI - Operational Support (Continued)

L. Weighing and Measuring Facilities:

1. Scales

   a. Description NONE

   b. Location N/A

   c. Charges N/A

2. Other (specify)

   a. Type Cubic Yard Measure

   b. Description N/A

   c. Location N/A

M. Records System (See Guide in Instructions): X Yes ___ No

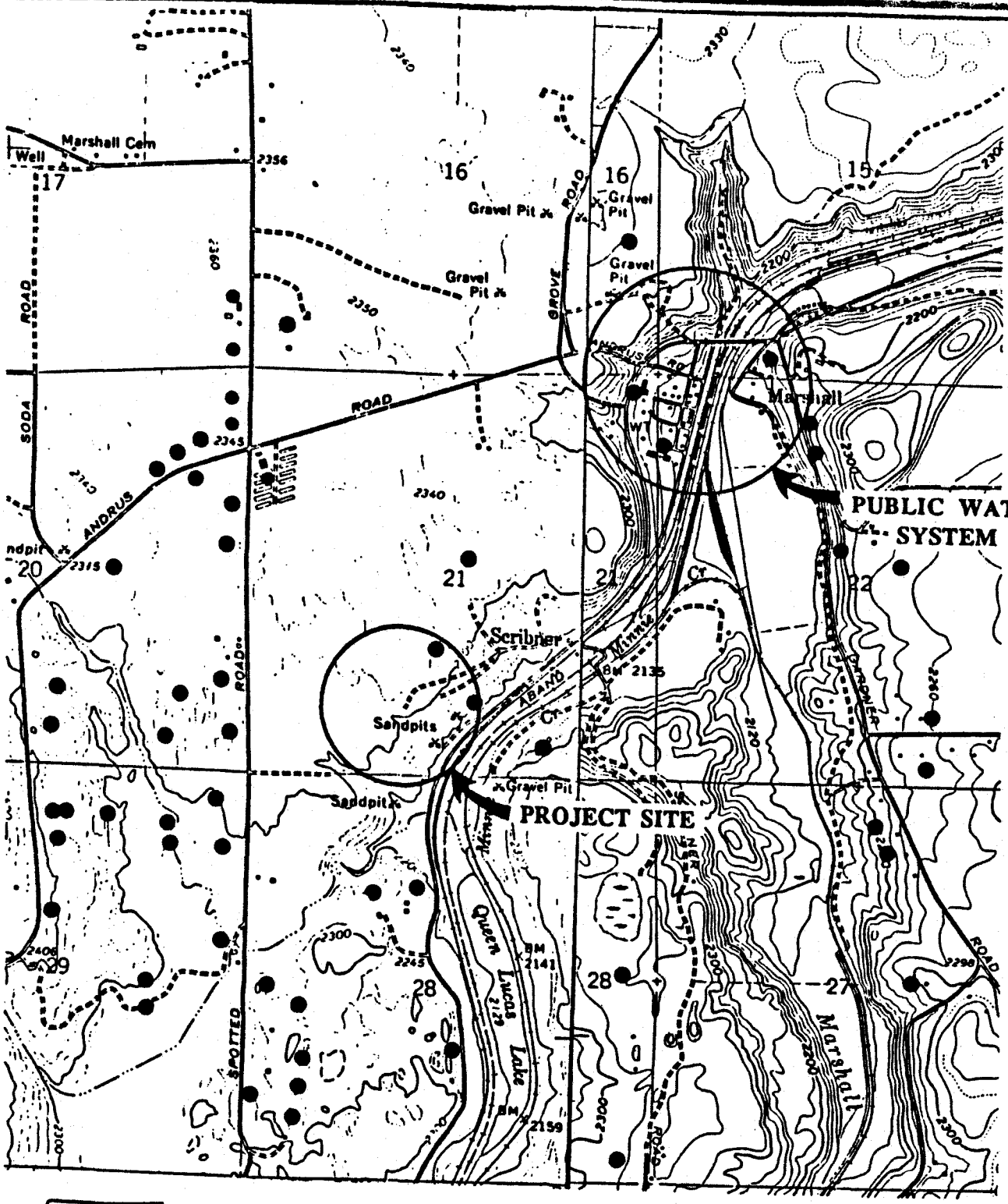
Prepared by: Marshall Landfill, Inc.

BY: Ralph W. Christensen

Russ Fetrow Engineering, Inc.

Title: Senior Geologist

Date: September, 1989



SITE VICINITY MAP FOR THE MARSHALL LANDFILL

BASE MAP FROM THE USGS SPOKANE, SW, WASH., (1986), AND FOUR LAKES, WASH., (1973), 7.5' QUADRANGLES.

RUSS FETROW ENGINEERING, INC.

GeoEnvironmental Branch

● WELL LOCATIONS

TAKEN FROM
WASTE-DISPOSAL SITE INVESTIGATION
MARSHALL SANITARY LANDFILL
SHANNON & WILSON, INC., JUNE 1983

ATTACHMENT 1

MARSHALL LANDFILL PROPERTY

SOILS MAP AND REFERENCES

ATTACHMENT 2

Hardesty soils are used for grain, alfalfa, and grass, for grazing, and as woodland.

Hardesty silt loam, 0 to 5 percent slopes (HhA).—This soil occurs throughout Spokane County, generally in small depressions. Most slopes are between 2 and 5 percent. Representative profile:

0 to 4 inches, very dark grayish-brown, friable silt loam; granular structure; slightly acid.
4 to 11 inches, dark-brown, very friable silt loam; slightly acid.
11 to 32 inches, brown, friable light silt loam mottled with dark brown; neutral.
32 to 60 inches +, yellowish-brown, friable very fine sandy loam mottled with dark brown; neutral; underlain by pale-brown, friable loamy fine sand below a depth of 39 inches; laminated with thin, wavy bands of dark-brown loam; neutral.

The surface layer ranges from very dark brown to dark grayish brown. The texture of the subsoil ranges from very fine sandy loam to silt loam. In the subsoil the mottles range from few and faint to common and distinct. As much as 5 percent of some areas consists of Cocolalla, Cheney, Uhlig, or moderately shallow Hardesty soils.

This soil is moderately well drained and has moderate permeability. It holds 7 to 9 inches of water that plants can use. It is easy to work. Root penetration is very deep. The fertility is low. Surface runoff is very slow, and there is little or no hazard of erosion.

About 25 percent of the acreage is cultivated; the rest is woodland or grassland. The cultivated areas are used for wheat, oats, barley, alfalfa, and grass. All crops except legumes respond to nitrogen; legumes respond to sulfur and phosphorus. (Capability unit IIIs–1; woodland group 10; not in a range site)

Hardesty silt loam, moderately shallow, 0 to 5 percent slopes (HmA).—This soil is underlain by gravel, coarse sand, or bedrock at a depth of 20 to 36 inches. As a consequence it holds only about 4 to 6 inches of water that plants can use. Included in mapping were small areas of Cocolalla, Cheney, Uhlig, and deep Hardesty soils.

Most of this soil is used for native or improved pasture. All crops except legumes respond to nitrogen. Legumes respond to sulfur and phosphorus. (Capability unit IIIs–1; woodland group 10; not in range site)

Hesseltine Series

The Hesseltine series consists of well-drained, medium-textured soils underlain by sand, gravel, and cobblestones at a depth of 12 to 36 inches. Many areas are gravelly or stony throughout, and some are underlain by bedrock below a depth of 20 inches. These soils occupy nearly level to very steep areas in the channeled scablands. They formed in glacial outwash mixed in the upper part with loess and volcanic ash, under ponderosa pine and grass. The annual precipitation is 17 to 20 inches, and the frost-free season is about 125 days.

Hesseltine soils are used for grain, alfalfa, and grass, for grazing, and as woodland.

Hesseltine silt loam, 0 to 10 percent slopes (HnB).—This soil is extensive in the channeled scablands. Most slopes are between 4 and 8 percent. Representative profile:

0 to 6 inches, dark-brown, friable silt loam; granular structure in upper 3 inches; slightly acid or neutral.
6 to 17 inches, dark-brown, firm silt loam, gravelly below a depth of 13 inches; breaks into ¼-inch to ½-inch subangular blocks; neutral.
17 to 36 inches, multicolored very gravelly, cobbly, and stony coarse sandy loam; loose; neutral.
36 to 60 inches +, gravel, cobblestones, and stones; nearly free of finer material.

The surface color ranges from very dark grayish brown to dark brown. In some places from 2 to 10 percent of the surface layer consists of waterworn gravel. The texture of the subsoil ranges from very gravelly loam to gravelly silt loam. The depth to the gravelly and cobbly layer ranges from 12 to 20 inches. Bedrock is present in places below a depth of 20 inches. As much as 10 percent of some areas consists of Cheney, Uhlig, Phoebe, Bong, or gravelly Hesseltine soils.

This soil is well drained and moderately permeable. It holds less than 5 inches of water that plants can use. It is easy to work. The roots of most plants penetrate only a few inches into the layer of gravel, cobblestones, and stones. The fertility is medium. Surface runoff is slow, and the hazard of erosion is slight.

About 35 percent of the acreage is cultivated; the rest is used for grazing and as woodland. Small grain and alfalfa are the chief crops. Legumes and grass for green manure are sometimes included in the crop rotation. This soil should be tilled early in spring while it is still moist, because it hardens when dry. Grass and grain crops respond to nitrogen, and legumes respond to sulfur. Ponderosa pine is the chief forest species. (Capability unit IVe–5; woodland group 16; not in a range site)

Hesseltine silt loam, moderately deep, 0 to 8 percent slopes (HoB).—This soil has a surface layer 2 to 3 inches thicker than that of Hesseltine silt loam, 0 to 10 percent slopes, and it is 20 to 36 inches deep over the cobbly layer. It holds 5 to 7 inches of water that plants can use. About 10 to 15 percent of some areas consists of Cheney, Uhlig, Bong, Phoebe, or gravelly Hesseltine soils.

About 80 percent of the acreage is cultivated; the rest is pasture or woodland. Small grain, alfalfa, and grass are the chief crops. Because of its greater effective depth, this soil has more alternative uses than Hesseltine silt loam, 0 to 10 percent slopes, and yields are higher. Grass and grain crops respond to nitrogen. Legumes respond to sulfur. (Capability unit IIIe–6; woodland group 16; not in a range site)

Hesseltine gravelly silt loam, 0 to 10 percent slopes (HrB).—The gravelly surface layer of this soil hinders cultivation to some extent. As much as 10 percent of some areas consists of Cheney, Uhlig, Bong, Phoebe, or stony Hesseltine soils.

About 35 percent of the acreage is cultivated; the rest is pasture or woodland. Small grain and alfalfa are the chief crops. (Capability unit IVe–5; woodland group 16; not in a range site)

Hesseltine stony silt loam, 0 to 20 percent slopes (HsB).—This soil is too stony to be tilled with machinery. About 10 percent of some areas consists of basalt rock outcrops or of Hesseltine gravelly loam that has a slope range of 0 to 10 percent.

This soil is used for grazing and for growing ponderosa pine (fig. 3). A few small areas are seeded to alfalfa and grass for pasture. (Capability unit VIs–1; woodland group 16; not in a range site)

Figure 3.—Thinning and pruning ponderosa pine on Hesseltine stony silt loam, 0 to 20 percent slopes.

Hesseltine stony silt loam, mounded, 0 to 8 percent slopes (HtB).—From 20 to 50 percent of this mapping unit consists of mounds, or "biscuits," of moderately deep Hesseltine silt loam. The mounds are surrounded by Hesseltine stony silt loam, which makes up 50 to 80 percent of the mapping unit. The mounds are 15 to 60 feet in diameter and are from 2 to 5 feet in depth to basalt bedrock (fig. 4). These soils were mapped as a complex because they are so intermingled that is is not practical to show them separately on the map.

These soils are used for grazing and for the production of ponderosa pine. (Capability unit VIs–1; woodland group 16; not in a range site)

Hesseltine very rocky complex, 0 to 30 percent slopes (HvC).—From 25 to 50 percent of this mapping unit consists of basalt rock outcrops and unnamed very stony, very shallow soils. Most of the rest is Hesseltine silt loam that has a slope range of 0 to 10 percent. Steeper areas of Hesseltine soils and a few small areas of the poorly drained Cocolalla soils were included in mapping.

This complex is used for grazing and for the production of ponderosa pine. (As a complex: capability unit VIIs–2. By components: Hesseltine soil—capability unit IVe–5; woodland group 16; not in a range site. Rock outcrops—capability unit VIIIs–1; not in a woodland group or range site)

Hesseltine very rocky complex, 30 to 55 percent slopes (HvD).—From 25 to 50 percent of this mapping unit consists of basalt rock outcrops and unnamed very shallow, very stony soils. The rest is Hesseltine silt loam that has a slope range of 30 to 55 percent. The acreage is used for growing ponderosa pine and for grazing. (As a complex: capability unit VIIs–2; Hesseltine soil—capability unit VIe–2; woodland group 16; not in a range site. Rock outcrops—capability unit VIIIs–1; not in a woodland group or range site)

Hesseltine extremely rocky complex, 0 to 30 percent slopes (HxC).—From 50 to 80 percent of this mapping unit consists of basalt rock outcrops and unnamed very stony, very shallow soils. The rest is Hesseltine silt loam that

Figure 4.—Hesseltine stony silt loam, mounded, 0 to 8 percent slopes. The soil in the mounds is moderately deep Hesseltine silt loam; the soil surrounding the mounds is stony Hesseltine silt loam.

has a slope range of 0 to 10 percent. Included in mapping were areas of steeper Hesseltine soils and a few small areas of poorly drained Cocolalla soils.

This complex is used for grazing and for growing ponderosa pine. (As a complex: capability unit VIIs–2. By components: Hesseltine soil—capability unit IVe–5; woodland group 1G; not in a range site. Rock outcrops—capability unit VIIIs–1; not in a woodland group or range site)

Konner Series

The Konner series consists of dark-colored, poorly drained and somewhat poorly drained, moderately fine textured soils that are mottled below a depth of 2 feet. These soils are on nearly level and gently sloping bottom lands. They formed in stratified alluvium under sedges, rushes, and grass. The alluvium contained some volcanic ash. The annual precipitation is about 21 inches, and the frost-free season is about 100 days.

Soils of the Konner series are used mainly for grain, clover, and grass and for grazing.

Konner silty clay loam (Kc).—This soil is along Deadman Creek and around the fringes of Saltese Flats and Newman Lake. In most areas it is nearly level, but in a few small areas it is gently sloping. Representative profile:

0 to 27 inches, black, friable silty clay loam above a depth of 11 inches; very dark grayish-brown, firm silty clay loam below 11 inches; soil breaks into prisms 1 to 2 inches wide; granular structure; neutral.

27 to 40 inches, very dark grayish-brown, firm clay loam that breaks into prisms ½ to 1 inch wide and then into ¼-inch to ½-inch angular blocks; dark-colored clay films occur on prisms and angular blocks; few faint mottles; neutral.

40 to 60 inches +, dark-brown, firm clay loam, almost sandy clay loam; few faint mottles; neutral.

The surface layer ranges from black to very dark gray in color and from silt loam to silty clay loam in texture. The subsoil ranges from silty clay loam to clay loam and may contain thin lenses of sand and gravel in the lower part. The mottling is faint to distinct. As much as 8 percent of some areas consists of Bridgeson silt loam or Semialmoo muck.

This soil is poorly drained and slowly permeable. It holds 9 to 11 inches of water that plants can use and is high in fertility. It is difficult to work when wet, and cultivation is usually delayed in spring. Root penetration is limited by the excess water. Surface runoff is very slow or ponded. During spring runoff this soil is often flooded, and fresh material is deposited on the surface. There is little or no hazard of erosion.

This soil is used for hay, pasture, and small grain. All crops except legumes respond to nitrogen; legumes respond to sulfur. (Capability unit IVw–1; Wet Meadow range site; not in a woodland group)

Figure 5.—Bluegrass swathed before a harvest of seed on Larkin silt loam, 5 to 20 percent slopes, eroded. Grass will be plowed under after 7 to 10 years.

8 to 32 inches, black, firm silty clay loam, very dark gray below a depth of 23 inches; soil breaks into prisms 1 inch to 2 inches wide and then into angular blocks ¼ to 1 inch wide; strong-brown mottles; slightly acid.
32 to 38 inches, dark-gray, very friable heavy silt loam; neutral.
38 to 60 inches +, very dark gray, firm silty clay; soil breaks into prisms 1 inch to 2 inches wide; strong-brown mottles; clay films on prisms; neutral.

The surface layer ranges from very dark gray to black in color and from silt loam to silty clay loam in texture. The subsoil is silty clay loam to silty clay. The profile is slightly acid to moderately alkaline. A few small areas of Caldwell silt loam were included in mapping.

This soil is somewhat poorly drained or poorly drained and very slowly permeable. It holds 9 to 11 inches of water that plants can use. It is high in fertility. It is easy to work, but tillage is sometimes delayed in spring by a temporary high water table. Freezes late in spring are common. Although restricted by excess water and the very slowly permeable subsoil, some roots penetrate below a depth of 5 feet. Surface runoff is slow, and the hazard of erosion is slight. Low areas are subject to overflow.

More than 90 percent of the acreage is cultivated; the rest is used as grassed waterways. Spring wheat is the chief crop. Other crops grown are barley, oats, clover, and grass. Grain crops respond to nitrogen; legumes respond to sulfur. (Capability unit IIIw–2; Bottomland range site; not in a woodland group)

Marble Series

The Marble series is made up of excessively drained soils that have a surface layer of loamy sand, loamy coarse sand, or sandy loam and a subsoil or substratum of coarse sand. These soils occupy level to moderately steep terraces. They formed in sandy outwash under grass, shrubs, and scattered pines. The annual precipitation is 15 to 20 inches, and the frost-free season is about 140 days.

Marble soils are used for grass and alfalfa, as woodland, and as building sites.

Marble loamy sand, 0 to 30 percent slopes (MoC).—This is the dominant soil on the sandy, somewhat dunelike terraces near Deep Creek and the town of Chester. Most slopes are between 4 and 12 percent. Representative profile:

0 to 3 inches, very dark brown, very friable loamy sand; granular structure; slightly acid.
3 to 6 inches, dark-brown, very friable loamy coarse sand; slightly acid.
6 to 60 inches +, light olive-brown, loose coarse sand; multicolored below a depth of 47 inches; few, irregular, wavy bands of loam ⅛ to ¼ inch thick at a depth between 6 and 47 inches; neutral.

The color of the surface layer ranges from very dark grayish brown to very dark brown. As much as 5 percent of some areas consists of Springdale or other Marble soils.

This soil is excessively drained and rapidly permeable. It holds less than 5 inches of water that plants can use and is low in fertility. It is easy to work. Root penetration is very deep. Surface runoff is slow. There is a slight hazard of water erosion and a severe hazard of wind erosion.

This soil is suited to grazing and to growing ponderosa pine. It is not generally considered suitable for cultivation; however, fair stands of alfalfa are obtained a few years after establishment. (Capability unit VIIs–1; woodland group 17; not in a range site)

Marble sandy loam, 0 to 8 percent slopes (McB).—This soil occurs on terraces in the central part of the county. Representative profile:

0 to 8 inches, dark grayish-brown, very friable sandy loam; granular structure; neutral; undisturbed areas have an organic mat 1 inch thick on the surface.
8 to 23 inches, light yellowish-brown, very friable fine sandy loam underlain by friable coarse sandy loam below a depth of 16 inches; slightly acid.
23 to 60 inches, variegated coarse sand; loose; neutral.

The color of the uppermost 8 inches ranges from very dark grayish brown to dark brown. The texture of the subsoil ranges from fine sandy loam to coarse sandy loam. The depth to coarse sand ranges from 20 to 48 inches. In some areas a few waterworn pebbles occur in the soil. As much as 10 percent of some areas consists of Springdale, Marble, or Bong soils that have a slope range of 0 to 8 percent.

This soil is somewhat excessively drained and has moderately rapid permeability. It holds 5 inches or less of water that plants can use. It is low in fertility. It is easy to work. Root penetration is very deep. Surface runoff is slow, and there is little or no hazard of erosion.

About 10 percent of the acreage is cultivated; the rest is used for growing ponderosa pine, for grazing, and as homesites. The principal crops are wheat, alfalfa, grass, and legumes. Grass and grain crops respond to nitrogen, and nitrogen is also desirable for establishing legumes. This soil is very good for residential and other building sites. (Capability unit IVe–5; woodland group 15; not in a range site)

Marble loamy coarse sand, 0 to 30 percent slopes (MbC).—This is the dominant soil that formed from glacial sands reworked by wind. It is near Mead. Most slopes are between 7 and 15 percent; there are a few slopes of more than 15 percent, and a few of less than 7 percent. Representative profile:

0 to 5 inches, very dark brown loamy coarse sand; granular structure; slightly acid; undisturbed areas have a thin layer of pine needles and twigs on the surface.
5 to 13 inches, dark-brown loamy coarse sand; slightly acid.
13 to 24 inches, brown to dark-brown sand; neutral.
24 to 60 inches +, variegated but dominantly dark yellowish-brown sand; three yellowish-brown, wavy, irregular band-like stainings occur in this layer, and they are finer textured than the surrounding material; neutral.

The color of the surface layer ranges from very dark brown to very dark grayish brown, and the texture from loamy sand to sand. The texture of the subsoil ranges from loamy coarse sand to coarse sand. In places there are a few pebbles in the profile. A few granite outcrops occur in places. As much as 7 percent of some areas consists of Marble sandy loam, Marble loamy sand, or Hagen loamy fine sand.

This soil is excessively drained and rapidly permeable. It holds less than 5 inches of water that plants can use. It is low in fertility. It is easy to work. Root penetration is very deep. Surface runoff is slow, and the hazard of water erosion is slight, but there is a severe hazard of wind erosion.

Less than 20 percent of this soil is cultivated. Alfalfa and grass are the chief crops. Grain should be grown only when reestablishing alfalfa and grass. Yields of hay and pasture are fair, but yields of grain are low. Alfalfa needs phosphorus and minor elements. (Capability unit VIs–1; woodland group 14; not in a range site)

Mondovi Series

The Mondovi series consists of very deep, dark-colored, well-drained soils of silt loam texture throughout. These soils formed under grass in silty alluvium that included volcanic ash. They are in nearly level areas along drainageways. The annual precipitation is 15 to 18 inches. The frost-free season is about 110 days.

The Mondovi soils are used for grain, peas, alfalfa, clover, and grass.

Mondovi silt loam (Md).—This is the dominant soil along drainageways in the silty uplands in the western and southwestern parts of the county. The slope range is 0 to 5 percent. Representative profile:

0 to 60 inches, very dark brown, friable silt loam; granular structure in upper 8 inches; neutral.

In places the surface layer is black. As much as 5 percent of some areas consists of Athena, Reardan, or Uhlig soils.

This soil is well drained and moderately permeable. It holds more than 11 inches of water that plants can use. It is high in fertility. Root penetration is very deep. Surface runoff is slow, and the hazard of erosion is slight. This soil may be saturated for a few days in spring, and some areas are flooded occasionally.

More than 95 percent of the acreage is cultivated; the rest is used for seeded pasture and waterways. Wheat is the chief cash crop. In most places it is grown in a wheat-fallow rotation, but some areas are cropped annually and peas, barley, and oats are included in the rotation. Other crops grown are alfalfa for hay or green manure, and grass for pasture or hay. All crops except legumes respond to nitrogen. Some crops, especially legumes, respond to sulfur. (Capability unit IIe–5; Bottomland range site; not in a woodland group)

Moscow Series

The Moscow series consists of well-drained, medium-textured soils underlain by bedrock at a depth of 20 to 30 inches or more. These soils formed under conifers in weathered granite, gneiss, or schist that is mixed in the upper part with loess and volcanic ash. They are on hilly to steep uplands. The annual precipitation is 20 to 27 inches, and the frost-free season is about 90 days.

Moscow soils are used for grain, alfalfa, and grass and as woodland.

Moscow silt loam, 30 to 55 percent slopes (MmD).—This is the dominant soil on the mountainous uplands in

unit VIe–2; woodland group 7; not in a range site. Spokane loam—capability unit IVe–4; woodland group 6; not in a range site)

Spokane complex, 30 to 70 percent slopes (SsE).—From 60 to 70 percent of this complex is moderately shallow Spokane loam; from 15 to 25 percent is Spokane loam that has a slope range of 30 to 55 percent; the rest consists of Moscow soils and other Spokane soils. The moderately shallow Spokane loam has a surface layer 3 or 4 inches thinner than that of Spokane loam, 0 to 30 percent slopes, and is 20 to 30 inches deep to bedrock. Surface runoff is rapid or very rapid, and the hazard of erosion is very severe.

This complex is used as woodland and for limited grazing. (As a complex: capability unit VIIe–1. By components: Spokane loam, moderately shallow—capability unit VIIe–1; woodland group 7; not in a range site. Spokane loam—capability unit VIe–2; woodland group 6; not in a range site)

Spokane very rocky complex, 0 to 30 percent slopes (StC).—From 50 to 80 percent of this mapping unit is moderately shallow Spokane loam; the rest consists of granite rock outcrops and of Moscow soils or other Spokane soils. These soils make up 15 percent of some areas. (As a complex: capability unit VIIs–2. By components: Spokane loam, moderately shallow—capability unit VIe–2; woodland group 7; not in a range site. Rock outcrops—capability unit VIIIs–1; not in a woodland group or range site)

Spokane very rocky complex, 30 to 70 percent slopes (StE).—From 50 to 80 percent of this mapping unit is moderately shallow Spokane loam. The rest consists of granite rock outcrops.

The acreage is used for timber and for grazing. The use of tractors for logging is limited. (As a complex: capability unit VIIs–2. By components: Spokane soil—capability unit VIIe–1; woodland group 7; not in a range site. Rock outcrops—capability unit VIIIs–1; not in a woodland group or range site)

Spokane extremely rocky complex, 20 to 70 percent slopes (SuE).—From 20 to 50 percent of this mapping unit is a moderately shallow Spokane loam that has a slope range of 30 to 70 percent. The rest consists of rock outcrops. The acreage is used for timber and for grazing. (As a complex: capability unit VIIs–2. By components: Spokane soil—capability unit VIIe–1; woodland group 7; not in a range site. Rock outcrops—capability unit VIIIs–1; not in a woodland group or range site)

Springdale Series

The Springdale series consists of somewhat excessively drained, coarse textured and moderately coarse textured, gravelly and cobbly soils. These soils formed in glacial outwash mixed with some volcanic ash, under ponderosa pine and grass. They are nearly level to very steep soils on outwash terraces and flood plains. The annual precipitation is 15 to 18 inches, and the frost-free season is about 140 days.

Soils of the Springdale series are used for alfalfa, grass, and grain. They are also used for grazing and as woodland.

Springdale gravelly sandy loam, 0 to 20 percent slopes (SwB).—This is the dominant soil on the outwash terraces and glacial flood plains near Colbert and Chattaroy in the central part of Spokane County. Most slopes are between 2 and 10 percent; a few are steeper. Representative profile:

0 to 2 inches, very dark grayish-brown, very friable gravelly coarse sandy loam; granular structure; neutral; undisturbed areas have an organic mat 1 inch thick on the surface.
2 to 12 inches, dark-brown, friable gravelly coarse sandy loam; slightly acid, medium acid below a depth of 6 inches.
12 to 24 inches, dark yellowish-brown gravelly loamy coarse sand; slightly acid.
24 inches +, gravelly coarse sand.

The color of the surface layer is very dark grayish brown to very dark brown. The subsoil ranges from dark brown to dark yellowish brown in color and from gravelly sandy loam to gravelly loamy coarse sand in texture. Gravelly coarse sand is at a depth of 20 to 36 inches. In some areas cobblestones occur throughout the profile. As much as 10 percent of some areas consists of other Springdale soils; 5 percent of Bonner gravelly silt loam; and 3 percent of Clayton sandy loam.

This soil is somewhat excessively drained and has moderately rapid permeability. It holds less than 5 inches of water that plants can use. It is low in fertility. In general, it is easy to work. Roots of most plants penetrate only a few inches into the gravelly coarse sand. Surface runoff is slow, and the hazard of erosion is slight.

Most of the acreage is used as woodland and for grazing. Yields of forage are low. Less than 10 percent is cultivated, and only a few small areas are irrigated. The crops grown are alfalfa and grass for hay or pasture. Wheat or rye is grown during reestablishment of alfalfa and grass. Legumes respond to sulfur and sometimes to boron. (Capability unit VIe–2; woodland group 17; not in a range site)

Springdale gravelly loamy sand, 30 to 70 percent slopes (SzE).—This soil is moderately extensive on terrace breaks and colluvial slopes along major drainageways in the central part of the county. Representative profile:

0 to 11 inches, dark-brown gravelly loamy sand; neutral; granular structure and slightly darker color in upper 3 inches.
11 to 17 inches, brown gravelly loamy sand; few dark-brown and reddish-brown mottles; neutral.
17 to 60 inches +, brown very gravelly coarse sand; neutral.

The texture of the surface layer ranges from gravelly loamy sand to gravelly or cobbly sand. The gravel content of the subsoil ranges from 40 to 90 percent. As much as 10 percent of some areas consists of Marble loamy coarse sand, 0 to 30 percent slopes, and of other Springdale soils.

This soil is somewhat excessively drained and has moderately rapid permeability. It holds less than 5 inches of water that plants can use. The fertility is low. Root penetration is deep. The use of machinery is difficult. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

This soil is used as a source of gravel for concrete. There is some grazing on the less sloping areas, but yields of forage are low. (Capability unit VIIs–1; woodland group 19; not in a range site)

Springdale gravelly sandy loam, deep, 0 to 20 percent slopes (SxB).—This soil has a surface layer 1 or 2 inches thicker than that of Springdale gravelly sandy loam, 0 to 20 percent slopes, and the depth to gravel and cobblestones is more than 36 inches. This soil holds 5 to 7 inches of water that plants can use. As much as 10 percent of some

(Joins sheet 81)

R. 42 E

MARSHALL LANDFILL PROPERTY

Marshall

Scribner

Needham

MIL RES

T. 24 N.

(Joins sheet 89)

(Joins sheet 91)

(Joins sheet 99)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

MARSHALL LANDFILL IMPORTED COVER MATERIAL SOURCE

Wilcox Pit Legal Description:

That portion of the SE quarter of Section 31, Township 24 North, Range 42 East, Willamette Meridian, Spokane County, Washington, lying southerly of Jensen Road and Easterly of Andrus Road with a southern boundary along a line beginning 750 feet east of Andrus Road and 500 feet south of Jensen Road and proceeding due east.

More than 95 percent of the acreage is cultivated; the rest is used for grazing and as farmsteads. Grass seed and wheat are the principal crops. Other important crops are barley, oats, grass, legumes, vegetables, and orchard fruits. All crops except legumes respond to nitrogen. Specialized crops respond to trace elements. (Precipitation 15 to 18 inches—capability unit IIIe-2; precipitation 18 to 21 inches—capability unit IIIe-1; Loamy range site; not in a woodland group)

Uhlig silt loam, 0 to 5 percent slopes (UhA).—This soil has a surface layer 2 to 4 inches thicker than that of Uhlig silt loam, 5 to 20 percent slopes, and the depth to lime is more than 60 inches. Surface runoff is slow, and the erosion hazard is slight. Small areas of Cheney, Nez Perce, Bernhill, Reardan, and Hesseltine soils were included in mapping.

The same crops are grown as on Uhlig silt loam, 5 to 20 percent slopes, but more vegetables are grown and yields are slightly higher. (Precipitation 15 to 18 inches—capability unit IIe-1; precipitation 18 to 21 inches—capability unit IIe-2; Loamy range site; not in a woodland group)

Uhlig silt loam, moderately shallow, 5 to 30 percent slopes (UmC).—This soil has a surface layer 3 to 5 inches thinner than that of Uhlig silt loam, 5 to 20 percent slopes. Bedrock is at a depth of 30 to 40 inches, and the lower subsoil is gravelly. Roots penetrate to the gravel or bedrock. This soil holds 5 to 7 inches of water that plants can use. It has medium fertility. Small areas of Bernhill soils were included in mapping.

Most of the acreage is seeded to small grain, to grass for seed, and to alfalfa and grass for hay and pasture. (Capability unit IIIe-4; Shallow range site; not in a woodland group)

Vassar Series

The Vassar series consists of well-drained, medium-textured soils underlain by gneiss bedrock below a depth of 36 inches. These soils formed in coarse loess and volcanic ash, under conifers. They occupy rolling to very steep mountainous areas. The annual precipitation is 30 to 47 inches. The frost-free season is 60 to 90 days.

Soils of the Vassar series are used for woodland, wildlife, recreational, and watershed purposes.

Vassar silt loam, 30 to 55 percent slopes (VaD).—This is the dominant soil above an elevation of 3,000 feet near Mount Spokane. Representative profile:

0 to ½ inch, dark grayish-brown very friable loam, light brownish gray when dry; medium acid; undisturbed areas have an organic mat 1½ inches thick on the surface.
½ inch to 22 inches, dark-brown, very friable silt loam in upper part, loam below a depth of 15 inches; medium to slightly acid.
22 to 55 inches, pale-brown, friable gravelly loam; medium acid.
55 inches +, gneiss bedrock.

The bleached surface layer is absent in some places and as much as 1 inch thick in others. Gneiss bedrock is at a depth of 36 to 60 inches or more. As much as 5 percent of some areas is Vassar silt loam, 0 to 30 percent slopes, and as much as 1 percent consists of gneiss rock outcrops. At lower elevations, as much as 10 percent is Moscow silt loam.

This soil is well drained and moderately permeable. It holds 5 to 7 inches of water that plants can use. The fertility is medium. Roots penetrate to bedrock. Surface runoff is rapid, and the hazard of erosion is severe.

None of this soil is cultivated. It is suited to forest Tractor logging is difficult because of the slope. (Capa ity unit VIe-2; woodland group 1; not in a range site)

Vassar silt loam, 0 to 30 percent slopes (VaC).—T soil has medium surface runoff. The hazard of erosio moderate. As much as 5 percent of some areas is Mos silt loam, and 1 percent consists of gneiss outcrops.

This soil is suitable for woodland. There is no difficu in the use of tractors for logging. A small acreage been cleared and seeded to small grain, grass, and alf for hay. (Capability unit VIe-2; woodland group 1; in a range site)

Vassar very rocky silt loam, 20 to 55 percent slo (VsD).—From 40 to 80 percent of this mapping uni Vassar silt loam, 30 to 55 percent slopes; the rest sists of gneiss rock outcrops. The acreage is used producing timber. (As a complex: capability VIIs-2. By components: Vassar soil—capability VIe-2; woodland group 1; not in a range site. Rock crops—capability unit VIIIs-1; not in a woodland gr or a range site)

Wethey Series

The Wethey series consists of nearly level, somew poorly drained and poorly drained sandy soils a streams. These soils formed in alluvium derived p cipally from granite and argillite, under grass, reeds, aspen. The annual precipitation is 18 to 22 inches. frost-free season is about 100 days.

Wethey soils are used for spring grain, alfalfa, cl and grass and as range.

Wethey loamy sand (We).—This is the dominant along Wethey Creek and the southern end of Dra Creek. The nearly level topography is cut by n sloughs and abandoned stream channels. Represent profile:

0 to 23 inches, light-gray to black, grayish-brown, and b loose, stratified loamy sand and sand; neutral.
23 to 45 inches, very dark brown, very friable fine sandy or loamy fine sand; dark-brown mottles; neutral.
45 to 60 inches, very dark gray, friable loam; dark-l mottles; neutral.

As much as 5 percent of some areas consists of Br son silt loam, drained, or Wethey loamy sand, draine

This soil is poorly drained and moderately perme The depth to the water table ranges from 36 to 65 in The soil holds 5 to 7 inches of water that plants ca and is low in fertility. Root penetration is limite the water table. Surface runoff is very slow, and is little or no hazard of erosion. Floods commonly during spring runoff and deposit fresh material o surface.

This soil is suited to grass and clover. Grass resp to nitrogen, and clover responds to sulfur. (Capal unit Vw-1; Wet Meadow range site; not in a wood group)

Wethey loamy sand, drained (Wh).—Because dra has been improved by stream cutting or by artificial m this soil is now somewhat poorly drained rather poorly drained. As much as 5 percent of some area sists of Bridgeson silt loam or undrained Wethey s

This soil is used for grain, alfalfa, and grass. and grass crops respond to nitrogen; alfalfa respon

areas consists of other Springdale soils, and as much as 8 percent consists of Bonner and Clayton soils.

This soil is used for the same crops as Springdale gravelly sandy loam, 0 to 20 percent slopes, but produces higher yields. (Capability unit IVe-5; woodland group 15; not in a range site)

Springdale cobbly sandy loam, 0 to 20 percent slopes (SyB).—This soil contains gravel and cobblestones at a depth of 20 to 36 inches. As much as 10 percent of some areas consists of other Springdale soils.

This soil is used as woodland and for grazing. (Capability unit VIIs-1; woodland group 17; not in a range site)

Tekoa Series

The Tekoa series consists of well-drained, gravelly, medium-textured soils. These soils formed under conifers and grasses in weathered sandstone, quartzite, schist, and shale. They occupy gently sloping to very steep hilly and mountainous areas. The annual precipitation is about 22 inches, and the frost-free season is about 120 days.

Tekoa soils are used for grazing, as woodland, and as wildlife habitats. A few small areas are used for grain, grass, and legumes.

Tekoa gravelly silt loam, 30 to 55 percent slopes (TeD).—This soil occurs on Tekoa Mountain and similar promontories in the county. Most slopes are between 30 and 45 percent. Representative profile:

0 to 14 inches, dark-brown, friable gravelly silt loam, granular in the upper 5 inches; neutral, grading to slightly acid below a depth of 5 inches; undisturbed areas have an organic mat ½ inch thick on the surface.
14 to 20 inches, dark-brown, friable gravelly heavy silt loam that breaks into prisms 1 to 2 inches wide and then into subangular blocks ⅛ to ½ inch wide; medium acid.
20 to 38 inches, yellowish-brown very gravelly loam; massive or finely laminated; medium acid.
38 inches +, fractured sandstone.

The color of the surface layer is brown or dark brown. The texture of the subsoil is gravelly loam or gravelly silt loam. Fractured parent rock occurs at a depth of 24 to 40 inches. As much as 8 percent of some areas consists of Bernhill and Schumacher soils.

This soil is well drained and moderately permeable. It holds 5 to 7 inches of water that plants can use. The fertility is low. Roots penetrate to the sandstone. Surface runoff is rapid, and the hazard of erosion is severe.

None of this soil is cultivated. It is used for timber, for grazing, and by wildlife. (Capability unit VIe-2; woodland group 7; not in a range site)

Tekoa gravelly silt loam, 5 to 20 percent slopes (TeB).—The surface layer of this soil is a little thicker than that of Tekoa gravelly silt loam, 30 to 55 percent slopes. Surface runoff is medium, and the erosion hazard is moderate. Surface gravel hinders cultivation in some places. As much as 3 percent of some areas consists of Bernhill and Schumacher soils.

This soil is used mainly for timber and grazing. A few small areas are used for small grain and alfalfa, or are seeded to grass and legumes for pasture or hay. Yields are fair. Grain and grass crops respond to nitrogen; legumes respond to sulfur and phosphorus. (Capability IVe-4; woodland group 7; not in a range site)

Tekoa gravelly silt loam, 20 to 30 percent slopes (TeC).—This gravelly soil has medium to rapid surface runoff and a moderate to severe hazard of erosion. About 3 percent of some areas consists of Bernhill and Schumacher soils.

This soil is used primarily for timber production. Small areas are seeded to small grain or to grass and legumes for hay or pasture. (Capability unit VIe-2; woodland group 7; not in a range site)

Tekoa very rocky complex, 25 to 55 percent slopes (TkD).—From 20 to 50 percent of this mapping unit consists of sandstone outcrops; the rest is a Tekoa gravelly silt loam that has a slope range of 30 to 55 percent. The acreage is used for grazing. (As a complex: capability unit VIIs-2. By components: Tekoa soil—capability unit VIe-2; woodland group 7; not in a range site. Rock outcrops—capability unit VIIIs-1; not in a woodland group or range site)

Uhlig Series

The soils of the Uhlig series are dark colored, well drained, and medium textured. They are very deep for the most part, but bedrock is at a depth of 30 to 40 inches in some places. These soils formed under grass in glacial till mixed in the upper part with loess and volcanic ash. They occupy gently sloping to moderately steep uplands. The annual precipitation is 15 to 21 inches. The frost-free season is about 140 days.

Uhlig soils are used for grain, peas, lentils, grass, alfalfa, vegetables, and orchard fruits.

Uhlig silt loam, 5 to 20 percent slopes (UhB).—This is the dominant soil on Peone, Orchard, and Pleasant Prairies in the central part of the county, which receives 18 to 21 inches of rainfall annually. It also occurs on the glacial outwash plain in the western and southwestern parts of the county, which receive 15 to 18 inches of rainfall. Most slopes are between 6 and 10 percent; a few are steeper. Representative profile:

0 to 4 inches, black, very friable silt loam; granular structure; medium acid.
4 to 18 inches, very dark gray, very friable silt loam above a depth of 10 inches; breaks into plates 1/16 to ⅜ inch thick; slightly acid; very dark brown, very friable silt loam below a depth of 10 inches; neutral.
18 to 42 inches, dark-brown, firm loam, friable below a depth of 32 inches; breaks into subangular blocks ½ to 1 inch wide; neutral.
42 to 60 inches, brown, very friable very fine sandy loam; neutral.

The color of the surface layer ranges from black to very dark brown. The texture of the subsoil ranges from silt loam to very fine sandy loam. Lime occurs in places below a depth of 36 inches. In some areas as much as 15 percent of the subsoil consists of coarse granite and basalt sand, gravel, and a few cobblestones. In places a gravelly and sandy layer is present at a depth of 36 to 48 inches. As much as 10 percent of some areas consists of Bernhill, Cheney, Snow, and Hesseltine soils.

This soil is well drained and moderately permeable. It holds 7 to 11 inches of water that plants can use. The fertility is high. Root penetration is very deep. There is no difficulty in the use of farm machinery. Surface runoff is medium, and the hazard of erosion is moderate.


U.S. MILITARY RESERVATION
U.S. MILITARY RESERVATION
Borrow Pit
MEADOW RD
ROAD
JENSEN
ROAD
JENSEN
Well
Substation
Minnie
BURLINGTON
NORTHERN
Rodeo Grounds
Borrow Pit
Prosser Hill
Borrow Pit
WILCOX PIT
ANDRUS
ROAD
MURPHY
ROAD
Green Mound Cem
Borrow Pit
Creek
Sandpit
BETZ
ROAD
Water Tank
CHENEY
Big Springs
BURLINGTON
ANDERSON
UNION
Sandpit
30
31
36
6
5
1
20
29
32
2384
2732
2623
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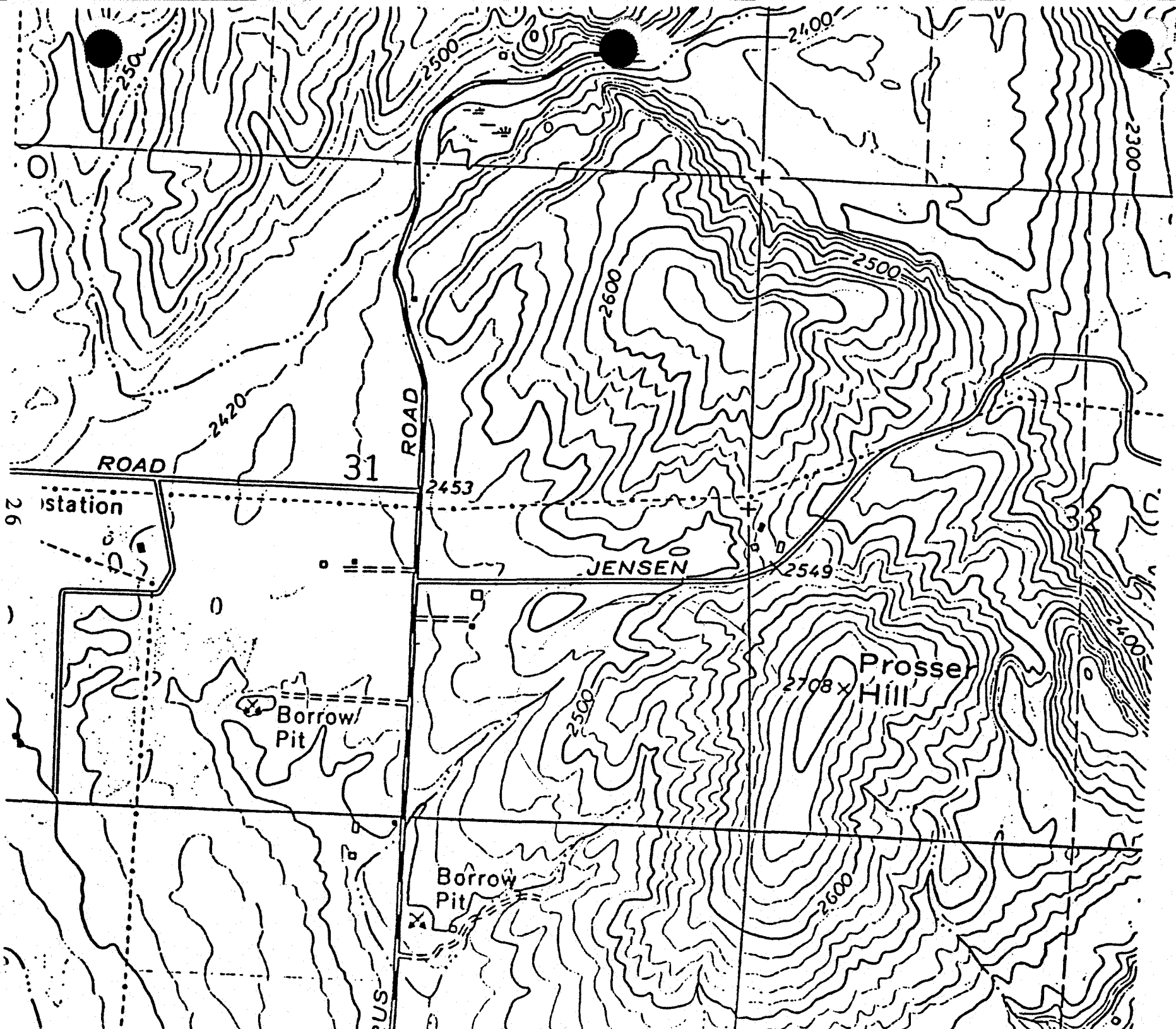

2500
2400
2300
2600
2500
2420
ROAD
31
ROAD
2453
26
Station
JENSEN
2549
32
2400
Prosser
Hill
2708
Borrow
Pit
2500
Borrow
Pit
2600

(Joins sheet 81)

ENVIRONMENTAL CHECKLIST

Purpose of Checklist:

The State Environmental Policy Act (SEPA), chapter 43.21C RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The purpose of this checklist is to provide information to help you and the agency identify impacts from your proposal (and to reduce or avoid impacts from the proposal, if it can be done) and to help the agency decide whether an EIS is required.

Instructions for Applicants:

This environmental checklist asks you to describe some basic information about your proposal. Governmental agencies use this checklist to determine whether the environmental impacts of your proposal are significant, requiring preparation of an EIS. Answer the questions briefly, with the most precise information known, or give the best description you can.

You must answer each question accurately and carefully, to the best of your knowledge. In most cases,m you should be able to answer the questions from your own observations or project plans without the need to hire experts. If you really do not know the answer, or if a question does not apply to your proposal write "do not know" or "does not apply". Complete answer to the questions now may avoid unnecessary delays later.

Some questions ask about governmental regulations, such as zoning, shoreline, and landmark designations. Answer these questions if you can. If you have problems, the governmental agencies can assist you.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal; or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Use of checklist for nonproject proposals:

Complete this checklist for nonproject proposals, even though questions may be answered "does not apply." IN ADDITION, complete the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D).

For nonproject actions, the references in the checklist to the words "project," and "property or site" should be read as "proposal," "proposer," and "affected geographic area," respectively.

A. BACKGROUND

1. Name of proposed project, if applicable:

Marshal Landfill

2. Name of applicant:

Marshal Landfill Inc.

3. Address and phone number of applicant and contact person:

P.O. Box 10
Marshall, Washington 99020

4. Date checklist prepared:

September 1, 1989

5. Agency requesting checklist:

Spokane County Health District

6. Proposed timing or schedule (including phasing, if applicable):

Begin filling to final contours September 30, 1989. Close the final landfill section by October 1, 1991.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

Yes, under separate permit a new six (6) acre fully lined landfill cell at an adjacent location. The new facility will have leachate collection, treatment and disposal as well as gas venting.
This request is for continuation of existing waste disposal while reshaping and preparing the landfill for closure. A proposal will be submitted for the new landfill which will allow for the opening to coincide with the closure of the present site.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

- WDOE Phase I and II Site Inspection Report, December 1987.
- Waste-Disposal Site Investigation, Phase I Report,Shannon & Wilson, June 1983.
- An EIS is being prepared by Century West Engineering for this site as a possible ash disposal site.
- Application and geotechnical narrative which accompanies this request and checklist.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? if yes, explain.

Yes, Conditional Use Permit request for expansion landfill.

10. List any government approvals or permits that will be needed for your proposal, if known.

Variance approval for time extension.

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The proposal consists of two interrelated activities. The first activity is the continuation of deposition of waste to allow for shaping, contouring and grading the landfill to final closure configuration. These activities are in preparation for the second activity which is final closure of the existing landfill.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit application related to this checklist.

Approximately one mile southwest of Marshall, Washington, between the Cheney-Spokane Road and Spotted Road. Public access is from Spotted Road. (Section 21, Township 24 North, Range 42 East)

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other _____.

Slightly rolling hills with Minnie Creek Valley on the eastern margin of the site.

b. What is the steepest slope on the site (approximate percent slope)?

Approximately 40%, final slopes at closure will be no greater than 33%.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

Glaciofluvial sands predominate at the site.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

There are no visible indications of unstable soils in the vicinity of the site.

e. Describe the purpose, type and approximate quantities of any filling or grading proposed. Indicate source of fill.

Approximately 205,000 cu. yds. of waste, compacted and in place, will be deposited at the site prior to closure, approximately 40,000 cu. yds. of daily cover will be used during final stages of shaping and contouring the landfill. Approximately 75,000 cu. yds. of clay cover material will be imported from the Fawcett and Wilcox clay borrow areas to be placed in

a continuous two foot closure cover. Approximately 19,000 cu. yds. of local sandy top soil will be used as the final six inches of cover.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Erosion control features are included in the closure plans.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Daily cover will be provided as needed while final lifts and contours are shaped. Upon closure, 100% of the landfill will be covered. The closure will be completed with a minimum thickness of two feet of clayey material (permeability of less than 1×10^{-6} cm/sec). Final surface will be native soils.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

Surface drainage will divert seasonal storm runoff away from the closed landfill.

2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? if any, generally describe and give approximate quantities if known.

Odors which are associated with municipal landfill waste are present, but controlled with daily cover. Upon closure, some production of gasses is expected.

b. Are there any off-site sources of emissions or odor that may affect your proposal? if so, generally describe.

There is a chicken ranch to the northwest of the site which has significant odors, but is not expected to impact this site.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

Daily cover of waste will reduce odor generated at the site. A passive gas collection and elimination system is included in the closure plans.

3. Water

a Surface:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

Queen Lucas Lake lies about a quarter mile to the south of the site. Minnie Creek, an intermittent stream, is located 0.2 mile southeast of the landfill. Drainage from the lake is to Marshall Creek via Minnie Creek. Marshall Creek flows into the Spokane River which in turn flows into the Columbia River.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

No

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

None

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

Surface drainage will be provided to divert seasonal runoff.

5) Does the proposal lie within a 100-year floodplain? If so, not location on the site plan.

No

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

None will be discharged.

b. Ground:

1) Will groundwater be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.

Some leachate from the existing landfill can be expected. Discharge of leachate to ground water will be reduced in the area where top cover is complete.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals . . .; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

There is one on-site sewage disposal system which serves the employees at the site.

c. Water Runoff (including storm water):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Runoff sources are occasional storms and seasonal thaws. Collection of runoff will be accomplished by perimeter ditching which will divert surface water to a point topographically below the landfill. At this point the runoff will either percolate into the sandy soil or flow to Minnie Creek, an intermittent stream.

2) Could waste materials enter ground or surface waters? If so, generally describe.

Some incidental leachate from this landfill could possibly reach ground water.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

Surface drainage will be provided to control surface runoff, and closure cover will be provided to reduce leachate generation with in the landfill.

4. Plants

a. Check or circle types of vegetation found on the site:

____deciduous tree: alder, maple, aspen, other

__X__evergreen tree: fir, cedar, pine, other

____shrubs

__X__grass

____pasture

____crop or grain

____wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other

____water plants: water lily, eelgrass, milfoil, other

____other types of vegetation

The actual site is currently denuded. There are a total of 30 vascular plant species found in the surrounding area.

b. What kind and amount of vegetation will be removed or altered?

The closed landfill will be planted to grass.

c. List threatened or endangered species known to be on or near the site.

None

d. Proposed landscaping. use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

The closure will include seeding of the area.

5. Animals

a. Circle any birds and animals which have been observed on or near the site or are known to be on or near the site:

birds: hawk, heron, eagle, songbirds, other:

mammals: deer, bear, elk, beaver, other:

fish: bass, salmon, trout, herring, shellfish, other:

A total of seven bird species and two mammal species may be seen at or near the site.

b. List any threatened or endangered species known to be on or near the site.

None

c. Is the site part of a migration route? If so, explain.

No

d. Proposed measures to preserve or enhance wildlife, if any:

Upon completion of landfill closure, natural feed will be available on the planted cover material.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

None

b. Would your project affect the potential use of solar energy by adjacent properties? if so, generally describe.

No

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Does not apply.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk or fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

Closure of the landfill reduces risk of exposure to potential hazards.

1) Describe special emergency services that might be required.

Standard emergency services, which would be required for any heavy earthwork construction site, would be required.

2) Proposed measures to reduce or control environmental health hazards, if any:

Cover material will have a very low permeability and therefore will greatly reduce any possible recharge of the watertable through the waste.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

There are train tracks to the east of the site and a chicken farm to the north of the site, neither will affect the operation or closure of the landfill.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Noise levels will remain constant at current levels, excepting a slight increase in noise associated with truck and grading equipment during final closure. Upon completion of closure noise will be incidental.

3) Proposed measures to reduce or control noise impacts, if any:

None

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

Solid waste disposal, agricultural, mining, and rural residential.

b. Has the site been used for agriculture? If so, describe.

No

c. Describe any structures on the site.

Presently, two mobile homes, two shop buildings and one office building are present on the site.

d. Will any structures by demolished? If so, what?

No

e. What is the current zoning classification of the site?

Agricultural and Mining.

f. What is the current comprehensive plan designation of the site?

Rural

g. If applicable, what is the current shoreline master program designation of the site?

Does not apply.

h. Has any part of the site been classified as an "environmentally sensitive" area? if so, specify.

No

i. Approximately how many people would reside or work in the completed project?

Approximately nine people are currently employed at the site on a daily basis. Upon closure, employment at the existing site will be negligible. No on-site housing is anticipated, none currently is in use.

j. Approximately how many people would the completed project displace?

None. Upon closure, if another site was not opened, the nine people employed at the site would not be employed. No residences would be displaced by this action.

k. Proposed measures to avoid or reduce displacement impacts, if any:

An expansion of the current site, which will be proposed, would employ any displaced persons.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

Continued use of the site at existing levels until closure. Quarterly monitoring of groundwater will evaluate long-term compatibility. The current site is compatible with rural uses in poor agricultural and silvacultural areas.

Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

Does not apply.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

Does not apply.

c. Proposed measures to reduce or control housing impacts, if any:

Does not apply.

10. Aesthetics.

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The completed landfill will stand approximately fifty feet above surrounding terrain on the west side and approximately 170 feet above the Cheney-Spokane road on the east. A 140 foot bluff already exists on the east side along the Cheney-Spokane Road.

b. What views in the immediate vicinity would be altered or obstructed?

None, most of this landfill is not visible from off site directions. Along the Cheney-Spokane Road a hillside will be visible.

c. Proposed measures to reduce or control aesthetic impacts, if any:

The closed landfill will have a moderate slope of approximately 33%, it will be contoured, graded and planted with grass.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Landfill activities and closure activities will take place during regular daylight working hours, not requiring lighting.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Does not apply.

c. What existing off-site sources of light or glare may affect your proposal?

Does not apply.

d. Proposed measures to reduce or control light and glare impacts, if any:

Does not apply.

12. Recreation

a. What designated and informal recreational \opportunities are in the immediate vicinity?

None

b. Would the proposed project displace any existing recreational uses? If so, describe.

No

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

None

13. Historical and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

None

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

Does not apply.

c. Proposed measures to reduce or control impacts, if any:

Does not apply.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans , if any.

Spotted Road and Cheney-Spokane Road are adjacent to the site on the west and east. Haul routes in the immediate site vicinity include Grove Road, Andrus Road, Spotted Road, and the Cheney-Spokane Road.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

No, Does not apply.

c. How many parking spaces would the completed project have? How many would the project eliminate?

None, Does not apply.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

None required.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

Yes, the project area is near rail transport. Use of the railroad is not anticipated.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

Currently there are approximately 30 commercial waste haulers and approximately 15 private haulers per day. Approximately 75,000 cu. yds. of cover material will be moved to the site during closure activities.

g. Proposed measures to reduce or control transportation impacts, if any:

Transportation levels should remain constant with the exception of a short term increase of truck traffic while cover material is being imported.

15. Public Service

a. Would the project result in an increased need for public services (for example: fire protection, police protection health care, schools, other)? If so, generally describe.

No

b. Proposed measures to reduce or control direct impacts on public services, if any:

None needed.

16. Utilities

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.

Refuse service is available, other utilities are available adjacent to the landfill. Water by an on-site well, a septic system is also on-site. Electricity is acquired from Washington water and Electric, and telephone by U. S. West.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

No utilities are proposed for the closed facility.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

D. SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS

Because these questions are very general, it may be helpful to read them in conjunction with the list of the elements of the environment.

When answering these questions, be aware of the extent the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

1. How would the proposal be likely to increase discharge to water: emissions to air: production, storage, or release of toxic or hazardous substances; or production of noise?

Temporary continuation of waste deposition while reshaping, contouring and grading the landfill and the proposed closure will decrease discharge to water by limiting recharge; decrease emissions to the air by providing cover; help contain potentially hazardous substances which may have been deposited at the site in the past.

Proposed measures to avoid or reduce such increases are:

Does not apply.

2. How would the proposal be likely to affect plants, animals, fish, or marine life?

When closure is complete, the area will be planted to grass.

Proposed measures to protect or conserve plants, animals, fish, or marine life are:

Does not apply.

3. How would the proposal be likely to deplete energy or natural resources?

Neither the continuation of landfill use nor the closure of the landfill will deplete natural resources.

Proposed measures to protect or conserve energy and natural resources are:

Does not apply.

4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?

There are no parks, wilderness areas, wild and scenic rivers, threatened or endangered species habitat, or historical or cultural sites in the area of the landfill. The proposed closure will not affect any wetlands, floodplains or prime farmlands.

Proposed measures to protect such resources or to avoid or reduce impacts are:

Does not apply.

5. How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

The current activities and proposed closure are compatible with existing land planning.

Proposed measures to avoid or reduce shoreline and land use impacts are:

Does not apply.

6. How would the proposal be likely to increase demands on transportation or public services and utilities?

Demands on transportation will remain the same or decrease. The landfill exerts no demand on utilities. Closure will require opening of another landfill site or other disposal process for municipal and public wastes.

Proposed measures to reduce or respond to such demand(s) are:

Does not apply.

7 Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.

The proposed closure will enhance compliance with local, state and federal laws and requirements for the protection of the environment.

SECTION 2

PERMIT REPORT

TABLE OF CONTENTS

Figures

MARSHALL LANDFILL

INTRODUCTION

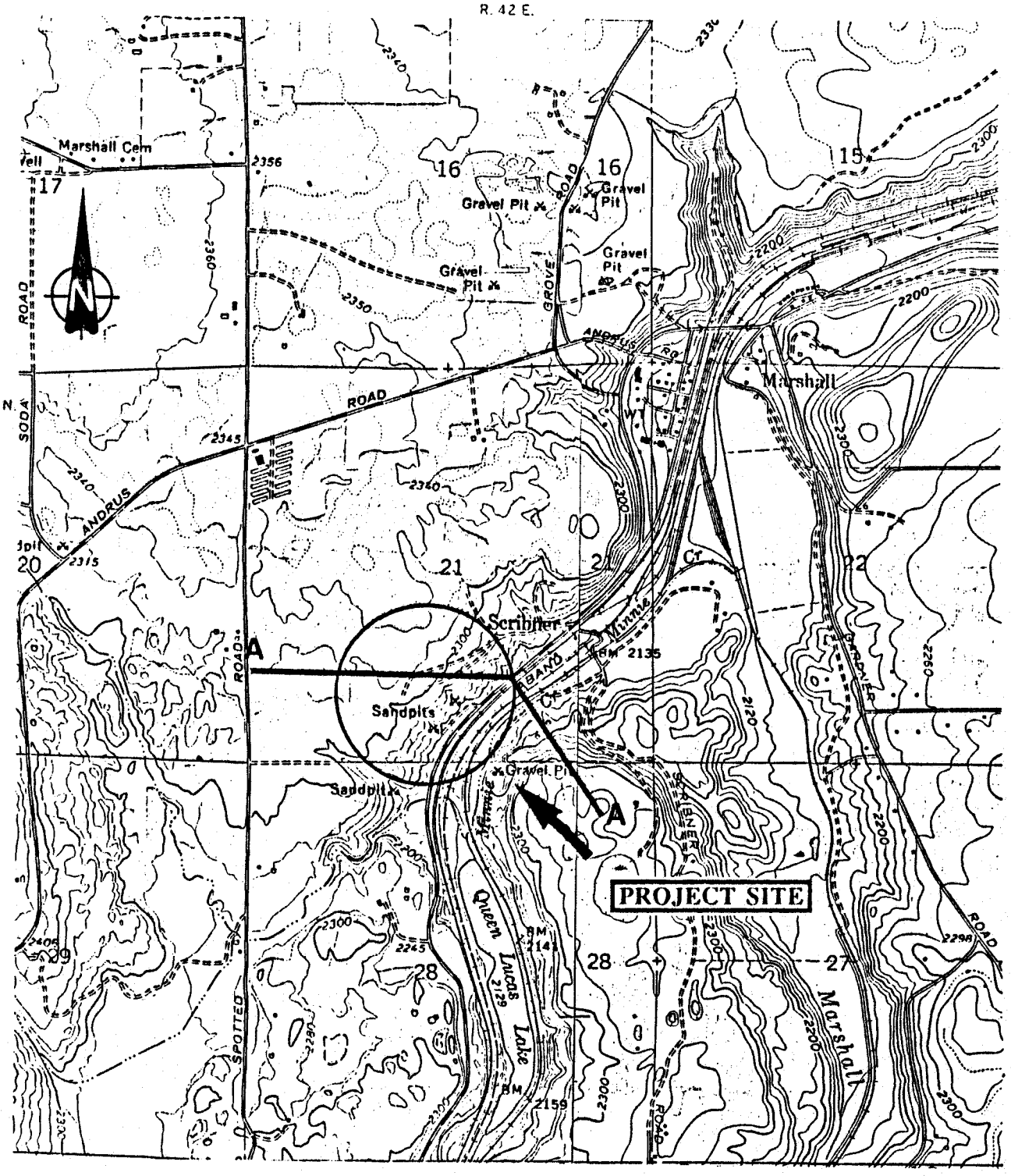
The Marshall landfill is located in central Spokane County, Washington, approximately ten miles south-southwest of Spokane and approximately one mile southwest of the town of Marshall. The existing landfill site occupies about 75 acres in Section 21, Township 24 North, Range 42 East, Willamette Meridian (Figure #1). The landfill is bounded to the north by Andrus Road, to the west by Spotted Road and to the east by the Cheney-Spokane Road. The site is visible only from the Cheney-Spokane Road. The main access is by a gravel road with the entrance on Spotted Road. There are two other entrances off of the Cheney-Spokane Road, with restricted access via locked gates. The landfill is open from 9:00 AM to 5:00 PM Monday through Saturday.

HISTORY

Between 1954 and 1971 Spokane County owned and operated a landfill site directly south of the Marshall landfill. The county landfill was used as a burn site during the 1950's and as a landfill with cell construction and sand cover during the 1960's.

The Marshall Landfill has been privately owned and operated since 1971, when it was purchased from Spokane County. Most of the initial wastes disposed of at the site consisted of domestic garbage and demolition materials. Currently, the Marshall landfill accepts municipal solid waste, demolition debris, tires and appliances. The only hazardous waste accepted is soil contaminated with petroleum hydrocarbons. This soil is deposited over an older cell, spread for air stripping of volatile organic compounds and then mixed with sand, for cover material.

The Marshall landfill receives solid waste from southwest Spokane County, including the towns of Cheney, Medical Lake, Airway Heights, Spangle, and Colfax. The site also receives solid waste from the City of Spokane and from Fairchild Air Force Base. Prior to 1984 it is estimated that the site received between 8,000 to 10,000 cubic yards of waste

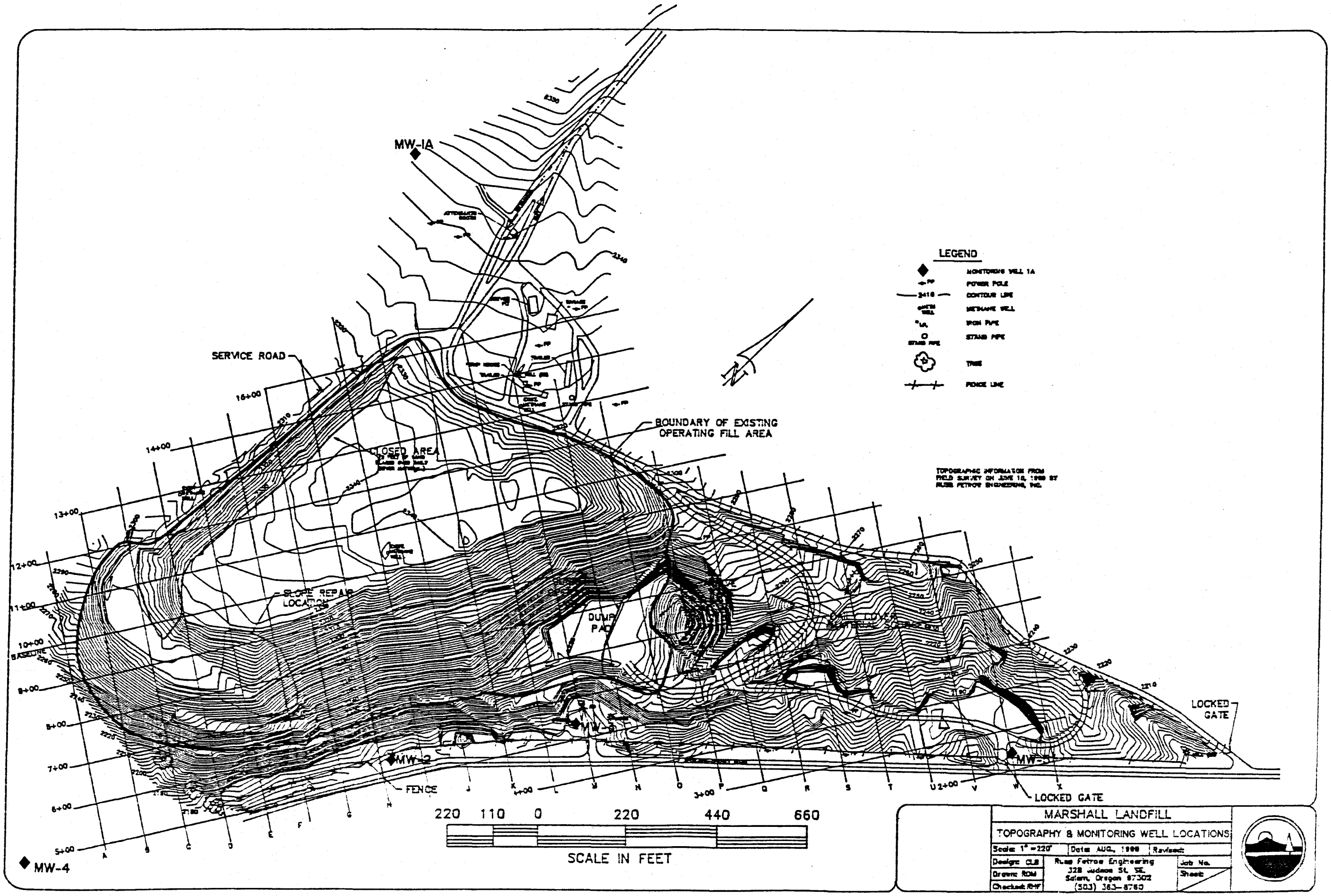


SITE VICINITY MAP FOR THE MARSHALL LANDFILL

BASE MAP FROM THE USGS SPOKANE, SW, WASH., (1986), AND FOUR LAKES, WASH., (1973), 7.5' QUADRANGLES.

RUSS FETROW ENGINEERING, INC.
GeoEnvironmental Branch
2545K PRAIRIE RD., EUGENE, OR 97402
(503) 689-6116

FIGURE # 1



MARSHALL LANDFILL

TOPOGRAPHY & MONITORING WELL LOCATIONS

Scale: 1" = 220'	Date: AUG., 1988	Revised:
Design: CLB	Russ Petrov Engineering	Job No.
Drawn: RDM	328 Judson St. SE.	Sheet:
Checked: RHF	Salem, Oregon 97302	
	(503) 363-8760	

FIGURE #2

per month. In 1987 the Department of Ecology reported that the site received approximately 20,000 cubic yards of waste per month. Presently, landfill records indicate that the site receives approximately 21,000 cubic yards of waste per month. Approximately 82% of the waste stream is municipal solid waste (MSW) and the other 18% consists of demolition debris, tires, stumps and appliances. Approximately 85% of the MSW received at the site is delivered by commercial haulers while the remaining 15% is hauled by the public.

The Marshall landfill operates as a combined sand and gravel material source site and landfill. As sand and gravel is excavated from each disposal unit cell, solid waste is filled in, compacted, and covered daily with a 6-inch layer of sand. At the start of disposal operations in 1971, solid waste was deposited near the base of the excavations, near the 2,200-foot elevation. This occurred near the southeast perimeter of the site, adjacent to the old county dump. As sand and gravel excavation continued into the terrace, the solid waste was deposited progressively to a current summit elevation of 2,340 feet above mean sea level. Upon closure and covering of the landfill the summit elevation is expected to be approximately 2,380 feet above mean sea level.

CLIMATE

The climate in the area of the Marshall Landfill is semiarid. Annual precipitation averages from 15 to 18 inches, with a mean of approximately 17.4. Most precipitation falls during the winter months as snow. Maximum mean monthly precipitation occurs in January (2.5 inches), and the minimum mean in July (0.40 inches).

Summers are warm and dry. Midsummer temperature highs range from 85°F to 95°F and lows from 45°F to 55°F. Extreme temperatures are common during late summer and reach as high as 105°F on occasion.

The average daily temperature during winter months is near freezing. Average minimum temperatures range from 15°F to 25°F. Extremely cold weather occurs

occasionally when arctic air spills over the Rocky Mountains and into the inland basin of the Spokane area. During these periods temperatures down to -20°F are common.

The average relative humidity in the summer is about 50 percent at night and less than 20 percent in the late afternoon when temperatures are generally highest. In midwinter average relative humidity ranges from 85 percent at night to 70 percent in midday.

Frost penetration during a normal winter is generally between 12 and 18 inches. Deeper frost penetration may be expected during very cold winters with little or no snow cover to insulate the ground surface.

Warm winds and rain are not uncommon during winter months in the Spokane area. These winds, referred to as chinooks, melt the snow cover very rapidly. When the surface soils are frozen most of the melt is discharged as runoff and very little recharge to the groundwater occurs.

HYDROGEOLOGY

This report is a summary of previous work done on geology and hydrogeology of the area and the landfill specifically. The previous reports used were; WIRS Technical Bulletin No. 15, 1975; Waste-Disposal Site Investigation Marshall Sanitary Landfill, Phase I Report, Shannon & Wilson, Inc., 1983; and Washington Department of Ecology, Phase I and II Site Inspection Report, Marshall Landfill, Marshall, Spokane County, Washington, WAD980511794, December 1987.

Local and Regional Geology

The regional geology reviewed for this report and reported here extends approximately five miles out from the Marshall landfill. The geology appears as an overprint of younger units lying on top of older ones. Five primary geologic units are exposed at or very near the landfill site. They are, from oldest to youngest, the Precambrian Revett and Burke formations, Miocene to Pliocene Columbia River Basalt

Group, the Latah Formation which was deposited contemporaneously with the basalts, Pleistocene Glaciofluvial deposits and recent alluvium.

The Precambrian metamorphic Revett and Burke Formations underlie the site at depth, as basement, and can be observed in surface outcrops to the south of Queen Lucas Lake, and west of the landfill site in the Needham Hills. Domestic water wells drilled on the southeast perimeter of the landfill and further to the southeast across Minnie Creek are terminated in these older rocks. Pre-Tertiary plutonic rocks are locally exposed in the area but none are seen at the surface in the immediate vicinity of the landfill site.

During Miocene and Pliocene(?) times basalt flows of the Columbia River Basalt Group filled and blocked valleys eroded into the older Precambrian rocks. The basalt flowed around the Precambrian hills and where valleys were blocked, depressions were filled with sedimentary deposits of the Latah Formation. The Latah Formation consists of semi-consolidated clay and silt with some sand and gravel. In a quarry across the Minnie Creek Valley and to the southeast of the landfill, flows of Columbia River Basalt can be observed in direct, baked, contact with interfingered sediments of the Latah Formation. A flow is present in the quarry which varies in thickness from 15 feet to 5 feet where it laps against an uneven deposit of sedimentary material.

The glaciofluvial deposits found at the landfill site fill a window in the Columbia River Basalt Group. "Windows" are areas where the basalt and contemporaneous sediments were scoured out by repetitive flooding during the Pleistocene and exposed the Precambrian Rocks below. This provided depressions which have subsequently been filled with glacially derived flood deposits. The glaciofluvial deposit at the landfill site is 200 feet thick and lies directly over Precambrian metamorphic rocks. The glacial materials may have originally filled Minnie Creek Valley. Late stage flood flows and "normal" stream flows could have removed some of the flood deposits and resulting in deposits of reworked sediments. Geologic features of sedimentation such as cut and fill channels, cross bedding and flood episode cutoff surfaces can be observed in the gravel excavations on the landfill properties. The Palouse Formation, a thick blanketing deposit of loess which covers a

large part of eastern Washington, is not present at or near the landfill site. It was removed by the repetitive glacial flood episodes which formed outwash channels and coulees.

The glaciofluvial sands are not cemented and vary from loose to well compacted. Although a vertical cut bank will stand for some time if undisturbed, slopes within these glaciofluvial deposits are unstable beyond the angle of repose of sand (30°, 58%).

Recent (post glaciation) alluvial deposits can be observed in the Minnie Creek valley as floodplain or channel deposits. The majority of these deposits have been significantly altered by railroad construction, maintenance, and the use of Minnie Creek as a cleared firebreak.

No faults have been mapped in the vicinity of the landfill site. No surficial discontinuities or breaks were observed in the sand suggestive of recent faulting.

The sands, resting on top of the metamorphic basement rocks and basalt, are compacted to such a degree that no subsidence is taking place nor has a geologic record of subsidence been left.

Local and Regional Hydrology

The hydrology of the region is relatively simple in concept but locally may present complex interactions and flow paths. The permeability of the basement metamorphic rocks is generally considered to be very low. Weathered contact zones and fracture zones provide the primary "aquifers" within this unit. Aquifers within the overlying Columbia River Basalt Group are developed in horizontal contacts or scoria zones, fractures and weathered zones between the specific basalt flows. Aquifers in the Columbia River Basalt Group are interconnected with the basement rock aquifers and water level contours within the rock formations generally appear to be continuous in the vicinity of the landfill. The general regional groundwater flow is toward the Spokane and Columbia Rivers to the North.

At the landfill site the water table and hydraulic head in the glaciofluvial sands, on which the landfill is located, is lower in elevation than the "water table" in the surrounding less permeable bedrock, particularly on the west side of the site (see Figures #3 and #4). Beneath Minnie Creek Valley the heads in the gravel aquifer may exceed bedrock heads. Groundwater in the surrounding bedrock generally moves into the sand-filled window and then proceeds to the east and north through the valley-fill sediments in the Minnie Creek Valley. Well data, from monitoring wells #1a through #5 which were completed during March 1989, suggests a hydraulic gradient of 0.018 ft/ft in the sand and gravels. The gradient of the head within the sands below the landfill is in an easterly direction.

Seasonal fluctuations of groundwater elevation may be significant and have been reported to be as great as 30 feet in the area (WRIS Tech. Bull. No. 15). Recharge to the area is attributed to precipitation and, therefore, may have significant annual variability.

GROUNDWATER ELEVATIONS

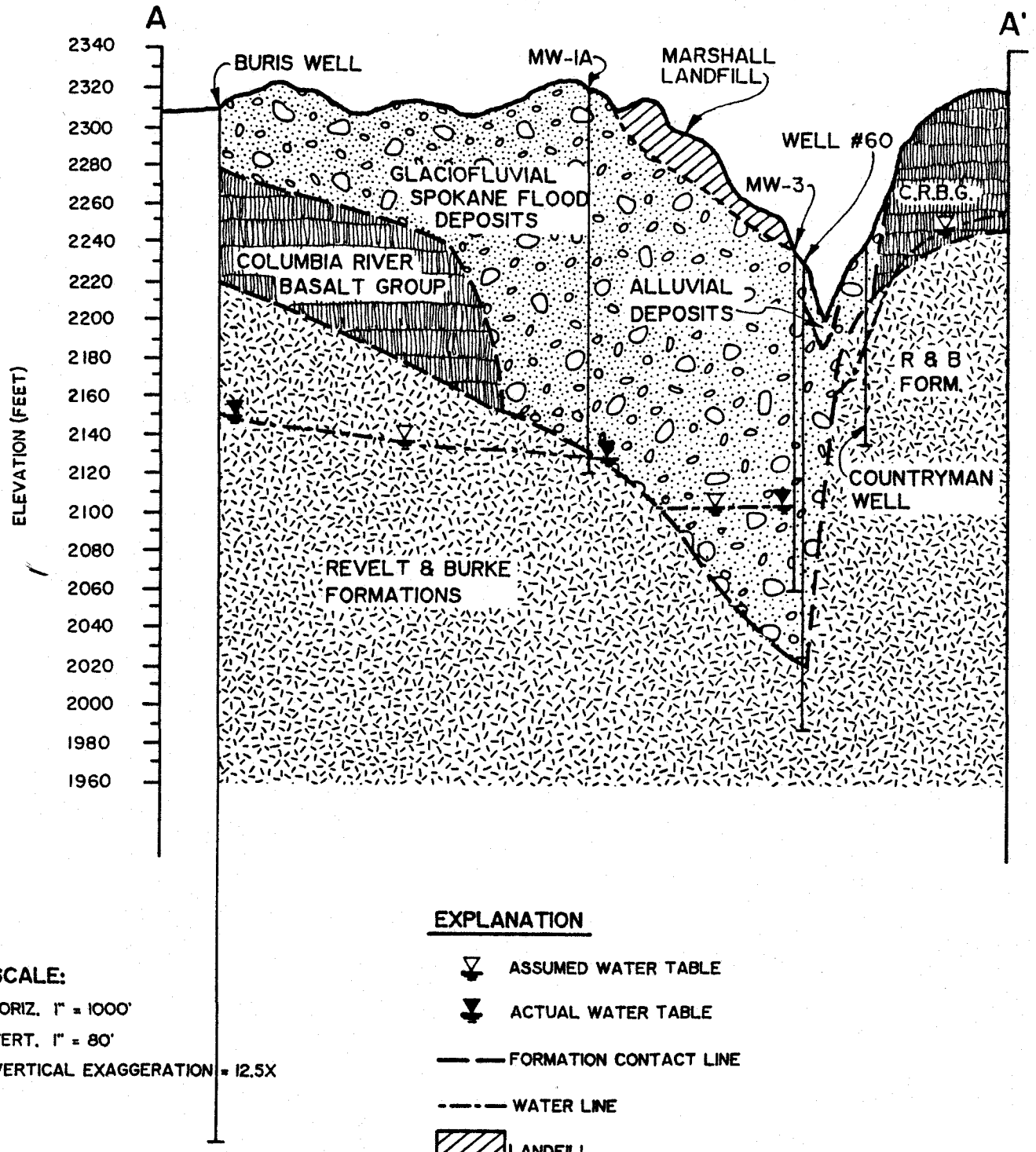
Marshall Landfill Monitoring Wells

Monitoring Well #	April 14, 1989	June 7, 1989	Surface Elevation
MW #1a	none recorded	2128.3	2332.6
MW #2	2114.3	2111.15	2175.2
MW #3	2104.5	2102.4	2179.2
MW #4	2128.9	2122.7	2159.1
MW #5	2093.3	2092.15	2184.8

WATER BALANCE and HELP MODEL

The water balance for the Marshall Landfill site was evaluated using the following three water balance protocols or methods 1) Thornthwaite-Mather; 2) Fenn; and 3) the EPA Hydrological Evaluation of Landfill Performance (HELP) Model (Appendix B). All

DIAGRAMMATIC HYDROGEOLOGIC CROSS-SECTION



SCALE:

HORIZ. 1" = 1000'

VERT. 1" = 80'

VERTICAL EXAGGERATION = 12.5X

EXPLANATION

- ASSUMED WATER TABLE
- ACTUAL WATER TABLE
- FORMATION CONTACT LINE
- WATER LINE
- LANDFILL

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GeoEnvironmental Branch

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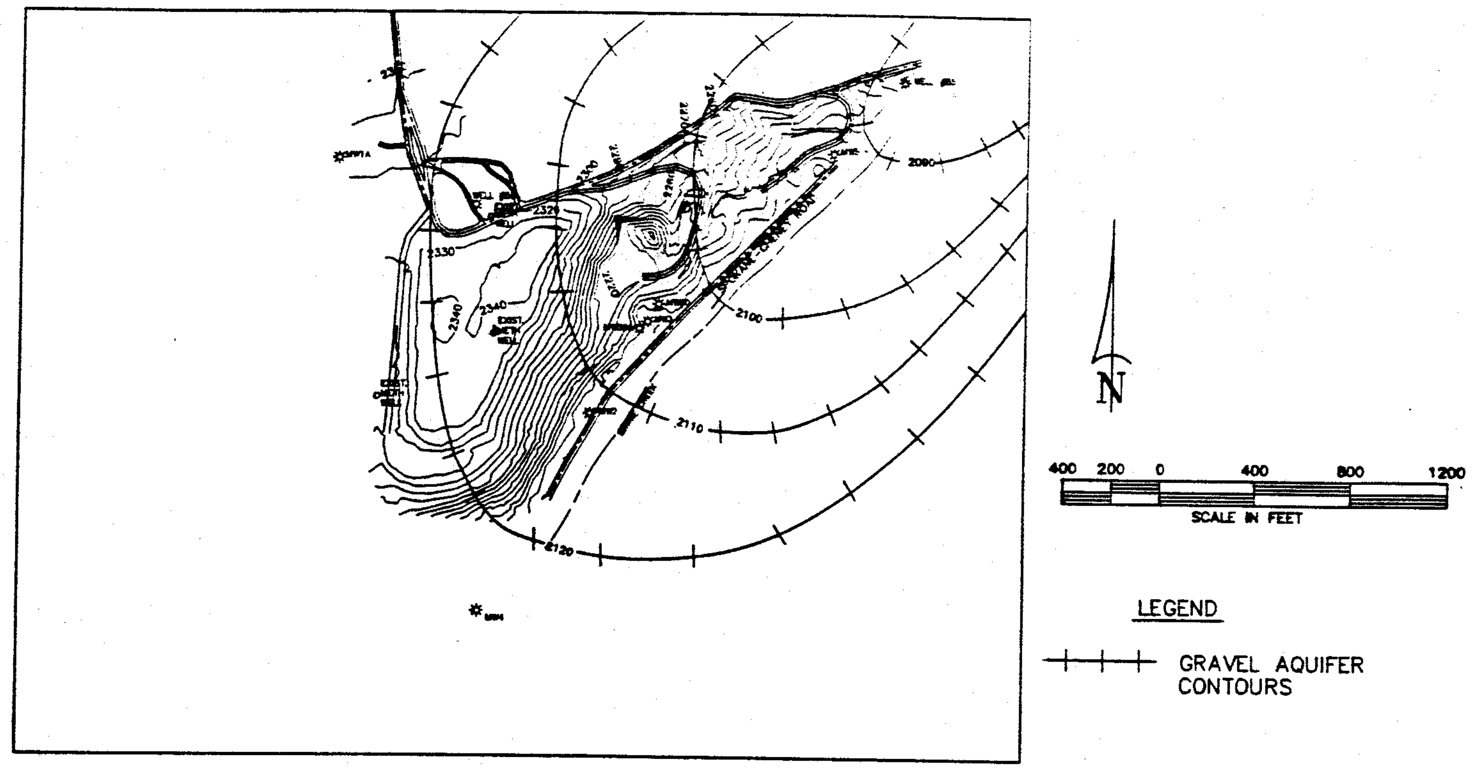
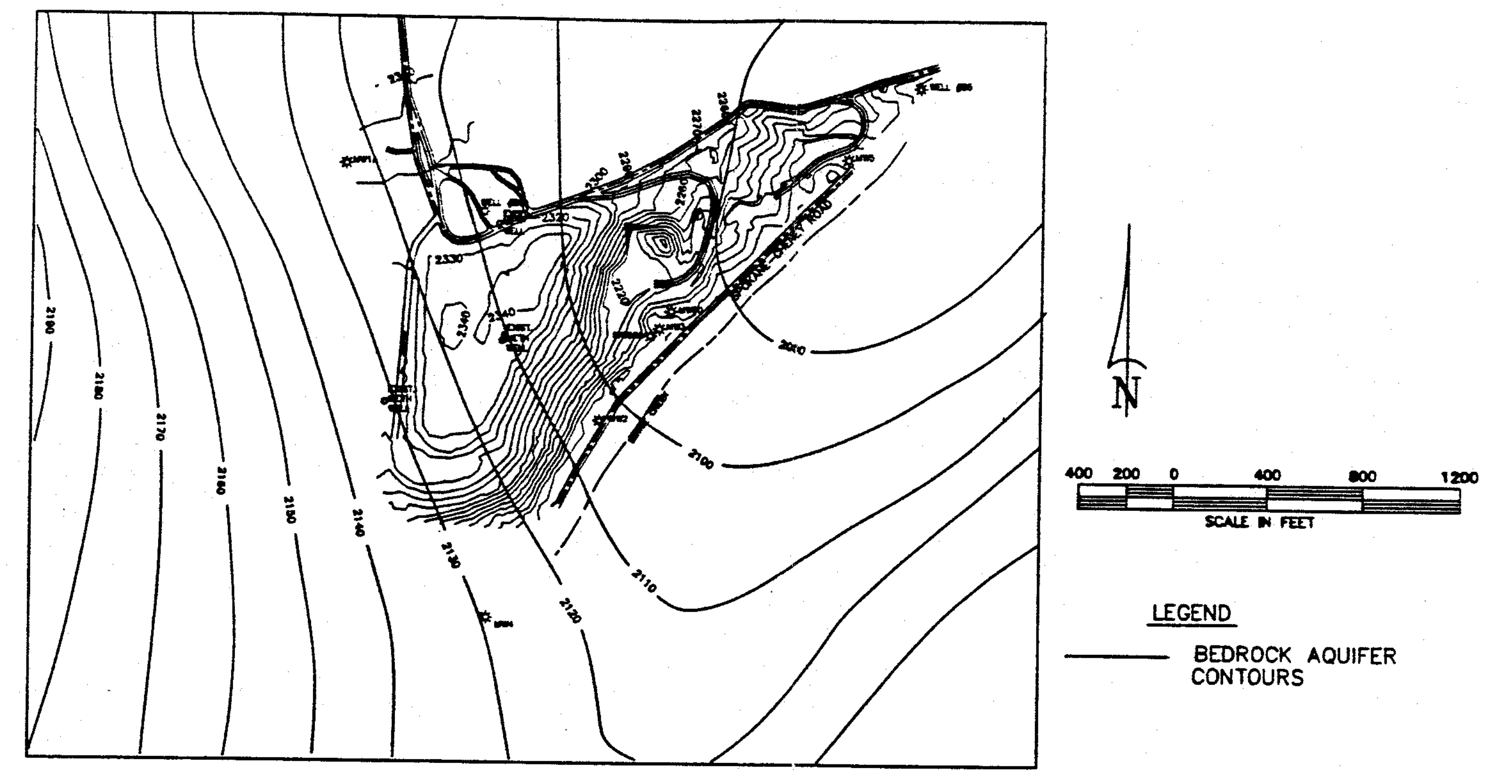
FIGURE #3

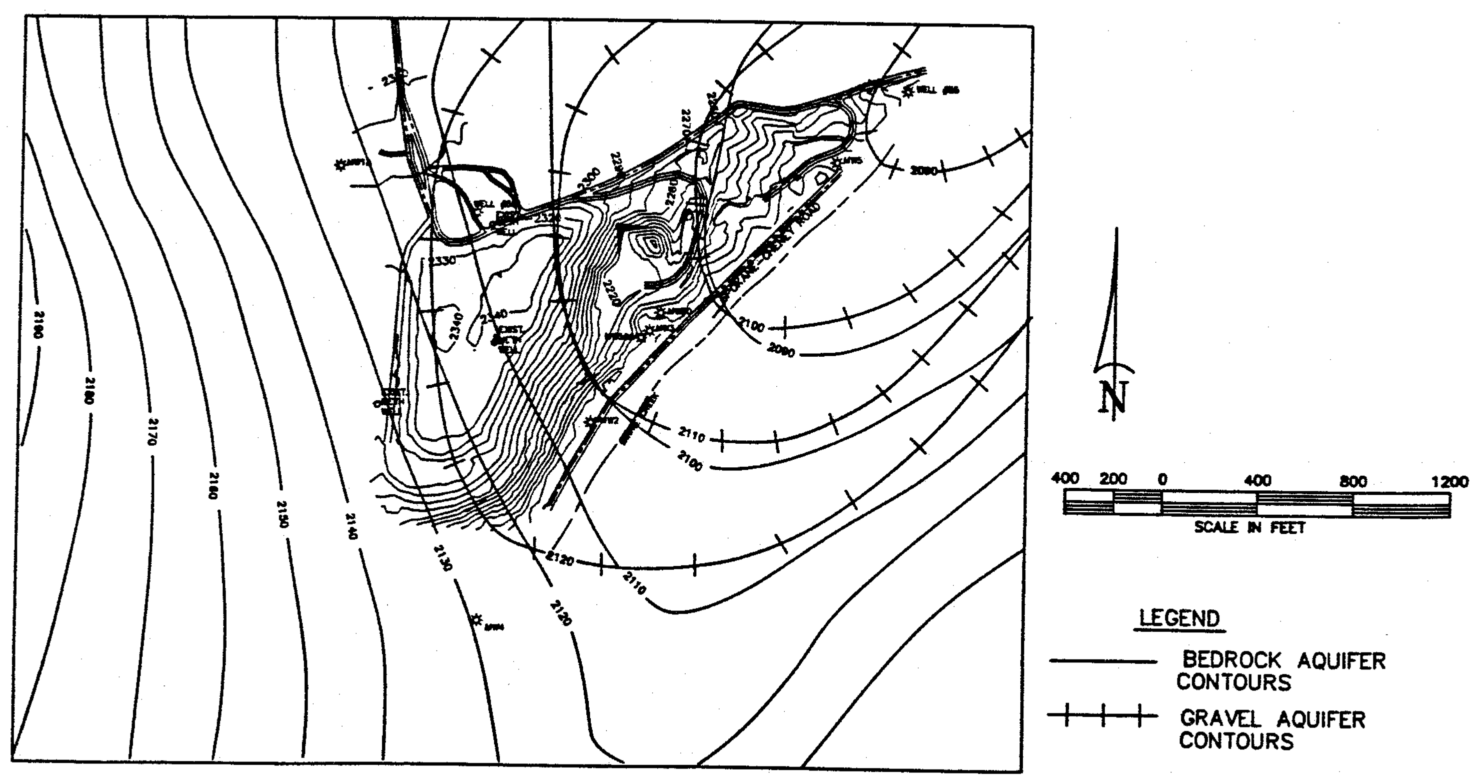


GRAVEL AQUIFER



BEDROCK AQUIFER

NOTE: AQUIFER CONTOURS ESTABLISHED FROM READING TAKEN ON ____



GRAVEL AND BEDROCK AQUIFER

FIGURE #4

MARSHALL LANDFILL, INC. EXISTING LANDFILL CLOSURE PLAN	
GROUNDWATER CONTOURS	
Scale: 1"=400'	Date: AUGUST, 1989	Revised:
Design: CLB / Drawn: RDM / Checked: RHF	Russ Fetrow Engineering, Inc. 890 Promontory Pl. SE Salem, OR 97302 PH (503) 363-6760	Job No: / Sheet

three models treat a water balance in the manner of an accounting system by "adding" precipitation, "banking" water in storage (e.g. in soils), and "debiting" or subtracting water lost to runoff, evaporation, transpiration, pumping and other phenomena. Climatological factors such as precipitation, average monthly temperature and hours of sun light per day and site features such as soil types and vegetation are also used in the water balance calculations.

The following parameters were used in the water balance evaluations:

1. A precipitation average of 16.71 inches per year.
2. Historically documented average monthly temperatures; the months of December and January had average monthly temperatures below freezing.
3. Various cover materials: a) native sandy soils; b) a clay cover cap (closure cap 2 feet thick); and c) a membrane liner system (one run of HELP model).
4. Poor to fair vegetative cover due to native sandy soil.

Fenn Water Balance

The Fenn water balance was developed in 1975 by Dennis G. Fenn and others for the EPA. This method is used to predict the potential for leachate production from landfills. One strength of the Fenn method is its ability to quickly assess the possibility of recharge and concomitant potential for leachate production in response to precipitation with native soil and vegetative cover.

The Fenn water balance was only run as a check on the Thornthwaite-Mather water balance method and HELP model. It was run only once using a clay soil cover material as the soil type to determine if leakage would occur through the cap. Under these conditions, the water balance predicted that the clay cap would pass about 0.6 inch of water on to recharge in the month of March. This reflects the onset of spring thawing conditions after two months of below freezing temperatures with no evapotranspiration. The Fenn water balance method was not run using a native soil as an input parameter.

Thornthwaite-Mather Water Balance

The Thornthwaite-Mather water balance was developed primarily for the agricultural community and is generally recognized as the most usable method. Although this method was not developed specifically for landfills, it can provide useful indications of the water balances that will act on landfill soil types. For the native sandy soils of the Marshall landfill site the calculated water balance indicated about 3 inches of recharge per year. A Thornwaite-Mather water balance was also calculated with a two-foot thick clay cap with variable runoff factors. With a runoff factor of 50% from the cap during rainfall or snow melt periods the predicted recharge would be about 0.4 inches per year (coming in February). With the runoff factor increased to 70% the predicted recharge would decrease to a little more than 0.1 inches per year. When the runoff factor was set to 80% of precipitation the predicted recharge fell to zero (0). This indicates that recharge will not occur, and thus leachate production will be reduced to near zero, if runoff from the cap can be maintained at or greater than 80%. It should be noted that the waste at this site will take some time before it reaches field capacity, which is the moisture content at which any added moisture will begin to "leak out" of the material. Therefore, recharge through the clay cap could become leachate only when the waste reaches field capacity. This could take a number of years.

Hydrologic Evaluation of Landfill Performance, HELP Model

More recently, in the mid 1980's, the EPA developed the HELP Model to specifically address landfill leachate production. The HELP model utilizes inputs for landfill design parameters as well as climactic data. The HELP model was run with the following sets of parameters:

1. Two (2) feet of native sandy soil over 70 feet of waste with 70 feet of native sands beneath;

2. One (1) foot of native soil over 2 feet of clay soil top liner over 70 feet of waste and 70 feet of native sand;

3. One (1) foot of native soil over a membrane liner over 70 feet of waste and 70 feet of native sand; and

4. A native soil, in two layers 70 feet thick, to a total of 140 feet thick.

The results of run #1, with the native sandy soils as top cover, predicted only 0.0085 inches of leachate production per year (once field capacity was reached). This is equivalent to 31 cubic feet per year per acre or 5300 gallons per year from the 23 total acres of the landfill.

Run #2, run with the clay soil top liner, predicted production of 0.002 inches of leachate which is about a fourth as much as predicted with sandy soil cover material. This is equivalent to 8 cubic feet of leachate could be produced per year per acre or about 1400 gallons per year for the whole landfill. In comparison, other water balance methods for an adjacent 23 acres underlain by native sands predict production of 1.9 million gallons of water. This is a ratio of 1:1500.

With the membrane liner, run #3, the model predicted zero (0) leachate production.

With native soils, run #4, the model indicated a very low recharge factor of .001 inches per year. This may be a reflection of the large water holding capacity of the soils.

MONITORING WELLS

Five groundwater monitoring wells were installed in March of 1989 by Golder and Associates for Century West Engineering. The wells were installed as part of a geological and hydrogeological study of the site as a potential incinerator ash disposal facility. Appendix A contains copies of well logs provided by Golder and Associates. These logs are preliminary and are, therefore, subject to revision.

One groundwater monitoring well was installed hydraulically upgradient of the site (MW-1A) and four monitoring wells were installed hydraulically downgradient of the old County and Marshall landfills (see Figure #2).

These monitoring wells were to be installed according to standard monitoring well construction practices. However, in two instances the temporary casing, which was to be removed after completion of the wells, became stuck and could not be removed from the boring. Therefore, monitoring wells 2 and 5 have steel casing around the well annulus to within a few feet of the screened interval of the well. They also lack a seal outside of the steel casing. However, it does not appear that this will significantly impact sample integrity.

All of the monitoring wells were completed to allow measurement of static water level and groundwater sampling of the uppermost aquifer beneath the landfill site. The boring for monitoring well MW-1A penetrated into the Precambrian bedrock beneath the sand aquifer but the screened interval is located at the interface between the Precambrian bedrock and the overlying Pleistocene sands. Because the overlying sand aquifer has much higher permeability it will greatly dominate the water quality and static water level measured in this well. The other four monitoring wells, MW-2 through MW-5, were all completed exclusively in the sand aquifer.

An attempt to install a monitoring well north of MW-1A was aborted when the boring encountered basalt at 15 feet below the land surface. The well log for this boring, originally identified as MW-1, shows that the lower 8 feet caved and that the upper 7 feet was plugged with a bentonite-grout seal.

SAMPLING RESULTS

Water quality data was obtained for two sets of split samples collected from the monitoring wells installed by Golder Associates at the Marshall Landfill. These preliminary sample results indicate that chlorinated hydrocarbon compounds have been detected in monitoring wells MW-1A and MW-5. Other wells may have traces of these compounds as well. A review of the Spokane County Health Department files and records at the landfill indicate that various sources of these compounds had, with official sanction of the

Health District and the Department of Ecology (DOE), been allowed to dispose of liquid wastes at the Marshall Landfill.

It should be clearly noted that in order to remediate a site that has had a release, a source of income to that site is necessary to pay for such remediation. Also, the siting of a landfill, such as the proposed ash monofill, at a "virgin" site which is uncomplicated by previous impacts sounds very attractive but is in the long run counter productive. There is risk of contamination of a second site, with all the requisite monitoring and remediation installations, Whereas the monitoring and remediation equipment of the first site can aid in monitoring and remediating, if it becomes necessary, of the secondary site.

Independent investigative work authorized by owners of the Marshall Landfill to confirm and define the presence of chlorinated hydrocarbon compounds has also indicated some release of chlorinated hydrocarbons. However the release does not appear to pose an immediate threat to health, safety or the environment.

GROUNDWATER FLOW

Static water level measurements in the five (5) monitoring wells at the Marshall Landfill indicate a generally east to northeast groundwater flow direction. The Marshall Landfill site is located over a pocket eroded into the bedrock on the west margin of the Minnie Creek Valley. This erosional depression became filled with medium- to coarse-grained sands with some gravels and scattered silt layers during deposition episodes of the Spokane Floods. These permeable sands are recharged by rainfall and during snow melt. Groundwater flows downgradient towards Minnie and Marshall Creeks.

Because the landfill site is surrounded by relatively impermeable Precambrian bedrock on the north, west and south sides, groundwater tends to flow out of the landfill site toward the east into Minnie Creek Valley. Wells completed in bedrock west of the landfill site tend to have higher static water level elevations than those in the sand aquifer under the landfill. This is generally to be expected because lower permeability units tend to have higher heads than more permeable units as restrictive flow tends to increase head

to overcome the resistance. If this is true, then the bedrock aquifers can be assumed to be somewhat protected because groundwater discharges from them which tends to minimize the opportunity for contaminated groundwater to enter them. However, more permeable zones in the bedrock (basalt interflow zones or preCambrian fault zones) could intercept the sand aquifer and provide permeable pathways for interaction between the two aquifer types. Also the head difference is not great and pumping wells in the bedrock could lower heads sufficiently to locally reverse the gradient so that groundwater would tend to flow from the sand aquifer into the bedrock, perhaps along the previously mentioned higher permeability zones.

Wells completed in the bedrock near the landfill tend to have heads (static water level elevations) above the sand aquifer. An exception is the landfill drinking water well, #60, which has a head about the same as the overlying sand aquifer. However, it is not known if the #60 well has this similar head elevation because of pumping, generally lower bedrock aquifer heads in this area, or because well construction (even though it is drilled into bedrock) allows the well to interact with the sand aquifer.

Once in the Minnie Creek Valley, groundwater is expected to flow to the northeast down the Minnie Creek Valley toward the town of Marshall and the confluence of Minnie Creek and Marshall Creeks. Evidence suggests that water in the Minnie Creek Valley generally flows as ground water. Little evidence suggestive of even seasonal (ephemeral) surface water flows in the valley is present and the water level response of Queen Lucas Lake, just upstream of the landfill in the Minnie Creek Valley, seems to indicate significant water loss by groundwater seepage.

Groundwater contours as mapped by Golder and Associates (Appendix A) and by Russ Fetrow Engineering, Inc. (Figure #4) are very similar and reflect the general flow directions as mentioned here.

BENEFICIAL USE

A number of residences, undeveloped residential lots and businesses are located within a one mile radius of the Marshall Landfill area. In the past, the homes, lots and establishments within this area ultimately obtain their domestic water from wells which pump from both shallow and deep groundwater aquifers. Water mains extend into the surveyed area from wells located in the Marshall municipality. These municipal wells are cased through the sand aquifer and pump water from the bedrock aquifer(s). The municipal water supply system serves residences northeast of the landfill site in the community of Marshall.

All currently recorded Water Right Permits at the Washington State Department of Ecology are included in Appendix C. These rights were established by property owners, previous owners, and the community of Marshall. The water rights were established to protect usage of groundwater extracted by domestic and irrigation wells. All water rights in the survey area, except for one established by Ground Water permit #4821 (Harry Smick), were established for groundwater pumped from the bedrock aquifer. The Smick water right is established for a hand dug well which draws groundwater from the sand aquifer overlying bedrock. The Smick well is located north of the existing landfill and is screened in a sand aquifer, but it is considered unlikely that it is in hydraulic continuity with the sand aquifer under the landfill. No water rights have been established within a one mile radius for surface water diversion.

Water Well Reports, filed with the Washington State Department of Ecology are included in Appendix C. There do not appear to be any downgradient wells within a mile radius of the site currently pumping groundwater from the sand aquifer. However, numerous wells located within a one mile radius of the Marshall Landfill and potentially hydraulically downgradient of the site are screened in and pump from the bedrock aquifer. Potential migration of leachate or contaminants from the landfill to wells which pump from the bedrock aquifer is considered to be unlikely due to: 1) the apparent hydraulic head

difference between the sand and bedrock aquifers, and 2) the poor permeability of the bedrock which would make interation between the aquifers very slow , limiting the potential volume of interactive waters. Specifically, the bedrock aquifer is characterized by a higher head (mean static water level) than that of the sand aquifer. Therefore, potentially generated leachate would remain within the sand aquifer.

Previous investigations (e.g. Shannon and Wilson, Inc., 1983) and current monitoring indicate that groundwater within the area of concern ranges from about 2,100 to 2,310 feet above mean sea level. Depth to water measurement (from the ground surface) range from 6.5 feet at the Smick well, located approximately 1/2 mile north of the landfill, to 204 feet in Monitoring Well 1A at the landfill. As previously noted, these two wells do not appear to draw from aquifers that are hydraulically connected. The nearest downgradient surface discharge of groundwater which has been noted is at the confluence of Minnie Creek (an intermittent stream that is usually dry) and Marshall Creek (a perennial drainage).

Wells which draw from the bedrock aquifer north, west, south, and east (across Minnie Creek) are considered to have low potential for impact by discharge from the Marshall Landfill. It is possible, though unlikely, that wells located northeast of the landfill along Minnie Creek and in the community of Marshall could be impacted by a leachate discharge from the landfill. Water supply wells with the greatest potential for impact are shallow wells which are screened in the sand aquifer (none currently known). Municipal water supply wells of the Marshall community are located in the vicinity where the shallow sand aquifer could be impacted. However, these wells draw from the bedrock aquifer and have significantly less potential for contamination because they are cased through any overlying surficial soils and the sand aquifer. The Community Water Association wells in the area of potential impact are the primary source of domestic water for the community of Marshall. These wells will be monitored on a regular schedule to assure water quality standards are met or exceeded.

CONCLUSIONS

1. The landfill is appropriately located with regard to land use of abutting properties, groundwater hydrology, and aesthetic considerations.
2. Groundwater in the uppermost "sand" aquifer below the landfill site flows toward the northeast and can be monitored at one upgradient and four downgradient locations with existing groundwater monitoring wells near the site boundaries.
3. Water balance calculations (Thornthwaite-Mather and Fenn) and HELP modeling predict that leachate production is possible.
4. Some groundwater impact by disposal of solvent-bearing liquids is indicated by preliminary sample results.
5. Groundwater flow from the landfill area is toward Minnie Creek and then down Minnie Creek Valley.
6. Groundwater users are primarily supplied by wells screened in bedrock and not the overlying sands.
7. No water users are immediately threatened.
8. The landfill site could accomodate new landfill cells without technical difficulties.

RECOMMENDATIONS

1. Monitor surrounding water users on a regular basis until more is known with regard to extent of indicated groundwater impact.
2. Evaluate existing monitoring well data and determine if additional monitoring wells are appropriate.
3. Contour the current landfill to appropriate closure specifications and cover with an impermeable capping material.
4. Evaluate the need for a membrane top cover.
5. Evaluate the possibility of "mining" the old landfill as part of a remedial action plan, if required.
6. Design a new state-of-the-art landfill for continued solid waste disposal needs.
7. Continue to meet all applicable WAC requirements.
8. Request variance for extended closure period to contour landfill for closure.
9. Continue use of the site for solid waste disposal by opening new landfill cells as an aid in remediation of the existing landfill.

SECTION 3

WAC	173-304-130	LOCATIONAL STANDARDS FOR DISPOSAL SITES
WAC	173-304-490	GROUND WATER MONITORING REQUIREMENTS
WAC	173-304-600	PERMIT REQUIREMENTS FOR SOLID WASTE FACILITIES

TABLE OF CONTENTS

WAC 173-304-130(2) Locational Standards. All applicable solid waste facilities shall be subject to the following locational standards:

(a) Geology. No facility shall be located over a holocene fault, in subsidence areas, or on or adjacent to geologic features which could compromise the structural integrity of the facility.

No Faults have been mapped in the vicinity of the landfill site. No surficial discontinuities or breaks were observed in the sand suggesting that there has been no recent faulting or subsidence. The landfill is sited on a deposit of glaciofluvial sands which rest directly on Precambrian metamorphic basement rocks. Basalt of the Columbia River Basalt Group can be found on the perimeter of the site to the north, south, and west.

(b) Ground water.

(i) No facility shall be located at a site where the bottom of the lowest liner is any less than ten feet above the seasonal high water in the uppermost aquifer; or five feet when a hydraulic gradient control system or the equivalent has been installed to control ground water fluctuations;

Well data, from monitoring wells #1a through #5 which were completed during March 1989, indicate a separation distance of 60 feet or more from the lowest point of the landfill to the water table. The gradient of the head within the sands below the landfill is in an easterly direction, with depth ranging from 204 feet to 30 feet below ground surface with a gradient of 0.018 ft/ft.

GROUNDWATER ELEVATIONS

Marshall Landfill Monitoring Wells

Monitoring Well #	April 14, 1989	June 7, 1989	Surface Elevation
MW #1a	none recorded	2128.3	2332.6
MW #2	2114.3	2111.15	2175.2
MW #3	2104.5	2102.4	2179.2
MW #4	2128.9	2122.7	2159.1
MW #5	2093.3	2092.15	2184.8

(ii) No landfill shall be located over a sole source aquifer, and;

Groundwater occurs in all exposed geologic units of the area. The hydrostratigraphic framework is divided into two aquifer systems, arbitrarily designated as: 1) the Bedrock Aquifer System, and 2) the Sand Aquifer System. Neither of these aquifer systems have been designated a "sole source aquifer".

(iii) No facility's active area shall be located closer than one thousand feet to a down-gradient drinking water supply well, in use and existing at the time of the county's adoption of the comprehensive solid waste management plan unless the owner or operator can show that the active area is no less than ninety days travel time hydraulically to the nearest down-gradient drinking water supply well in the uppermost useable aquifer.

The main source of drinking water in the area is the bedrock aquifer. The landfill is underlain by the local sand aquifer. There are no users of the sand aquifer system within one thousand feet down-gradient of the landfill. Any wells within 1,000 feet in a general downgradient direction are completed into the bedrock and are almost certainly more than

90 days travel from the landfill. If permeability is assumed to be 500 gpd/ft^2 (a high estimate), then with a gradient of 0.018 ft/ft and an effective porosity of 0.2 , then the distance traveled in 90 days will be approximately 550 feet. The landfill and the wells both predate this regulation.

(c) Natural Soils. See WAC 173-304-400, such as WAC 173-304-460 (3)(c)(i), landfill liners;

The existing landfill is not lined and is underlain by glaciofluval sands. The exposed sediments in the landfill consist of fine to coarse sand with occasional interbeds of gravel and scattered silt lneses.

Any new landfill cells will be lined with imported material which has a permeability of less than 1 X 10^{-7} cm/sec and a flexible membrane liner in a composite configuration as required in these regulations. Borrow materials, not having these low permeabilities, will be thoroughly mixed with bentonite to reduce the permeability to meet sandards.

(d) Flooding. See WAC 173-304-400 such as WAC 173-304-460 (3)(d), landfill, floodplains;

The landfill is not located on the 100 year floodplain.

(e) Surface water. No facility's active area shall be located within two hundred feet measured horizontally, of a stream, pond, river, or salt water body, nor in any wetland nor any public land that is being used by a public water system for watershed control for municipal drinking water purposes in accordance with WAC 248-54-660 (4);

The nearest potential surface water is Minnie Creek, an intermittent stream passing within 0.2 mile (SE) of the landfill. Queen Lucas Lake lies about a quarter mile to the south of the site. There is no recorded use of surface water for domestic supplies in the area. No evidence of recent surface flow in the landfill vicinity was observed in 1989.

(f) Slope. No facility's active area shall be located on any hill whose slope is unstable;

The glaciofluvial sands are not cemented and vary from loose to well compacted. Although a vertical cut bank will stand for several years undisturbed, slopes within the glaciofluvial deposits are considered unstable beyond the angle of repose of sand which is approximately 33 degrees or about 1.5:1.

(g) Cover material. See WAC 173-304-400, such as WAC 173-304-460 (3)(e), landfills, closure;

Cover material with a permeability of less than 1×10^{-6} will be imported to the site. If required, bentonite will be thoroughly mixed with the imported soils to further reduce permeabilities to this standard.

(h) Capacity. See WAC 173-304-400, such as WAC 173-304-460, Landfilling standards, (for standards that vary according to capacity);

The landfill is designed for closure by October 1991. The projected quantity of loose waste to be placed at the landfill is 820,000 cubic yards. The projected inplace volume, following compaction, is estimated at 245,000 cubic yards, this includes the daily cover material (Based on the June 1989-October 1991 time period).

(i) Climatic factors. See WAC 173-304-400, such as WAC 173-304-460 (3) landfill standards, (for standards applicable to arid climates);

The climate at the landfill and surrounding area is semiarid. It is characterized by cold, relatively moist winters and warm and dry summers. The mean annual precipitation and temperature is about 17.4 inches and 47 degrees Fahrenheit, respectively, at the Spokane Airport, about six miles north of the site. Most of the precipitation occurs as snow between October and March, with about 12 inches water equivalent. The estimated potential evapotranspiration rate for the area is 24.4 inches annually (Phillips, 1965). This is the amount of water that would be lost to the atmosphere if available when the evaporation and plant transpiration processes occur (March through November). The estimated actual evapotranspiration rate is 12.8 inches annually (Phillips, 1965). Design characteristics consider runoff potential of the twenty four hour twenty five year storm, providing adequate drainage.

(j) Land use. No facility shall be located:

(i) Within ten thousand feet of any airport runway currently used by turbojet aircraft or five thousand feet of any airport runway currently used by only piston-type aircraft unless a waiver is granted by the federal aviation administration. This requirement is only applicable where such facility is used for disposing of garbage such that a bird hazard to aircraft would be created;

Neither the current nor expanded landfill will not create a bird hazard for aircraft. Spokane airport is approximately six miles to the north and no runway lies within five thousand feet of the landfill.

(ii) In areas designated by the United States Fish and Wildlife Service or the department of game as critical habitat for endangered or threatened species of plants, fish, or wildlife;

The area is not critical habitat for endangered or threatened species of plants, fish, or wildlife. There do not appear to be any sensitive plant communities and there are no special features that enhance the wildlife value of this particular location or its habitat.

(iii) So that the active area is any closer than one hundred feet to the facility property line for land zoned as nonresidential, except the active area may be no closer than two hundred and fifty feet to the property line of adjacent land zoned as residential existing at the time of the county's adoption of the comprehensive solid waste management plan;

The privately owned Marshall landfill has been operational since 1971, when it replaced the adjacent County landfill (to the southwest). The terrain consists mostly of rolling hills with outcroppings of basaltic rock. Adjacent land uses are rural agricultural with some residential development. To the northwest a chicken ranch is operational. Due to the topography, the landfill is fairly well hidden or unrecongnizable to most adjoining property owners and passers-by. Current active areas are within the guidlines. Closure of the site may require some activity within 100 feet of property boundaries. Any new landfill cell, will meet these requirement explicitly.

(iv) So as to be at variance with any locally-adopted land use plan or zoning requirement unless otherwise provided by local law or ordinance; and

The landfill is compatible with current local land use. The dominant land use in the area is the Marshall landfill. The site is bounded on the north and west by undeveloped lands and on the south and east by the Burlington Northern Railroad and Cheney/Spokane

Road. The area is zoned for agricultural use and Spokane Planning Department land use plan maps designate the area as rural.

(v) So that the active area is any closer than one thousand feet to any state or national park.

There are no state or national parks within one thousand feet of the landfill.

(k) Toxic air emissions. See WAC 173-304-400, such as WAC 173-304-460 (2)(b), Landfill performance standards. [Statutory Authority: Chapter 43.21A RCW. 85-22-013 (Order 85-18), 173-304-130, filed 10/28/85.]

WAC 173-304-460(3)(c)(iv)Arid design. This design will apply to locations having less than twelve inches of precipitation annually, and, in lieu of (c)(i),(ii), and (iii) of this subsection, shall consist of vadose zone moisture monitoring, provided that:

Annual Precipitation averages 15 to 17 inches. Most precipitation falls as snow during the winter months. Precipitation is lowest during July and August.

(A) Waste material is no less than ten feet above the seasonal high level of ground water in the uppermost aquifer; and

(B) Any evidence of leachate or waste constituents detected in the vadose zone that violates or could be expected to violate the performance standard of WAC 173-304-460(2) shall cause the owner or operator to:

(I) Take corrective action, and either

(II) Close the facility according to these rules, or

(III) For all future expansions at that facility, meet the liner requirement of (c)(i) or (ii) of this subsection.

WAC 173-304-490 Ground water monitoring requirements (1) Applicability. These requirements apply to owners and operators of landfills, piles, landspreading disposal facilities, and surface impoundments that are required to perform ground water monitoring under WAC 173-304-400.

(2) Ground water monitoring requirements.

(a) The ground water monitoring system must consist of at least one background or upgradient well and three down gradient wells, installed at appropriate locations and depths to yield ground water samples from the upper most aquifer and all hydraulically connected aquifers below the active portion of the facility.

Five documented monitoring wells are present at the landfill site. Monitoring wells M1a and M4 are hydraulically upgradient of the landfill waste and wells M2, M3, and M5 are downgradient of the landfill. Screened intervals of the monitoring wells have been placed at depths where groundwater was first encountered. (see Figure #2 or Appendix E for monitoring well locations)

(i) Represent the quality of background water that has not been affected by leakage from the active area: and

As necessary additional monitoring wells will be placed to provide upgradient groundwater quality.

(ii) Represent the quality of ground water passing the point of compliance. Additional wells may be required by the jurisdictional health department in complicated hydrogeological settings or to define the extent of contamination detected.

Existing monitoring wells (M-2, M-3 and M-5) will be used to establish the quality of groundwater passing the point of compliance.

(b) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must allow collection of representative ground water samples. Wells must be constructed in such a manner as to prevent contamination of the samples, the sampled strata, and between aquifers and water bearing strata and in accordance with chapter 173-160 WAC, Minimum standards for construction and maintenance of water wells.

Two inch monitoring wells (M1a through M5) were installed to depths at which water was first encountered in each borehole. Standard monitoring well construction was used. As built drawings are included in Appendix A.

(c) The ground water monitoring program must include at a minimum, procedures and techniques for;

Sampling procedures are addressed in Appendix E, "Sampling Methods and Schedule"

(i) Decontamination of drilling and sampling equipment;
(ii) Sample collection:
(iii) Sample preservation and shipment;
(iv) Analytical procedures and quality assurance;
(v) Chain of custody control; and
(vi) Procedures to ensure employee health and safety during well installation and monitoring.

Addressed in Appendix E, "Sampling Methods and Schedule"

(d) Sample constituents.

(i) All facilities shall test for the following parameters:

(A) Temperature;

(B) Conductivity;

(C) pH:

(D) Chloride:

(E) Nitrate, nitrate, and ammonia as nitrogen;

(F) Sulfate:

(G) Dissolved iron:

(H) Dissolved zinc and manganese:

(I) Chemical oxygen demand:

(J) Total organic carbon; and

(K) Total coliform.

This will be done.

(ii) The jurisdictional health department in consultation with the department may specify additional or fewer constituents depending upon the nature of the waste; and

Monitoring for Methylene Chloride, 1,1,1-Trichloroethane (TCA), Trichloroethene (TCE), Freons and other organic solvents which have been found will continue.

(iii) Test methods used to detect the parameters of (d)(i) of this subsection shall be EPA Publication Number SW-846, "Test Methods for Evaluating Solid Waste-Physical/Chemical

Methods" except for total coliform which shall use the latest edition of "Standard Methods for the Examination of Water and Wastewater."

All samples will be submitted to an EPA approved laboratory for analysis and approved testing methods will be used.

(e) The ground water monitoring program must include a determination of the ground water surface elevation each time ground water is sampled.

This will be done. See Appendix E, "Sampling Methods and Schedules".

(f) The owner or operator shall use a statistical procedure for determining whether a significant change over background has occurred. The jurisdictional health department will approve such a procedure with the guidance of the department.

The data will be presented both as a graphical representation and using a standard statistical format. When sufficient data has been collected the Students T Test can be used to determine significance of any observed difference as outlined in CFR 40.264 Appendix IV and SW-846.

(g) The owner or operator must determine ground water quality at each monitoring well at the compliance point at least quarterly during the life of an active area (including the closure period) and the post-closure care period. The owner or operator must express the ground water quality at each monitoring well in a form necessary for the determination of statistically significant increases.

Graphic representation of parameters will allow for rapid screening and the statistical analysis will provide for the determination of statistically significant increases.

(h) The owner or operator must determine and report the ground water flow rate and direction in the uppermost aquifer at least annually.

These determinations will be made from observations made while sampling .

(i) If the owner or operator determines that there is a statistically significant increase for parameters or constituents at any monitoring well at the compliance point, the owner or operator must;

(i) Notify the jurisdictional health department of this finding in writing within seven days of receipt of the sampling data. The notification must indicate what parameters or constituents have shown statistically significant increases;

Quarterly letter reports will be sent to the jurisdictional health department as laboratory results are received.

(ii) Immediately resample the ground water in all monitoring wells and determine the concentration of all constituents listed in the definition of contamination in WAC 173-304-100 including additional constituents identified in the permit and whether there is a statistically significant increase such that the ground water performance standard has been exceeded, and notify the jurisdictional health department within fourteen days of receipt of the sampling data.

This will be done.

(j) The jurisdictional health department may require corrective action programs including facility closure if the performance standard of WAC 173-304-460(2)(a) is exceeded and, in addition, may revoke any permit and require reapplication under WAC 173-304-600.

If corrective action is required, appropriate plans will be submitted.

(3) Corrective action program. An owner or operator required to establish a corrective action program under this section must, at a minimum with the approval of the jurisdictional health officer;

(a) Implement a corrective action program that reduces contamination and if possible prevents constituents from exceeding their respective concentration limits at the compliance point by removing the constituents, treating them in place, or other remedial measures;

Remedial action proposed will be appropriate to meet the need to reduce contamination to regulated levels. The closure cover proposed here will significantly "remediate" the site or reduce potential impacts.

(b) Begin corrective action according to a written schedule after the ground water performance standard is exceeded;

Any corrective actions which are required will be accomplished in a timely manner.

(c) Terminate corrective action measures once the concentrations of constituents are reduced to levels below the limits under WAC 173-304-460(2)(a). [Statutory Authority; Chapter 43.21A RCW. 85-22-013(Order 85-18), 173-304-490, filed 10/28/85.]

Corrective actions or procedures will continue until concentrations of constituents are reduced to acceptable levels.

WAC 173-304-600 (3)(b)

(i) A geohydrological assessment of the facility that addresses:

(A) Local/regional geology and hydrology, including faults, unstable slopes and subsidence areas on site:

No Faults have been mapped in the vicinity of the landfill site. No surficial discontinuities or breaks were observed in the sand suggesting that there has been no recent faulting or subsidence. The landfill is sited on a deposition of glaciofluvial sands which rest directly on preCambrian metamorphic basement rocks. The glaciofluvial sands are not cemented and vary from loose to well compacted. Although a vertical cut bank will stand for several years undisturbed, slopes within the glaciofluvial deposits are unstable beyond the angle of repose of sand. Basalt of the Columbia River Basalt Group can be found on the perimeter of the site to the north, south, and west.

(B) Evaluation of bedrock and soil types and properties:

Five primary geologic units are exposed at or very near the landfill site. They are, from oldest to youngest, the Precambrian Revett and Burke formations, Miocene to Pliocene Columbia River Basalt Group, the Latah Formation which was deposited contemporaneously with the basalts, Pleistocene Glaciofluvial deposits and recent alluvium.

The Precambrian metamorphic Revett and Burke Formations, underlie the site at depth , as basement, and can be observed in surface outcrops to the south of Queen Lucas Lake, and west of the landfill site in the Needham Hills. Domestic water wells drilled on the southeast perimeter of the landfill and further to the southeast across Minnie Creek

are terminated in these older rocks. Pre-Tertiary plutonic rocks are locally exposed in the area but none are seen in the immediate vicinity of the landfill site.

During Miocene and Pliocene(?) times basalt flows of the Columbia River Basalt group filled and blocked valleys eroded into the older Precambrian rocks. The basalt flowed around the preCambrian hills and where valleys were blocked, depressions were filled with sedimentary deposits of the Latah Formation. The Latah Formation consists of semi-consolidated clay and silt with some sand and gravel. In a quarry across the Minnie Creek Valley and to the southeast of the landfill, flows of Columbia River Basalt can be observed in direct, baked, contact with interfingered sediments of the Latah Formation. A flow is present in the quarry which varies in thickness from 15 feet to 5 feet where it laps against an elevated deposition of sedimentary material.

The glaciofluvial deposits found at the landfill site fill a window in the Columbia River Basalt Group. "Windows", scoured through the basalt and contemporaneous sediments by repetitive flooding during the Pleistocene, provided depressions which have subsequently been filled with glacially derived material. The glaciofluvial deposit at the landfill site is 200 feet thick and lies directly over preCambrian metamorphics. The glacial materials originally filled Minnie Creek Valley but have been cut down by late stage flood flows and "normal" stream flows resulting in deposits of reworked sediments. Cut and fill channels, cross bedding and flood episode cutoff planes can be observed in the gravel pit on the landfill properties. The glaciofluvial sands are not cemented and vary from loose to well compacted. Although a vertical cut bank will stand for several years undisturbed, slopes within the glaciofluvial deposits are unstable beyond the angle of repose of sand.

Alluvial deposits can be observed near Minnie Creek deposited as floodplain or channel deposits. The majority of these deposits have been significantly altered by railroad construction and maintenance, and the use of Minnie Creek as a cleared firebreak.

(C) Depths to ground water and/or aquifer(s);

GROUNDWATER ELEVATIONS

Marshall Landfill Monitoring Wells

Monitoring Well #	April 14, 1989	June 7, 1989	Surface Elevation
MW #1a	none recorded	2128.3	2332.6
MW #2	2114.3	2111.15	2175.2
MW #3	2104.5	2102.4	2179.2
MW #4	2128.9	2122.7	2159.1
MW #5	2093.3	2092.15	2184.8

(D) Direction and flow rate of local ground water;

Well data, from monitoring wells #1a through #5 which were completed during March 1989, suggests a hydraulic gradient of 0.018 ft/ft. The gradient of the head within the sands below the landfill is in an easterly direction.

(E) Direction of regional ground water:

The general regional groundwater flow is toward the Spokane and Columbia Rivers to the North. Intermediate flows in this area may be toward Hangman Creek. Local flows are toward Minnie and Marshall Creeks.

(F) Quantity, location and construction (where available) of private and public wells within a two thousand foot radius of site:

Water Well Reports, received from the Washington State Department of Ecology, for the area within two thousand feet of the landfill, are presented in Appendix C.

(G) Tabulation of all water rights for ground water and surface water within a two thousand foot radius of the site:

Five Certificate of Water Right Permits have been issued for groundwater use. The Certificates are presented in Appendix C and are as follows.

CERTIFICATE OF WATER RIGHT

Permittee	Permit #	Quantity	Use
Marshal Community Water Association, Marshall, Wash.	10033	36 ac-ft/yr	Community domestic
Harry Smick Marshall, Wash.	4821	24 ac-ft/yr	irrigation
Western Poultry Inc. Cheney, Wash.	G3-23063P	28 ac-ft/yr 2 ac-ft/yr	irrigation domestic
J. & S. Rodriquez Cheney, Wash.	G3-24828P	20 ac-ft/yr 2 ac-ft/yr	irrigation domestic
Joseph Vernon Cheney, Wash.	G3-26315P	16 ac-ft/yr	irrigation/ domestic

No Water Rights for surface water have been established within the two thousand foot radius.

(H) Identification and description of all surface waters within a one-mile radius of the site:

Minnie Creek is an intermittent stream which drains to the northeast on the east perimeter of the site. Minnie Creek extends from Queen Lucas Lake, Approximately one quarter of a mile to the south of the site, to its confluence with Marshall Creek approximately three quarters of a mile to the northeast. Seasonal "scabland" ponds and marshes are located southeast of the site on a basalt plateau across Minnie Creek.

(I) Background ground and surface water quality assessment, and for expanded facilities, identification of impacts of existing facilities of the applicant to date upon ground and surface waters from landfill leachate discharges:

Much of this information will be provided in the EIS. Additional information will be provided in future geological reports. Some potential impact has been identified.

(J) Calculation of a site water balance:

The Thornthwaite-Mather Water Balance and HELP Model can be found in Appendix B, with discussion on page 6 of the Permit Report.

(K) Conceptual design of a ground water and surface water monitoring system, including proposed installation methods for these devices and where applicable a vadose zone monitoring plan:

If necessary, additional monitoring wells will be installed. Monitoring wells will be installed in accordance with WAC 173-304-490 (Ground water monitoring requirements).

(L) Land use in the area, including nearby residences: and

The dominant land use in the area is the Marshall landfill. The site is bounded on the north and west by undeveloped lands and on the south and east by the Burlington Northern Railroad and Cheney/Spokane Road.

(M) Topography of the site and drainage patterns.

The site gently slopes from west to east toward Minnie Creek. Runoff, which is generally restricted to spring thaw, is to the east and toward Minnie Creek. See Appendix F.

(ii) Preliminary engineering report/plans and specifications that address:

(A) How the facility will meet the locational standards of WAC 173-304-130;

The site is historically a landfill.

(B) Relationship of facility to county solid waste comprehensive plan and the basis for calculating the facility's life;

Marshall Landfill is part of the county's current waste disposal program. The facility will be prepared for closure while waste disposal continues until October 1, 1991.

(C) The design of bottom and side liners;

The landfill is not lined. The landfill predates current regulations.

(D) Identification of borrow sources for daily and final cover, and soil liners;

Daily cover is provided from on-site locations. Final cover will be imported from the Wilcox Pit, which is located on that portion of the SE 1/4 of Section 31, Township 24 North, Range 42 East in Spokane County Washington, lying southerly of Jensen Road and East of Androus Road.

(E) Interim/final leachate collection, treatment, and disposal;

No leachate collection facility is planned for this site.

(F) Landfill gas control and monitoring;

No gas monitoring or control devises are being used at the existing site. Upon closure a passive gas collection system will be installed.

(G) Trench design, fill methods, elevation of final cover and bottom liner, and equipment requirements; and

The 'Cell' is the basic design building block used in developing this landfill, refer to the Operation Manual (Section#4 of this report) for details, elevations, and equipment requirements.

(H) Closure/post-closure design, construction, maintenance, and land use.

These are addressed in the Section #4 of this report, "Closure Plan", and Appendix F, which contains the Operational and Closure drawings and Plans.

(iii) An operation plan that addresses:

(A) Operation and maintenance of leachate collection, treatment, and disposal systems:

There is no leachate collection or treatment system in place.

(B) Operation and maintenance of landfill gas control systems:

A gas collection system has not been included in the operational plan. Daily cover , a porous sandy material, disperses gasses.

(C) Monitoring plans for groundwater, surface water, and landfill gases to include sampling technique, frequency, handling, and analyses requirements:

Groundwater samples will be taken and handled as prescribed in Appendix E; there is no sampleable surface water at the landfill site; and landfill gasses will be monitored on a quarterly basis.

(D) Safety and emergency accident/fire plans:

As prescribed in the 'Operation Manual', "the operator is responsible for initiation and continuing appropriate fire fighting methods until all smoldering, smoking, and burning ceases. All fires shall be promptly reported to the Department of Ecology's Eastern Region office". Daily cover will help keep fires contained in a cell and from spreading. The Fire Department for this site is the Spokane Fire District #3. The fire department will respond to fire emergency's and may be called at (509) 235-6645.

(E) Routine filling, grading, cover, and housekeeping:

Daily operation of the landfill includes compaction, cell construction, and emplacement of cover materials. The landfill will be filled and graded in preparation for final cover, these

activities will be concurrent with daily operational activities. Housekeeping, or daily site maintenance, is addressed in the "Operational Manual" (Section #4 of this report) under the sub-section titled "Maintenance".

(F) Record system to address records on weights(or volumes), number of vehicles and the types of waste received:

A record system is currently in place which documents incoming waste volumes, carriers, and the number or private users.

(G) Vector control plans; and

Vectors including flies, rats, and birds can be controlled or prevented by proper application of soil cover material. If a vector problem develops, a professional exterminator will be consulted.

(H) Noise control.

Equipment will be properly maintained to control noise (i.e. properly lubricated, mufflers, etc.). Heavy equipment will be operated during normal business hours.

(iv) Closure plan to address:
(A) Estimate of closure season/year;

Before October 1, 1991.

(B) Capacity of site in volume and tonnage;

This site has an estimated 400,000 cubic yards of remaining in-place capacity which will accommodate the waste stream through closure.

(C) Maintenance of active fill versus completed, final covered acreage;

The active fill will be maintained for dust and litter control, noise, rainfall run-on and run-off control, and vector control. The closed landfill will be maintained for vegatative cover (fertilizing and seeding the top cap as required), drainage facilities, roads, fences and buildings, monitoring wells, gas collection systems, and site security.

(D) Estimated closure construction timing and notification procedures;

The proposed site closure contours have been prepared to include an estimated capacity capable of receiving waste until the closure date of October 1, 1991. It is impossible to forecast an exact date for closure activities to commence due to weather conditions or a major shift in filling rates. Closure construction cannot occur during the wet weather period. Partial closure can be anticipated for the summer of 1990, with the balance anticipated for the summer of 1991.

Upon completion of closure activities the Marshall landfill owner(s) shall:

1. Submit a Facility Closure Plan Sheet, signed by a professional engineer registered in the State of Washington and modified as necessary to represent as-built changes to the final closure construction as approved in the closure plan.

2. Submit certification by the owner or operator, and a professional engineer registered in the State of Washington that the site has been closed in accordance with the approved closure plan.

3. Record, with the County Auditor, any necessary deed clauses for land use, zoning or other restrictions for the closed landfill site.

(E) Inspection by regulatory agencies;

The landfill will be open for inspection by regulatory personnel at all times.

(v) Post-closure plan to address:

(A) Estimated time period for post-closure activities;

Post-closure activities will commence only after the Marshall landfill owner(s) has submitted the closure plan sheet and signed closure certification and has received notification from Spokane County Health District that the landfill is considered closed. It is estimated that closure of the landfill will be complete during the fall of 1991.

(B) Site monitoring of landfill gas, ground water, and surface water;

The monitoring of gas and water quality will be conducted quarterly with the results of these tests being forwarded to the Washington Department of Ecology.

(C) Deed clause changes, land use, and zoning restrictions;

Any necessary deed clauses for land use, zoning or other restrictions for the closed landfill site will be recorded with the County Auditor.

(D) Maintenance activities to maintain cover and run-off systems; and

The top cap will be fertilized and seeded as required to maintain a vegetative cover. Surface water drainage systems will be maintained as required to allow the free flow of water at all times.

(E) Identification of final closure costs including cost calculations and the funding mechanism.

Final closure and post-closure costs are discussed in the closure plan in Section 4 of this report. The funding mechanism for the closure/post-closure costs will satisfy state requirements.

SECTION 4

OPERATION MANUAL

AND

CLOSURE/POST-CLOSURE PLAN

TABLE OF CONTENTS

OPERATIONAL MANNUAL

INTRODUCTION

The scope of this section is to set forth operating and maintenance procedures necessary to effectively dispose of solid waste in the Marshall landfill through closure while maintaining compliance with the Washington Department of Ecology Minimal Functional Standards. A detailed operational description addressing all major landfilling considerations from general to specific are included in this section.

The scope of work for this project was outlined in the Proposal to provide Engineering and Geotechnical Consulting Services dated November 1988. The work is being performed and this manual prepared for the exclusive use of the Marshall landfill and their consultants for specific application to the project site. No other warranty, expressed or implied, is made.

GENERAL LANDFILL OPERATIONAL DETAILS

Background

The Marshall landfill is located in central Spokane County, Washington, approximately ten miles south-southwest of Spokane and approximately one mile southwest of the town of Marshall. The existing landfill site occupies about 75 acres in Section 21, Township 24 North, Range 42 East, Willamette Meridian. The landfill is bounded to the north by Andrus Road, to the west by Spotted Road and to the east by the Cheney-Spokane Road. The main access is by a gravel road with the entrance on Spotted Road. The Marshall landfill currently receives approximately 252,000 cubic yards of solid waste annually. The waste material presently being deposited at the landfill include municipal solid waste (MSW), demolition debris, tires and stumps (see Table 1).

TABLE 1

Waste Material	Cubic Yards/Year	Tons/Year
Compacted MSW	138,000	31,100
Loose MSW	71,000	8,000
Demolition Debris/Other	43,000	21,500
Totals	252,000	60,600

The following conversion factors were used to develop Table 1:

Density of compacted solid waste is 450 pounds per cubic yard

Density of loose solid waste is 225 pounds per cubic yard

Density of demolition debris/other is 1,000 pounds per cubic yard

Compacted municipal wastes make up 55 percent of this waste stream. The site has an estimated 400,000 cubic yards of remaining in-place capacity which will accommodate the waste stream through closure, October 1, 1991. Approximately 130,000 cubic yards of this available capacity will be required to landfill material that will need to be excavated along the eastern side slope to bring the grade to a maximum 33 percent slope in compliance with Department of Ecology standards.

A major area of the site has already been filled with solid waste (see boundaries noted on engineering plans). Waste is presently being deposited in the current operating area located on the northeast perimeter of the landfill as outlined on the engineering plans and will continue to be deposited there through closure.

Cell Construction

The landfill area is divided into two major cell areas. The upper area of the site will be filled with the material excavated from reshaping operations. The lower area will be filled from the incoming solid waste stream until final contours are achieved. Each phase is divided further into daily cells.

The cell is the basic element or building block in landfilling. A cell is defined as solid waste completely enclosed on all sides by soil. The cell size is determined by the volume of incoming solid waste and size of the working face. The working face should be kept as narrow as possible at all times but never less than two times the equipment width.

Solid waste should be spread up the working face in 1 foot to 2 foot layers and compacted with three to five passes of the equipment up and down the slope. Spreading up the slope achieves sufficient size reduction, maximizes compaction, and is the most efficient means of using the equipment. The working face should be maintained at a 3:1 slope or steeper as determined by the machine's capabilities. Special care should be taken to construct cell slopes at a slope that is maintainable and can be compacted. All exposed compacted waste should be covered daily with native soil material. Grade stakes should be used to control exterior cell configurations for proper cell height and drainage grades .

It is important that maximum compaction of the waste is achieved. The benefits of well compacted waste are:

- Extended landfill life;
- Reduction of cover requirements;
- Reduction of both total and differential settlement of waste;
- Reduction of litter;
- Leaves fewer voids for rats and insects;
- Provides for better roadways and smoother working area; and,
- Makes completed fill more suitable for other purposes.

Waste material excavated from reshaping operations will be deposited on the upper landfill area. There are basically three methods of moving the waste. The first method is to excavate the waste material with the use of a trackhoe and push it up the slope with a bulldozer. The area near the top of the slope could be easily excavated and moved in this manner, however to push the waste from near the bottom of the fill would be time consuming and quite expensive in equipment time.

A second method is to loosen and push the waste down slope, load the waste into dump or end dump trucks and transport the waste to the top. When excavating the waste near the bottom of the fill, waste can be loaded directly into the trucks with a trackhoe.

A third method is to push and/or transport the waste material to the active area and divert the incoming waste stream to the top area of the landfill. The preferred method, or any combination of these methods, will be left to the discretion of the landfill operator. It should be noted that the slopes of the old roadbed at the toe of the fill and below the waste is steeper than 3:1. Only the slope of the landfill will need to be reshaped. The slope of the road bed should be left alone since buffer trees are growing within the area.

Equipment is available on-site to perform this work, however the use of larger capacity end dumps would shorten the time requirement if either method two or three were chosen. It should be noted that the same cover requirements and compaction procedures will need to be observed as with incoming solid waste.

Cover Requirements

The three major categories of cover are daily, intermediate, and final. Daily cover, a minimum of six inches (6") in thickness, provides vector, litter, fire, and moisture control. Daily cover shall be compacted on top and side slopes as the cell is constructed and will

be graded to prevent erosion and ponding of water. Daily cover, which can include gravelly soils, may be applied to the exposed working face by drifting the soil from the top of the working face downward, spreading in a thin layer as it is applied.

Intermediate cover is that cover which will be utilized over areas that will not have additional solid waste placed on it for a period greater than twelve months (12). This cover will be a minimum of twenty-four inches (24") in thickness including the six inches (6") of previously placed daily cover. The intermediate cover addresses the same functions as daily cover but also provides a degree of gas control and can serve as a road base. Periodic grading of the intermediate cover may be required to repair erosion, cracks, depressions, and to prevent water ponding.

Final cover provides the same functions as daily and intermediate cover while providing a protective cap over the landfill to reduce infiltration of water and associated leachate generation as well as minimizing leakage of gas and leachate. The top cap will contain a minimum of 2 feet of final cover with a maximum permeability of $1x10^{-6}$ cm/sec. which is required for the Marshall Landfill and should be placed and compacted in six inch (6") to eight inch (8") lifts.

Final cover should be placed over a minimum of six inches (6") of daily cover material to provide a leveling coarse for the placement of the top cap liner. Because final cover must support vegetative growth, six inches (6") of good top soil high in nutrient value is required over the top cap and should not be compacted too tightly. Final cover shall be filled and shaped to the final grades as shown on the plans to insure proper drainage, to prevent erosion, and to insure that the projected landfill capacities are achieved. The suitabilities of different soils as cover material is outlined in the following table:

SUITABILITY OF SOILS AS COVER MATERIAL

Function	Clean Gravel	Clean Sand	Silt	Clay
Prevent rodents from burrowing	G	G	P	P
Keep flies from emerging	P	P	G	E*
Keep water out of waste	P	P	G-E	E*
Reduce odors from waste	P	P	G-E	E*
Control litter	E	E	E	E
Support Plant Growth	P	P	E	G

E = Excellent; G = Good; F = Fair; P = Poor

* Except when cracks extend through the entire cover

Daily and intermediate cover material is readily available from on-site sources. Final cover material is available from off-site sources within a fifteen mile proximity of the site.

Test holes, using a soil auger, should be dug to insure that proper cover depth is being obtained as each cell is completed and covered. The final surfaces shall be prepared, fertilized, and planted with grass to minimize future erosion. The type of seed, fertilizer, amounts to be applied, and time of planting shall conform to recommendations of the County Extension Agent.

Traffic Flow and Unloading

The unloading area shall be clearly defined by signs, fences, barriers, or other devices and kept as small as possible. Mechanically discharging vehicles (commercial) and manually discharging vehicles (public) should be kept separated but should utilize the same working

face if possible. If separate working areas are established, a sign should clearly designate the route. Fences and barriers need to be erected to prevent unauthorized entry and dumping. Vehicles should only be allowed to bypass the pay booth if it is inoperative.

Roads from the landfill entrance to the active operational area shall be constructed and maintained to minimize traffic hazards, dust, mud, and to provide reasonable all weather access for vehicles using the site. If snow builds up on the roads, it needs to be plowed regularly and maintained to keep them free of ruts and pot holes. Permanent and temporary roads will be constructed where shown on the plans and where determined necessary by the operator.

Signs

Clearly visible and legible signs shall be posted at the entrance to the disposal site specifying the name of the facility, the hours and days the site is open to the public, an emergency phone number, and listing the general types of materials which either will or will not be accepted.

Solid Waste Handling

Residential, Commercial, and Industrial Plant Wastes

Residential, commercial, and industrial plant wastes contain a heterogeneous mixture of such materials as paper, cans, bottles, cardboard and wooden boxes, plastics, lumber, metals, yard clippings, food waste, rocks, and soil. Waste shall be spread up a 3:1 slope working face in 1 foot to 2 foot layers and compacted by two to five passes with a tracked or steel wheeled compactor. Brush, yard clippings, and similar waste may require more compaction than other wastes. Hard to compact material should be placed at the toe of the working face. The operator should make passes until he can no longer detect that the waste layer is being depressed more than it is rebounding.

Industrial Process Wastes

Industrial process wastes include liquids and semi-liquids; films and other light, fluffy, easily airborne materials; large sheets of metal, plastics, or wood; granules, shavings, turning, powders, and defective manufactured products.

Liquids and semi-liquids are not acceptable at the landfill.

Films and other light, fluffy, easily airborne materials should be incorporated into the working face and covered immediately. Watering down such waste may be helpful, but the detrimental effects of adding water should be considered and only water waste when absolutely necessary and taking special precautions against overwatering.

Large sheets of metal, plastic, or wood should be aligned parallel to each other before compacting to help reduce voids and poor compaction due to bridging of waste.

Granules, shavings, turnings, and powders can be a health hazard to operating personnel and should be covered immediately. Operators should wear face masks, goggles, or protective clothing to avoid respiratory, eye, and skin contact.

Defectively manufactured products should be placed in the working face and incorporated immediately so that drivers, helpers, and other are not tempted to salvage this material and expose themselves to injury.

Dry chemicals should be approved by the Department of Ecology before accepting the wastes. Caution: Some materials react violently to water and may be classified as hazardous. Hazardous wastes are not acceptable.

Solid wastes from schools, rest homes, and hospitals are usually highly compactable and can often be handled in the same manner as residential and commercial wastes. If hospital waste is delivered separately, it shall be spread immediately, compacted, and enclosed with a layer of solid waste or cover. If pathological wastes are accepted, they should be covered immediately with 1 foot of cover.

Bulky Wastes

Tires that have not been split or ground shall be deposited on the cell floor and solid waste spread over them and compacted. Do not attempt to compact tires by themselves or place them all in one location. Concrete, lumber, and other debris can be incorporated evenly throughout the fill. Bulky wastes such as large rocks, stumps, trees, logs, papers and plastic rolls, and other waste shall be placed parallel at the top of the working face and incorporated into the fill. Extra care should be taken to achieve good compaction around these wastes. Do not allow bulky waste to remain uncovered because they provide harborage for rats and other pests.

Water and Wastewater Treatment Plant Sludges

Treated and dewatered sludge may be incorporated directly into the fill upon prior written approval by the Spokane County Health District (SCHD) but should be covered immediately. Treated and dewatered sludge can also be used to generate a fertile final soil cover. Raw sewage sludges and septic tank pumpings should not be disposed of in the landfill. The permittee shall insure that any on-site disposal of sewage is accomplished in a manner approved by the Department of Ecology and the SCHD.

Volatile and Flammable Wastes

These wastes include paints, paint residues, dry cleaning fluids and magnesium shavings and may be in the form of solids, powders, or liquids. These materials should be excluded from the fill due to their hazardous waste classification.

Agricultural Wastes

Residues from agricultural practices shall be recycled, utilized for productive purposes or disposed of in a manner not to cause vector harborage, air or water pollution, public health hazards, odors or nuisance conditions.

Pesticide Containers

Empty, rigid pesticide containers may be accepted for disposal or recovery if accompanied by a written statement that they have been properly decontaminated by jet or triple rinsing and crushing. Empty non-rigid pesticide containers (bags) need not be decontaminated prior to acceptance and disposal.

Incinerator Fly Ash and Residue

Fly ash may be moist or dry when delivered to the site. If ash is dry, water may have to be added to it so that it does not become airborne and create a nuisance. It should be covered immediately.

Dead Animals

Dead birds, cats, dogs, horses, cows, and other animals shall be placed in a trench cut in native ground and covered immediately. When there is no longer native ground available for this procedure, animals shall be immediately incorporated into the landfill and covered.

Waste Oil

No waste oil, grease, oil sludges, or oil soaked wastes will be permitted in the landfill. Oil shall be only accepted at a proper receiving station permitted by the Department of Ecology.

Radioactive Wastes and Explosives

No radioactive waste or explosives shall be accepted. If a hauler attempts to dispose of such wastes, the wastes, truck, and driver should be isolated and proper health authorities contacted. Demolition experts should be consulted for removal of explosives found at the site. Radioactive wastes are disposed of under the auspices of the United States Atomic Energy Commission.

Asbestos

No friable asbestos shall be disposed of at this site.

Hazardous Waste

Hazardous wastes shall not be disposed of, treated, stored, or otherwise handled at the Marshall landfill unless the requirements of chapter 173-303 WAC are met and with prior written approval of the Department of Ecology.

Prohibited Wastes

Any prohibited wastes shall be removed from the solid waste site as soon as discovered and shall be transported to a disposal site authorized to accept such waste. Such wastes shall be transported within 48 hours unless otherwise approved by the Department of Ecology. Temporary storage and transportation shall be performed in accordance with the rules of the Department of Ecology.

Surface Drainage Control

The landfill shall be constructed in accordance to the design plans and properly maintained so that drainage will be diverted around or away from active and completed operational areas. Surface grades will be maintained so that ponding of surface water is minimized. The maximum external slope is 3:1 and the minimum external slope shall be 2 percent. Grade stakes shall be used throughout construction to insure proper grades are reached.

Surface water diversions, ditches, or structures will be maintained to allow the free flow of water at all times.

Site Screening

To the extent practical, the active landfill areas shall be screened from public view by trees, shrubbery, fence, stockpiled cover material, earthen berm, or other appropriate means.

Maintenance

Dust Control

Dust is a problem especially in arid regions. Dust can be temporarily controlled by wetting down roads, oiling roads if permitted, application of cinders, and keeping final vegetative cover on closed out portions of the landfill or temporary vegetative cover of inactive areas.

Litter Control

Litter is visible proof that a landfill is not being operated properly. Litter can be controlled by keeping the working face as small as possible, constructing wind break berms, covering solid waste frequently, portable blow fences, and litter cleanup. Windblown materials from the disposal site will be collected from the site and adjacent properties and properly disposed of at sufficient frequency to prevent aesthetically objectionable accumulations. The entrance area shall be kept clean of litter at all times.

The control of litter helps aid in vector control and fire protection as well as projecting a good clean operation that is beneficial to the public.

Noise

Keep equipment properly maintained (i.e. mufflers, etc.) so equipment noise will not become a problem.

Salvage and Scavenging

The public is prohibited from scavenging and no person may salvage food products or furniture and bedding from the landfill. A permittee may conduct or allow the recovery of materials such as metal, paper, and glass from the landfill only when such recovery is conducted in a planned and controlled manner approved by the Department of Ecology. No person shall salvage at the working face and all salvage materials must be stored away from public view. Storage areas shall be kept orderly and materials removed at sufficient frequency to avoid creating a nuisance condition, vector harborage, or safety hazard.

Recyclable Materials

Recyclable materials including newspaper, corrugated paper, metals, glass and white goods shall be stored in other suitable areas. The storage area shall be maintained in an orderly manner and kept free of litter. Recyclable material should be removed at sufficient frequency to avoid creating a nuisance condition. Large metal appliances and other metal recyclable materials should be stockpiled in an area screened from public view for periodic removal as markets dictate.

Vector and Bird Control

Vectors including flies, rats, and birds can be controlled or prevented by proper application of soil cover material. If a vector problem develops, a professional exterminator should be consulted.

Groundwater

The landfill permittee shall insure that the introduction of any substance from the landfill into the groundwater source does not result in a violation of any applicable federal or state drinking water rules or regulations beyond the solid waste boundary of the landfill or an alternative boundary specified by the Department of Ecology. All solid waste disposed of at the Marshall landfill must be maintained at a minimum of thirty (30) feet above the highest anticipated ground water elevation.

Leachate

Leachate production shall be minimized by the proper use of cover material and proper grading and construction. Where required, leachate shall be collected and treated or otherwise controlled in a manner approved by the Department of Ecology. Any leachate that percolates through the cover material shall be kept from entering surface water drainage ways and the problem corrected as quickly as possible.

Gas Control

Operation, expansion, or modification of a landfill will not be permitted if the concentration of methane (CH_4) gas at the landfill exceeds: 25 percent of its lower explosive limit in facility structures (excluding gas control or recovery system components); the lower explosive limit for the gases at the property boundary or beyond; and one hundred parts per million (ppm) by volume of hydrocarbons (expressed as methane) in off-site structures. Proper covering and drainage will help control methane gas production and associated problems.

Burning

No burning of solid waste will be permitted at the landfill without the concurrent written permission of the SCHD, the Spokane County Air Pollution Control Authority, and the

Jurisdictional Fire District. If permitted, only burning of land clearing debris such as tree stumps, large tree limbs, and brush will be allowed. Burning will not be any closer than 500 feet to the working face.

Fire Control

Adequate on-site fire protection as determined by the local fire control agency must be provided and arrangements made to acquire immediate service. The operator is responsible for initiating and continuing appropriate fire fighting methods until all smoldering, smoking, and burning ceases. All fires shall be promptly reported to the Department of Ecology's Eastern Region office by calling their office at (509) 456-2926.

If a hot load (potentially flammable or burning load) is spotted, it should be dumped away from the working face where it can be spread out and extinguished. The jurisdictional Fire Department should be notified immediately. If burning waste is found, it should be pushed out and spread so it can be extinguished. Extinguished waste should only be put into the working face at the end of the day and then covered.

Daily cover will help keep fires contained in a cell and from spreading. As a precaution, fire extinguishers should be kept on all pieces of equipment and all operators trained in their use.

Equipment

Equipment of adequate size and design to properly operate the site shall be available at all times. In the event of equipment breakdown, alternative equipment must be provided unless a specific exemption is granted in writing by the Department of Ecology.

Emergency

In case of equipment breakdown, flooding, fire, sliding, or other occurrences that cause a violation of any condition of the permit or Department of Ecology rules, the operator or permittee shall:

1. Immediately take action to correct the unauthorized condition or operation;
2. Immediately notify the Department of Ecology so an investigation can be made to evaluate the impact and the corrective actions taken, and to determine what additional action must be taken; and
3. Immediately notify all pertinent County officials that an emergency has occurred.

AREA FILL METHOD

The present landfilling practice being utilized is an area fill method. An area fill includes a fairly large working face for waste disposal. Refuse is off-loaded either on undisturbed ground or on a prepared tipping pad where it is pushed onto the working face in lifts from 1 to 2 feet in thickness and then compacted. Each layer is compacted as the filling progresses over the course of the day. At that time, and at the end of each day's operation, a minimum six inch layer of cover material is placed over the completed fill. Cover material may be excavated from adjacent higher points of land, imported from borrow pit areas, or from previously constructed stockpiles. The width and length of the fill or working face depends upon several factors, such as the daily quantity, traffic volumes, and landfill equipment being utilized.

Normally a dump pad is used by utilizing natural elevation differences or by constructing a lift of solid waste large enough to provide a working platform for both public and commercial vehicles. Due to the short term operations of this site and the firm base provided by the local cover material, the present practice will be continued by the landfill operator. This consists of a large flat unloading area where waste is deposited on the ground and periodically pushed onto the active face with equipment.

Cell development will consist of filling the present operating area with waste and daily cover material in approximately two foot lifts, working along the perimeter of the area and shaping the cells to match final contour elevations minus the final (30") top cover. At the completion of each lift, the operation can move over this cell and a new cell developed over the previous cell. This process will continue until the required area is filled or overlaid with solid waste and the final cover is applied according to the Cover Section within the General Landfill Operational Details.

MARSHALL LANDFILL TECHNICAL DETAILS

Estimated Site Capacity, In-Place Cubic Yards/Life (0% Annual Growth Factor)

Lower Area = 190,000/19 months

Upper Area = 210,000/5 months (including excavated and replaced waste material)

Estimated Required Cover Material Volumes

Daily and interim cover material:

Upper fill area	=	26,200 cubic yards
Lower fill area	=	24,500 cubic yards
Total daily and interim cover	=	50,700 cubic yards

Final Cover Material:

24" clay top cap	=	75,000 cubic yards
6" top soil	=	19,000 cubic yards

Note: 1) Estimated percentage of daily and interim cover to in-place solid waste = 20%

2) All volumes are in-place measured

Estimated Available Native Cover Material (On-Site)

There are sufficient on-site sources for daily and intermediate cover material.

Equipment Available

D8 Caterpillar crawler/tractor with rippers

966 Caterpillar wheel mounted front-end loader

285 Caterpillar trackhoe

INTRODUCTION

This report is designed to meet the requirements of WAC 173-304-407 (4), (6), (7) and (8) and provide a plan for use by the landfill operators to initiate and complete closure/post closure activities at the Marshall landfill. It is intended to be a working document and conveys the intent of the designer for the most efficient closure/post closure of the landfill while maintaining compliance with the State of Washington's requirements.

This report covers the actual closure of the Marshall landfill in 1991 as well as post closure monitoring requirements.

CLOSURE COSTS

Items included in landfill closures are:

- Cover Material
- Gas Collection System
- Site Grading and Soil Placement and Compaction
- Fertilizing and Seeding
- Maintenance Roads

These categories and costs are described below:

Cover Material - Final closure requires at least two feet of soil, compacted to achieve a maximum permeability of $1x10^{-6}$ cm/sec., applied over a sand leveling course. Suitable clay soils are available from nearby sources. A final six inch layer of top soil will be applied to establish a cover crop. A detailed breakdown of the costs for the top cap is found in Table 1. Total cost for 28 acres is estimated at $642,120. Soil testing indicates no bentonite additive will be necessary for the top cap soil.

Gas Collection System - A system of perforated pipes for gas collection is required to minimize gas migration off site. It is estimated that this system will require 2,300 linear feet of perforated HDPE pipe and cost approximately $21,000 to install.

Site Grading and Soil Placement and Compaction - Grading of the site and placement and compaction of the top cap soil will be done with a crawler tractor. Grading of the site is included in the installation cost of the clay layer. The six inch sand leveling layer will

consist of the daily and interim cover already placed or being placed. Installation of the six inch top soil is estimated to cost approximately $46,190.

Fertilizing and Seeding - Grass seed and fertilizer will be applied by hydroseeding to establish a vegetative crop for erosion control at a cost of approximately $110/acre. Table 1 contains the estimated closure cost.

TABLE 1
MARSHALL LANDFILL
ESTIMATED CLOSURE COST
AUGUST, 1989

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
24" Clay Cap Installation	107,311	C.Y.	$3.70	$397,050
6" Top Soil Cap	25,661	C.Y.	$1.80	$46,190
Hydroseeding/Fertilizing	28	Acres	$110	$3,080
Gas Collection System	LS	LS	$21,000	$ 21,000
Construction Quality Assurance	LS	LS	$96,000	$96,000
Engineering Design & Construction Certification	LS	LS	$22,000	$22,000
Other Misc.				$56,800
ESTIMATED CLOSURE COSTS				$642,120

CLOSURE/POST-CLOSURE PROCEDURES

Closure Procedures

The proposal calls for closure of the existing Marshall landfill site by October 1, 1991. As such, some sequential or partial closure activities will be taking place. The remaining landfill space will be divided into two areas. The upper area will be constructed for closure by depositing additional lifts to the top portion of the landfill. This area will be reserved for the disposal of waste material that will need to be excavated along the eastern side slope to bring the grade in that area into compliance with Department of Ecology Standards. Closure of the lower area, located along the northeastern perimeter of the landfill, will

VARIANCE REQUEST

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SECTION 4

Marshall Landfill, Inc. intends to utilize on site manpower and equipment to perform the closure work for the Marshall Landfill. The estimated closure costs were calculated using Marshall Landfill's actual costs for labor and equipment. Hourly equipment costs are shown in Table 1. Although Marshall Landfill will be utilizing their own equipment, it has been assumed and anticipated that 20 cubic yard capacity dump trucks will need to be rented for transporting the clay material to the site.

The clay source is located approximately five miles from the site (haul distance). It was assumed that one round trip would take about 25 minutes. A 20 cubic yard capacity truck would therefore have a production rate of 50 cubic yards per hour. Rock, sand and top soil sources are located on site and 10 cubic yard trucks are available for transporting these materials.

TABLE 1 - MARSHALL LANDFILL, INC. EQUIPMENT COSTS

Equipment	Rate $/Hour	Operator Cost $/Hour	Fuel Usage Gal/Hour	Fuel[1] Cost $/Hour	Total Cost $/Hour	Alternate[3] Rate $/Hour	Rate Used $/Hour
D4 Cat	30.00	-0-[2]	-0-[2]	-0-[2]	$30.00	$44.48	$45.00
D8 Cat	80.00	15.00	10.0	7.90	$102.90	$100.30	$105.00
225 Trackhoe	60.00	12.00	6.0	4.74	$76.74	$61.44	$65.00
966 Loader	60.00	10.00	5.0	3.95	$73.95	$63.50	$65.00
10 Yard Truck	40.00	9.00	5.0	3.95	$52.95	$45.00[4]	$50.00
20 Yard Truck	65.00	-0-	-0-	-0-	$65.00	$65.00[4]	$65.00
Sheepsfoot	10.00	-0-	-0-	-0-	$10.00		$10.00
Water tank	1.00	-0-	-0-	-0-	$10.00		$10.00

[1]Fuel cost calculated using $0.79/gallon.

[2]Rental rate includes operator, fuel and attachments.

[3]Equipment rental rate from Western States Equipment Company, Spokane, WA, and includes fuel and operator. Operator cost based on prevailing wage rate for Spokane County.

[4]Customary equipment rental rates for Spokane County with operator and fuel.

The following is a detailed breakdown showing how the closure cost estimate was obtained. Bold line items correspond to the closure items listed in Table 1 of the Closure Plan.

24" Clay Cap Installation

Clay material/transport	Production	Cost per c.y.
Purchase cost		$0.50
Strip/excavate w/D8	200 c.y/hr @ $105.00/hr	$0.53

Truck (20 c.y.)	50 c.y./hr @ $65.00/hr	$1.30
Loading w/966	200 c.y./hr @ $65.00/hr	$0.32

Total clay material/transport cost $2.65

Placement/compaction	Production	Cost per c.y.
Spread/grade w/D8	200 c.y./hr @ $105.00/hr	$0.53
D8 w/water tank	500 c.y./hr @ $115.00/hr	$0.23
D8 w/sheepsfoot	400 c.y./hr @ $115.00/hr	$0.29

Total placement/compaction cost $1.05

Total 24" Clay Cap Installation $3.70

6" Top Soil Cap

Stripping/transportation/grading	Production	Cost per c.y.
Stripping w/D8	1,000 c.y./hr @ $105.00/hr	$0.11
Loading w/966	150 c.y./hr @ $65.00/hr	$0.43
Truck (10 c.y.)	50 c.y./hr @ $50.00/hr	$1.00
Grading w/D8	400 c.y./hr @ $105.00/hr	$0.26

Total 6" Top Soil Installation cost $1.80

Hydroseeding/Fertilizing

Preparation/finish	Production	Cost per acre
D4 w/harrow (prep)	2.0 ac./hr @ $45/hr	$22.50
D4 w/seeder	2.5 ac./hr @ $45/hr	$18.00
D4 w/harrow (finish)	2.5 ac./hr @ $45/hr	$18.00
D4 w/spreader	2.5 ac./hr @ $45/hr	$18.00
Seed		$13.50
Fertilizer		$20.00

Total Hydroseeding/Fertilizer cost $110.00

Gas Collection System

Equipment/labor	Unit Cost	Total Cost
Excavation w/225	20 hrs. @ $65.00/hr	$1,300.00
Backfill w/225	20 hrs. @ $65.00/hr	$1,300.00
Laborers	60 hrs. @ $25.00/hr	$1,500.00
Pipe welder/equip.		$1,700.00

Total equipment/labor $5,800.00

Materials	Unit Cost	Total Cost
4" HDPE perf pipe	2,100 l.f. @ $5.50/ft	$11,500.00
8 oz. filter fabric	1,000 s.y. @ $1.00/s.y.	$1,000.00
1" drain rock	120 c.y. @ $3.00/c.y.	$350.00
HDPE fittings		$1,000.00
Vents & misc. piping		$1,350.00
Total materials		$15,200.00
Total Gas Collection System cost		**$21,000.00**

Other Miscellaneous

Drainage ditches	Unit Cost	Total Cost
Shaping w/D8	16 hrs. @ $105.00/hr	$1,680.00
Excavation w/225	8 hrs. @ $65.00/hr	$520.00
Truck (10 c.y.)	16 hrs. @ $50.00/hr	$800.00
1" drain rock	100 c.y. @ $3.00/c.y.	$300.00
Total drainage ditches		$3,300.00

Reslope road	Unit Cost	Total Cost
Shaping w/D8	8 hrs. @ $105.00/hr	$840.00
Total reslope road		$840.00

Reshape slopes	Unit Cost	Total Cost
Exc./reshape w/D8	440 hrs. @ $105.00/hr	$46,200.00
Excavate w/225	100 hrs. @ $65.00/hr	$6,500.00
Total drainage ditches		$52,700.00
Total Other Miscellaneous cost		**$56,840.00**

consist of filling the existing operating area with incoming solid waste and shaping to proposed final contours.

A five-acre site located approximately 500 feet northwest of the existing permited landfill will be closed at the same time as closure operations begin on the 23 acre site. Closure of this site will consist of shaping and capping the slopes to proposed final contours.

When each area approaches its final elevation, closure contours will be verified and shaped so that installation of the final top cap may begin. Two feet of soil and/or bentonite will be placed as an impervious barrier and a final 6 inch layer of top soil will be placed to support a vegetative cover. When all final contours have been achieved the top cap will be seeded and fertilized.

As noted, the proposed site closure contours have been prepared to include an estimated capacity capable of receiving waste until the closure date of October 1, 1991, however, several variables may shorten or lengthen this estimate. It is impossible to forecast an exact date for closure activities to commence. However, closure construction cannot occur during the wet weather period. Therefore, partial closure can be anticipated for the summer of 1990 with the balance anticipated for the summer of 1991.

As the site is compacted and contoured for closure, some additional filling may be necessary to achieve final contours.

Upon completion of closure activities the Marshall landfill owner(s) shall:

1. Submit a Facility Closure Plan Sheet, signed by a professional engineer registered in the State of Washington and modified as necessary to represent as-built changes to the final closure construction as approved in the closure plan.

2. Submit certification by the owner or operator, and a professional engineer registered in the State of Washington that the site has been closed in accordance with the approved closure plan.

3. Record, with the County Auditor, any necessary deed clauses for land use, zoning or other restrictions for the closed landfill site.

Post-Closure Maintenance and Monitoring Costs

At the present time, the Washington Department of Ecology (WDOE) requires 20 years post-closure maintenance and monitoring, therefore, the post-closure maintenance costs were calculated using a 20 year maintenance period.

Items included in the post-closure are:

- Water Quality Monitoring
- Gas Monitoring
- Leachate treatment/disposal
- Facilities maintenance
- Operating staff and management

These categories and costs are described below:

WATER QUALITY MONITORING - The monitoring wells will be sampled quarterly each year with the data forwarded to the WDOE. Currently five (5) monitoring wells exist and additional monitoring wells will be installed if required. For the purpose of estimating the post closure water monitoring costs, a total of seven wells will be considered. The laboratory cost are estimated at $250 per sample delivered to the laboratory. Twenty eight samples per year will be required for a total annual water monitoring cost of approximately $7,000.

GAS MONITORING - Gas levels created from the biodegradation of the landfill waste will be sampled quarterly each year. Gas monitoring records as well as laboratory gas analysis will be forwarded to the WDOE. Costs for each sampling period are estimated at $1,250 for each quarter.

LEACHATE TREATMENT/DISPOSAL SYSTEM - From water balance models developed for this site (see geotechnical report), very little recharge through the waste is anticipated. Providing that a run-off rate above 80 percent can be achieved through proper selection of top soil and vegetative cover, the recharge will be near zero. Therefore a leachate collection, treatment, and disposal system will not be required at this site.

FACILITIES MAINTENANCE - Facilities maintenance includes fertilizing and seeding the top cap as required, maintaining drainage facilities, roads, fences and buildings, monitoring

wells, gas collection systems, and site security. It is difficult to determine with any certainty what maintenance problems could occur. It is anticipated that only minor maintenance will be required within the first years following closure of the site with an increase in maintenance costs being required as the facility ages. Annual facility maintenance costs are estimated to average $5,000 per year.

OPERATING STAFF AND MANAGEMENT - The above post-closure maintenance and monitoring requirements will require an operating staff of one part-time person and periodic professional services to sample. Annual cost for a part-time person and administration is estimated at $5,000. Professional services are estimated to cost approximately $5,000 per year. Table 2 contains the estimated annual post-closure cost.

TABLE 2
MARSHALL LANDFILL
ESTIMATED ANNUAL POST CLOSURE COST
AUGUST, 1989

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Water Quality Monitoring	28	samples	$250	$7,000
Gas Monitoring	4	quarters	1,250	5,000
Facilities Maintenance	ALL	L.S.	5,000	5,000
Operating Staff/Professional services	ALL	L.S.	10,000	10,000
Estimated Annual Cost				$27,000

Over a 20 year post-closure period total costs will be $540,000. Total closure/post-closure costs will be $1,182,120.

Post-Closure Procedures

Post-closure activities will commence only after the Marshall landfill owner(s) has submitted the closure plan sheet and signed closure certification and has received notification from Spokane County Health District (SCHD) that the landfill is considered closed.

Post-closure activities include monitoring of groundwater, surface water, gas emissions and maintenance of landfill and its facilities as detailed in the Post-Closure Costs section of this report.

When post-closure activities are complete, the owner or operator shall provide certification, signed by the owner or operator, and a professional engineer registered in the state of Washington stating why post-closure activities are no longer necessary.

SCHD may authorize the owner to discontinue post-closure maintenance and monitoring activities, if post-closure monitoring has established that the facility has-stabilized.

RUSS FETROW ENGINEERING, INC.
890 PROMONTORY PL. SE SALEM, OR 97302
P.O. BOX 47 EUGENE, OR 97401

MARSHALL LANDFILL, INC.
MARSHALL LANDFILL CLOSURE (CLAY)
TIME SCHEDULE
JANUARY, 1990

NOTE:
THIS TIME SCHEDULE ASSUMES THAT THE VARIANCE REQUEST HAS BEEN APPROVED

	1990									1991			
TASK TOTALS	$12,000				$510,000					$115,000			$5,000
TASK ITEMS	JANUARY	FEBRUARY	MARCH	APRIL	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
TASK 1: FINALIZE ENGINEERING, SPECIFICATIONS AND NOTIFICATION. 1-A DEVELOP ENGINEERING PLANS 1-B OWNER REVIEW/APPROVAL 1-C DEVELOP FINAL SPECIFICATIONS 1-D OWNER REVIEW/APPROVAL 1-E SCHD NOTIFICATION OF CLOSURE ACTIVITIES	$2,500 (1)	$2,500	$600 (31)										
	$3,000 (1)	$3,000	$400 (31)	(1–15)									
				(1–15) (30)									
TASK 2: PARTIAL CLOSURE CONSTRUCTION (ALL BUT ACTIVE AREA) 2-A CONSTRUCTION STAKING 2-B CONSTRUCTION MANAGEMENT\OBSERVATION/ TESTING 2-C CONSTRUCTION (CLAY COVER) 2-D FINAL INSPECTION 2-E ACCEPTANCE BY OWNER					$6,000 (1–15) $10,000 (15–) $70,000	$25,000 $135,000	$25,000 $135,000	$10,000 (20–) $89,000 (20–25) 20–25	$5,000				
TASK 3: CONSTRUCTION 3-A CONSTRUCTION STAKING 3-B CONSTRUCTION MANAGEMENT/OBSERVATION/ TESTING. 3-C CONSTRUCTION (CLAY COVER) 3-D FINAL INSPECTION 3-E ACCEPTANCE BY OWNER										(25–) $2,500 (5–31) $15,000 (1–31) $95,000	$2,500 (1–15)	(1)	
TASK 4: AS-BUILTS/CERTIFICATION/ POST CLOSURE. 4-A COMPLETION OF AS-BUILTS 4-B COMPLETION OF CERTIFICATION MANUAL 4-C SUBMIT AS-BUILTS/CERTIFICATION TO SCHD 4-D BEGIN POSTCLOSURE ACTIVITIES											(1) $2,500 (30) (1) $2,000 (30)	(1–30) (1) $500	
MONTHLY TOTALS	$5,500	$5,500	$1,000	$0	$86,000	$160,000	$160,000	$104,000	$0	$0	$112,500	$7,000	$500

RUSS FETROW ENGINEERING, INC.
890 PROMONTORY PL. SE SALEM, OR 97302
P.O. BOX 47 EUGENE, OR 97401

MARSHALL LANDFILL, INC.
MARSHALL LANDFILL CLOSURE (CLAY)
TIME SCHEDULE
NOVEMBER, 1989

NOTE:
THIS TIME SCHEDULE ASSUMES THAT
THE VARIANCE REQUEST HAS BEEN APPROVED

TASK TOTALS	← $12,000 →			← $5,000 →		← $620,000 →				$5,000
TASK ITEMS 1990	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
TASK 1: FINALIZE ENGINEERING, SPECIFICATIONS AND NOTIFICATION. 1-A DEVELOP ENGINEERING PLANS 1-B OWNER REVIEW/APPROVAL 1-C DEVELOP FINAL SPECIFICATIONS/CONTRACT/ DOCUMENT. 1-D OWNER REVIEW/APPROVAL 1-E SCHD NOTIFICATION OF CLOSURE ACTIVITIES	1 2,500 1 3,000	2,500 3,000	600 15 22 400 15 15 22	31						
TASK 2: ADVERTISE AND AWARD OF CONTRACT. 2-A FOWARD BID DOCUMENTS TO SELECTED CONTRACTORS. 2-B PREBID CONFERENCE/BID PREPARATION 2-C BID OPENING 2-D SELECT CONTRACTOR 2-E PRE-CONSTRUCTION CONFERENCE				500 1 10 10 1,000	10 10 500 10 400 20 25 20 2,600					
TASK 3: CONSTRUCTION 3-A CONSTRUCTION STAKING 3-B CONSTRUCTION MANAGEMENT/OBSERVATION/ TESTING. 3-C CONSTRUCTION(ASSUMES CLAY COVER DESIGN) 3-D FINAL INSPECTION 3-E ACCEPTANCE BY OWNER					1	6,000 15 15 12,000 15 90,000	30,000 160,000	30,000 160,000	13,000 20 114,000 20 25 5,000 20 25 25	
TASK 4: AS-BUILTS/CERTIFICATION/ POST CLOSURE. 4-A COMPLETION OF AS-BUILTS 4-B COMPLETION OF CERTIFICATION MANUAL 4-C SUBMIT AS-BUILTS/CERTIFICATION TO SCHD 4-D BEGIN POSTCLOSURE ACTIVITIES									1 2,500 20 1 2,000 20 500 20 31 31	
MONTHLY TOTALS	$5,500	$5,500	$1,000	$1,500	$3,500	$108,000	$190,000	$190,000	$132,000	$5,000

APPENDICES

APPENDIX A-	GOLDER ASSOCIATES •CROSS-SECTIONS •MONITORING WELL LOGS
APPENDIX B-	WATER BALANCES •THORNTHWAITE-MATHER METHOD •FENN MODEL •HELP MODEL
APPENDIX C-	WATER RIGHT CERTIFICATES AND DOMESTIC WELL LOGS
APPENDIX D-	LAND USE MAP AND ZONING MAP
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APPENDIX G-	CLAY CAP: MATERIAL PERMEABILITY TESTS
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APPENDIX I-	VARIANCE REQUEST: CLOSURE AND POSTCLOSURE FINANCIAL PROJECTION
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APPENDIX A

GOLDER ASSOCIATES
•CROSS-SECTIONS
•MONITORING WELL LOGS

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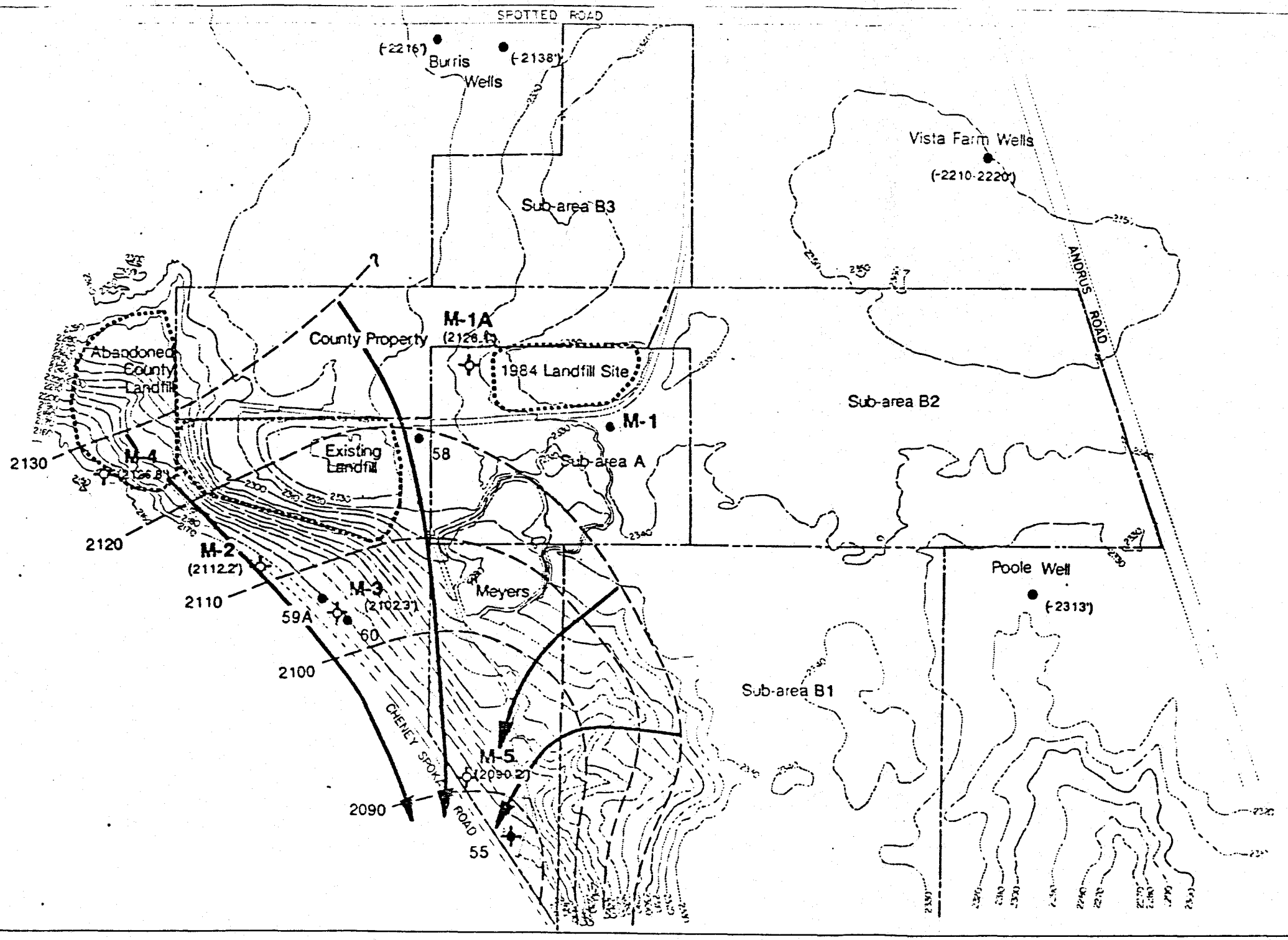


Elevation above mean sea level

PRELIMINARY
FOR REVIEW ONLY
AUG 21 1989

M-4 EXPLANATION

- Well location
- Private Well
- (1090.2') Water level elevation measured on May 14,1989 unless otherwise noted
- 2100 — — Equal potential isopliths of the uppermost aquifer.
- Groundwater flow direction.

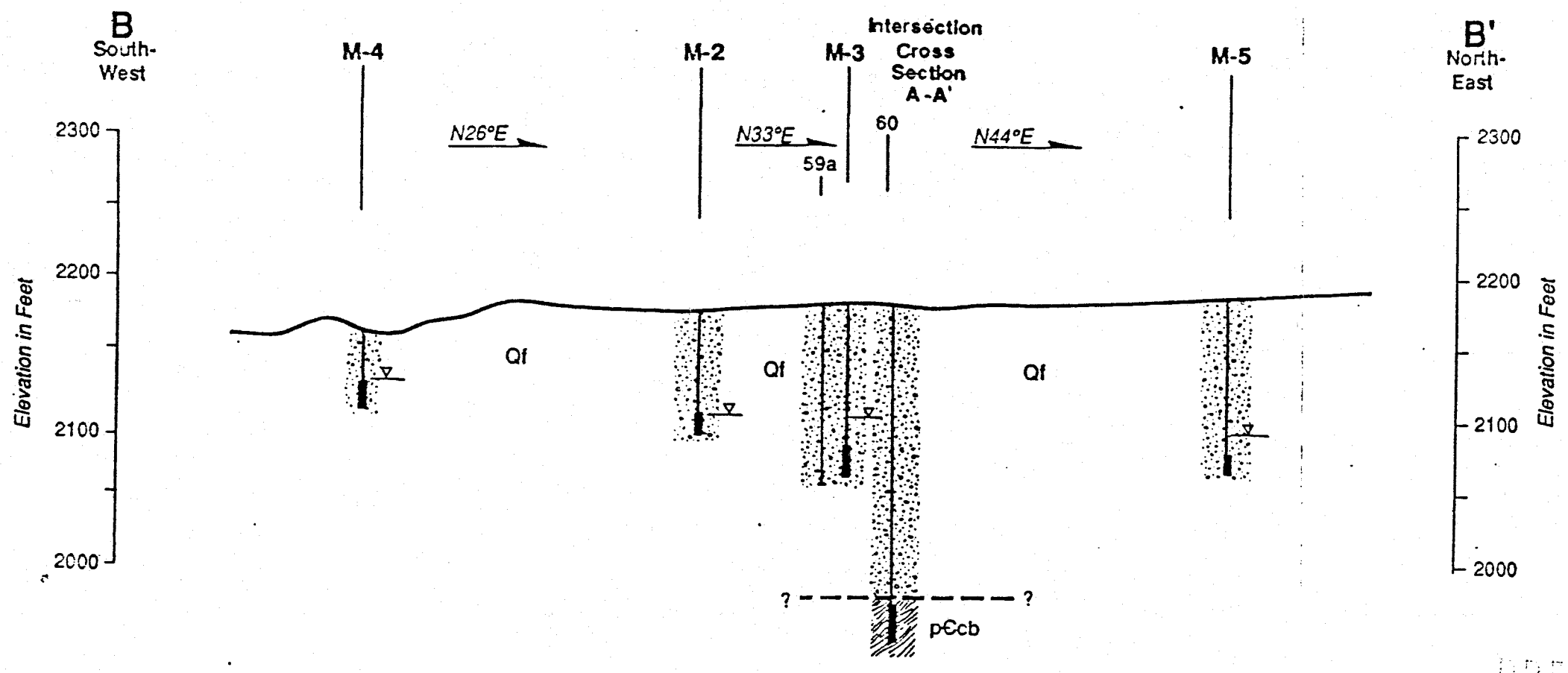
Note: Wells 58, 60, Vista Farms, and Burris #'s 1 and 2 wells installed in bedrock aquifer

0 600 1200

LANDFILL SITING AND DEVELOPMENT
SPOKANE REGIONAL SOLID WASTE DISPOSAL PROJECT
ENVIRONMENTAL IMPACT STATEMENT

MARSHALL LANDFILL SITE
GROUNDWATER ELEVATIONS

Figure 5-19



Elevation above mean sea level.

Scale:
Vertical 1" = 100'
Horizontal 1" = 400'
4x vertical exaggeration

EXPLANATION

Qf — Spokane Flood Deposits

pЄrb — Revett and Burke Formations Undivided

Qf — Spokane flood deposits: deposits of silt, sand, and gravel, usually stratified and well sorted. Probably slack-water deposits.

pЄrb — Metamorphosed Precambrian rocks composed of micaceous quartzite and mica schist.

Monitored interval groundwater measured on 4/14/89.

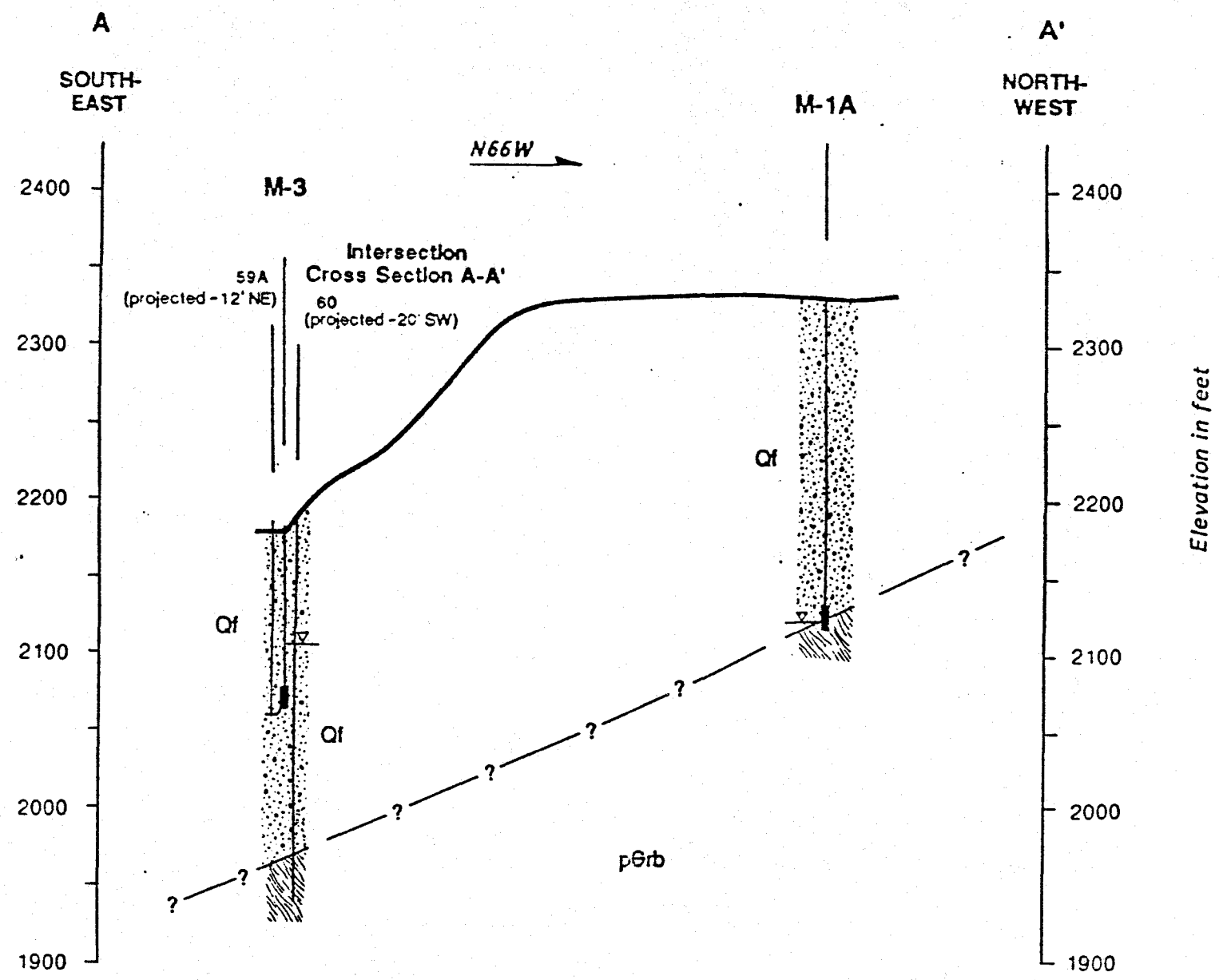
Special Note:
Data concerning the various strata have been obtained at exploration locations only. The stratigraphy between these locations has been inferred from geological evidence and so may vary from that shown.

LANDFILL SITING AND DEVELOPMENT
SPOKANE REGIONAL SOLID WASTE DISPOSAL PROJECT
ENVIRONMENTAL IMPACT STATEMENT

MARSHALL LANDFILL
CROSS-SECTION B-B'

Figure
5-18

PROJECT NO 893-1033.008 DWG NO 13178 DATE 6/23/89 DRAWN DC APPROVED SB



PRELIMINARY
FOR REVIEW ONLY
AUG 21 1989

EXPLANATION

Scale:
Vertical 1" = 100'
Horizontal 1" = 400'
4x vertical exaggeration

Qf — Spokane Flood Deposits

pЄrb — Revett and Burke Formations Undivided

Qf Spokane flood deposits: deposits of silt, sand, and gravel, usually stratified and well sorted. Probably slack-water deposits.

pЄrb Metamorphosed Precambrian rocks composed of micaceous quartzite and mica schist

Monitored interval groundwater measured on 4/14/89

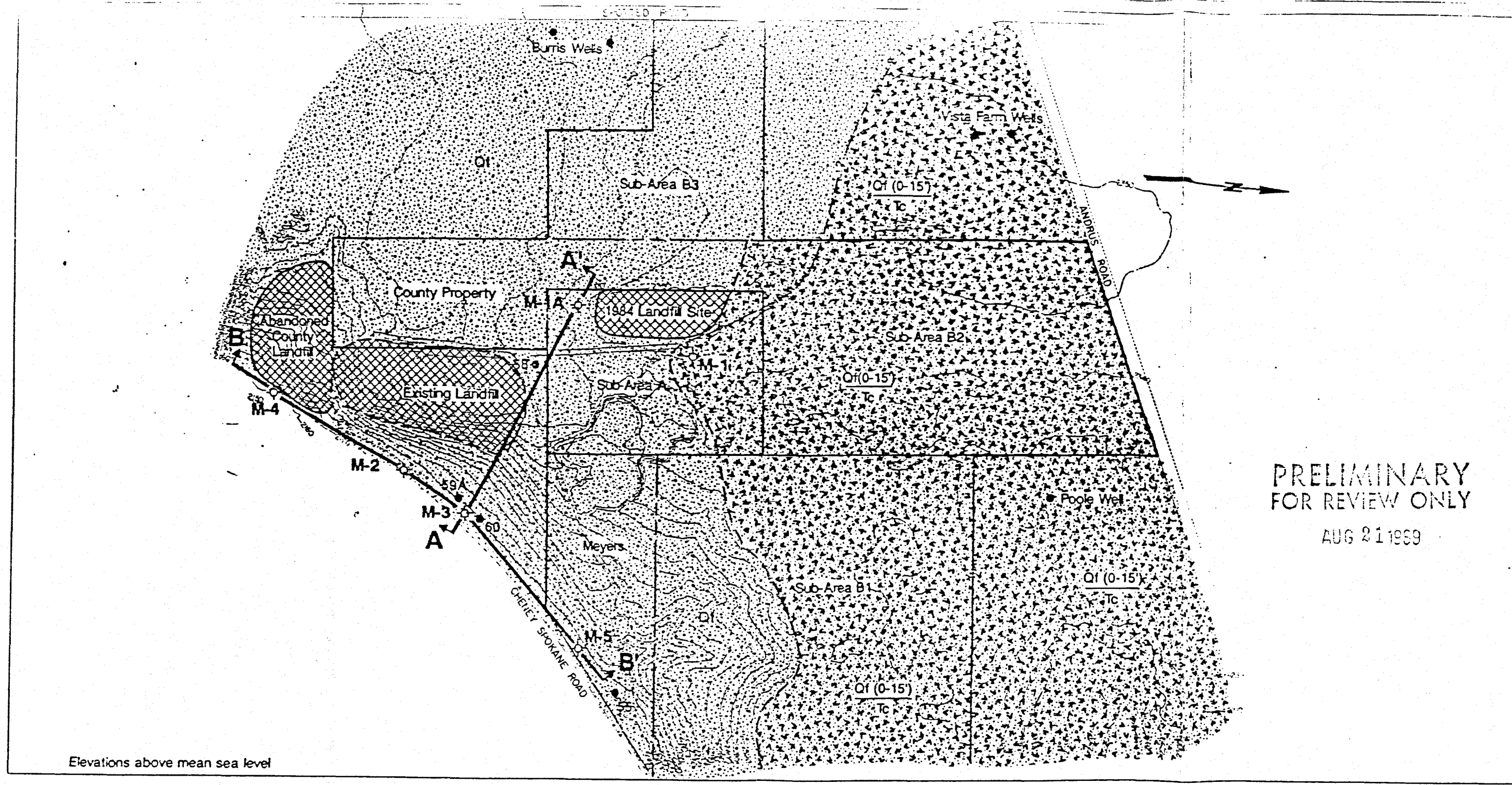
Special Note:
Data concerning the various strata have been obtained at exploration locations only. The stratigraphy between these locations has been inferred from geological evidence and so may vary from that shown.

LANDFILL SITING AND DEVELOPMENT
SPOKANE REGIONAL SOLID WASTE DISPOSAL PROJECT
ENVIRONMENTAL IMPACT STATEMENT

MARSHALL LANDFILL
CROSS-SECTION A-A'

Figure 5-17

PROJECT NO 89-033.008 DWG NO 13177 DATE 8/23/89 DRAWN DC APPROVED SB



PRELIMINARY
FOR REVIEW ONLY

AUG 21 1989

0 600 1200
FEET

EXPLANATION

- Area Boundaries
- Approximate Geologic Contact
- M-2 Well Location
- 59A Private Well Locations

msw Landfill wastes

Qf Spokane flood deposits: deposits of silt, sand, and gravel, usually stratified and well sorted. Probably slack-water deposits.

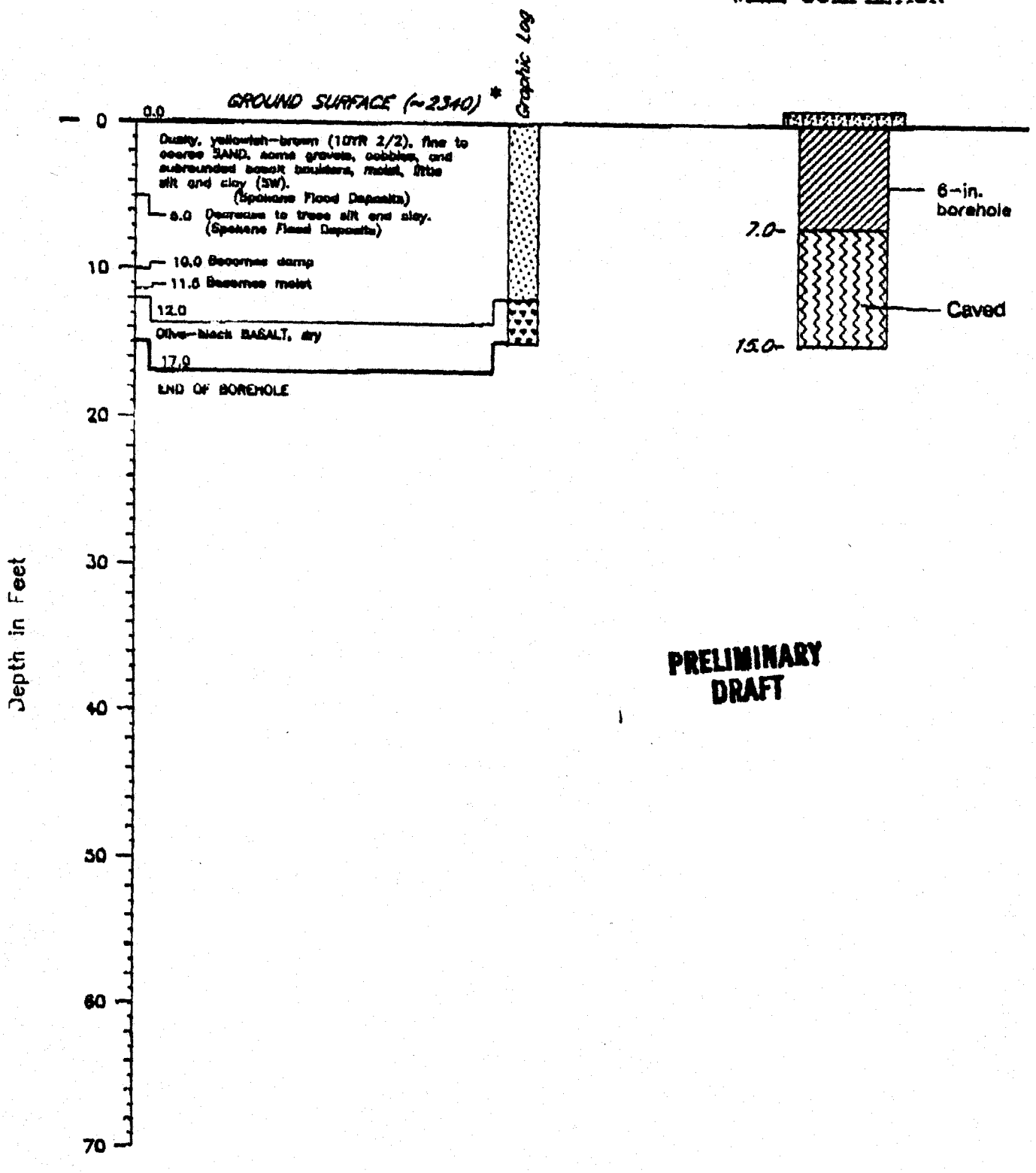
Tc Columbia River Group (Yakima Subgroup) and Latah Formation-flows of locally dense, dark, flat-lying tholeiitic basalt. Included with the basalt are the interlayered or underlying lacustrine beds of the Latah Formation. These are poorly-indurated thin beds of siltstone and claystone.

Qf / Tc Terrain Mapping Unit: 0-15' of Spokane Flood Deposits overlying Columbia Group Basalts

LANDFILL SITING AND DEVELOPMENT
SPOKANE REGIONAL SOLID WASTE DISPOSAL PROJECT
ENVIRONMENTAL IMPACT STATEMENT

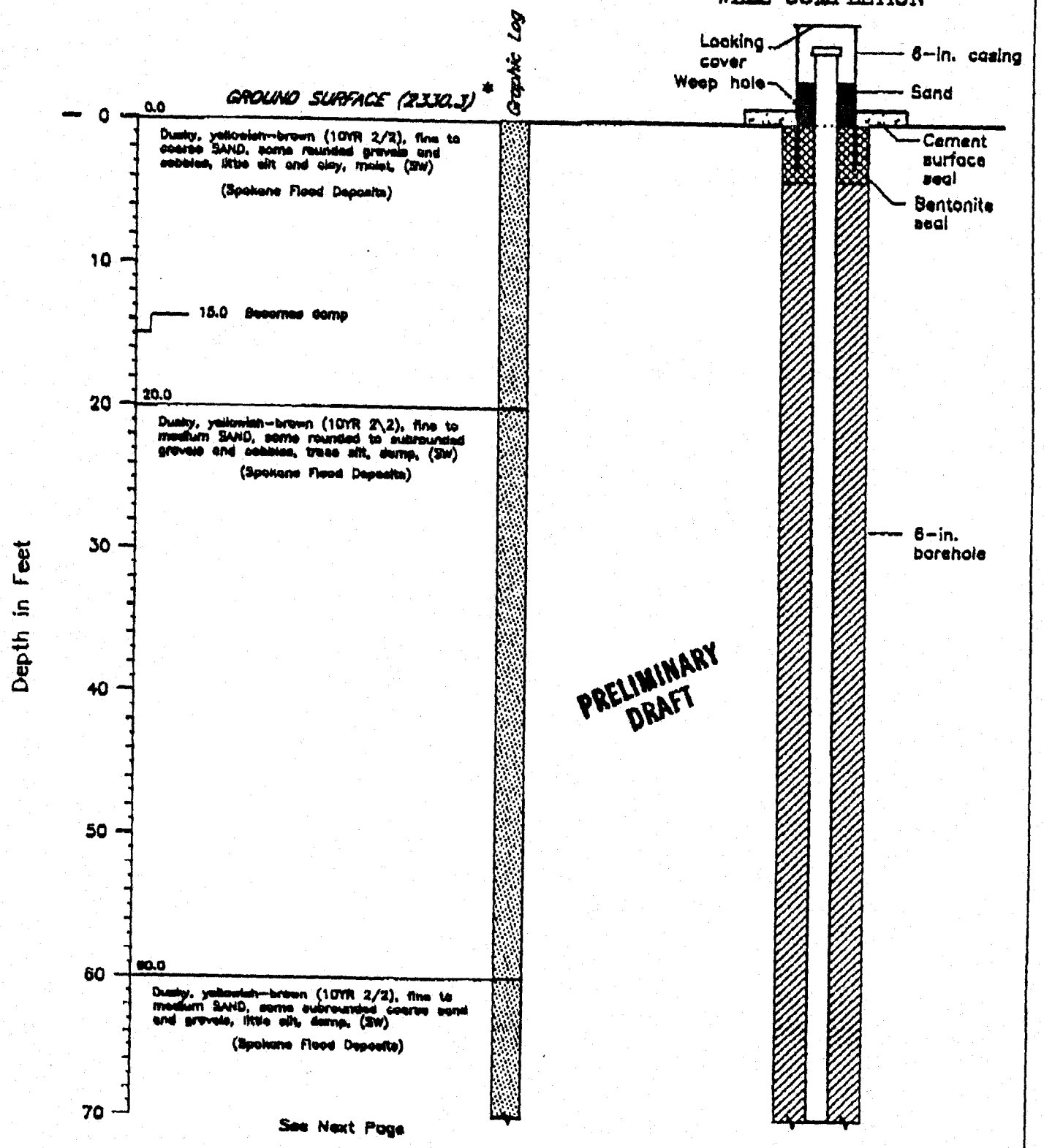
MARSHALL EXPANDED GEOLOGIC MAP AND WELL LOCATION PLAN

Figure 5-16



* Elevations above mean sea level.

FIGURE A-18
BORING M-1
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST



WELL COMPLETION LEGEND:

- Cement
- Grout - Bentonite
- Bentonite Chips (0.75-in.)
- Sandpack (#10-20)
- Water Level
- 2.0-in. Sch. 40 PVC Well Casing, Flush-Threaded
- 2.0-in. Sch. PVC Well Screen, 2.0-in. slot, Flush Threaded

NOT TO SCALE

Date: 3/10/89
Ground Elevation: 2330.3
T.O.C. (PVC) Elevation: 2332.8
Drill Rig: CP 650 W.S.
Drill Method: Air Rotary
Sampling Method:
1)Cyclone grab sample

*Elevations above mean sea level.

FIGURE A-18A
BORING M-1A
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

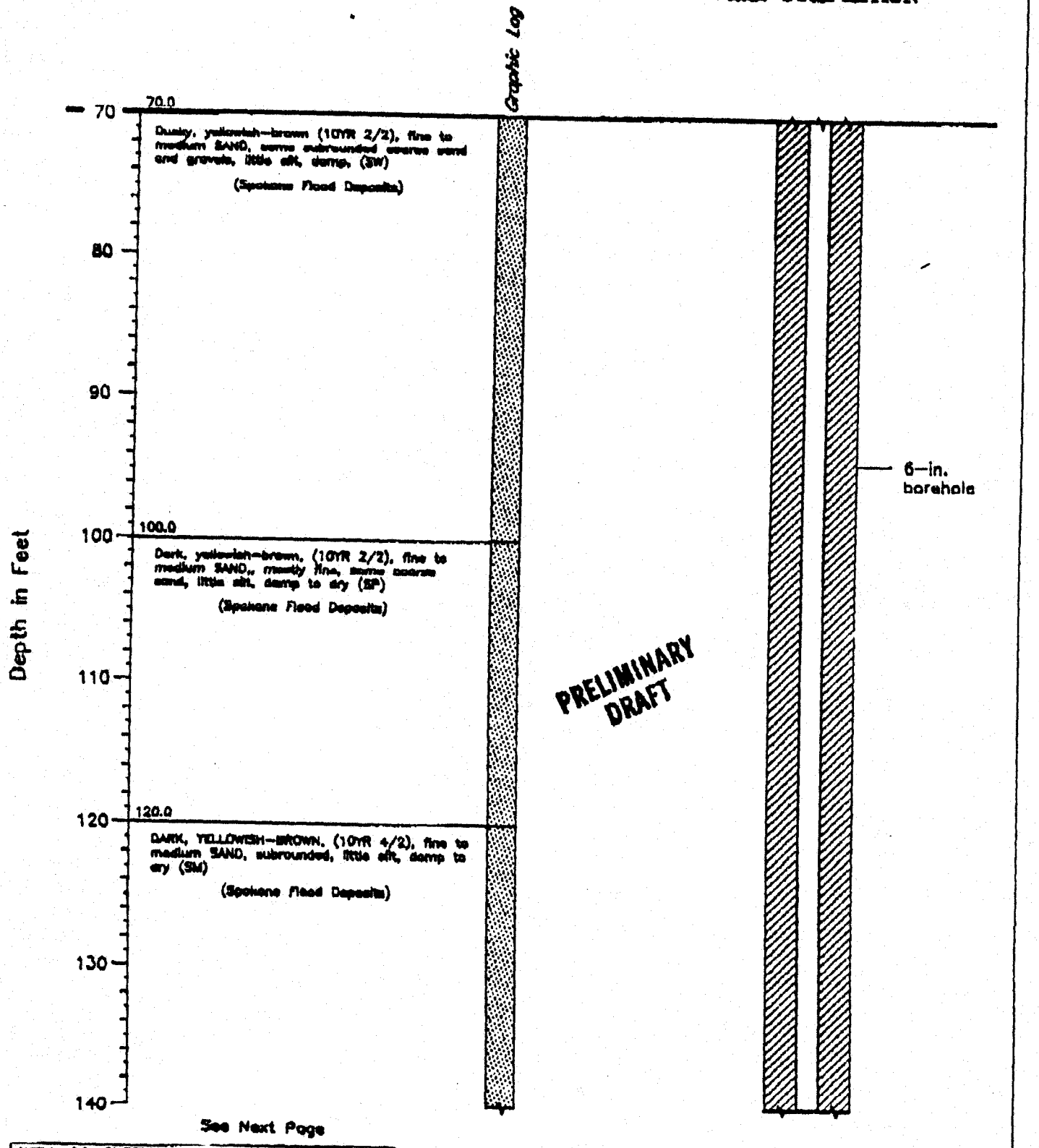


FIGURE A-18A
BORING M-1A
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

PROJECT NO 883-1033.008 DWG NO 7705 DATE 7/7/89 DRAWN RLM APPROVED DPF

Golder Associates

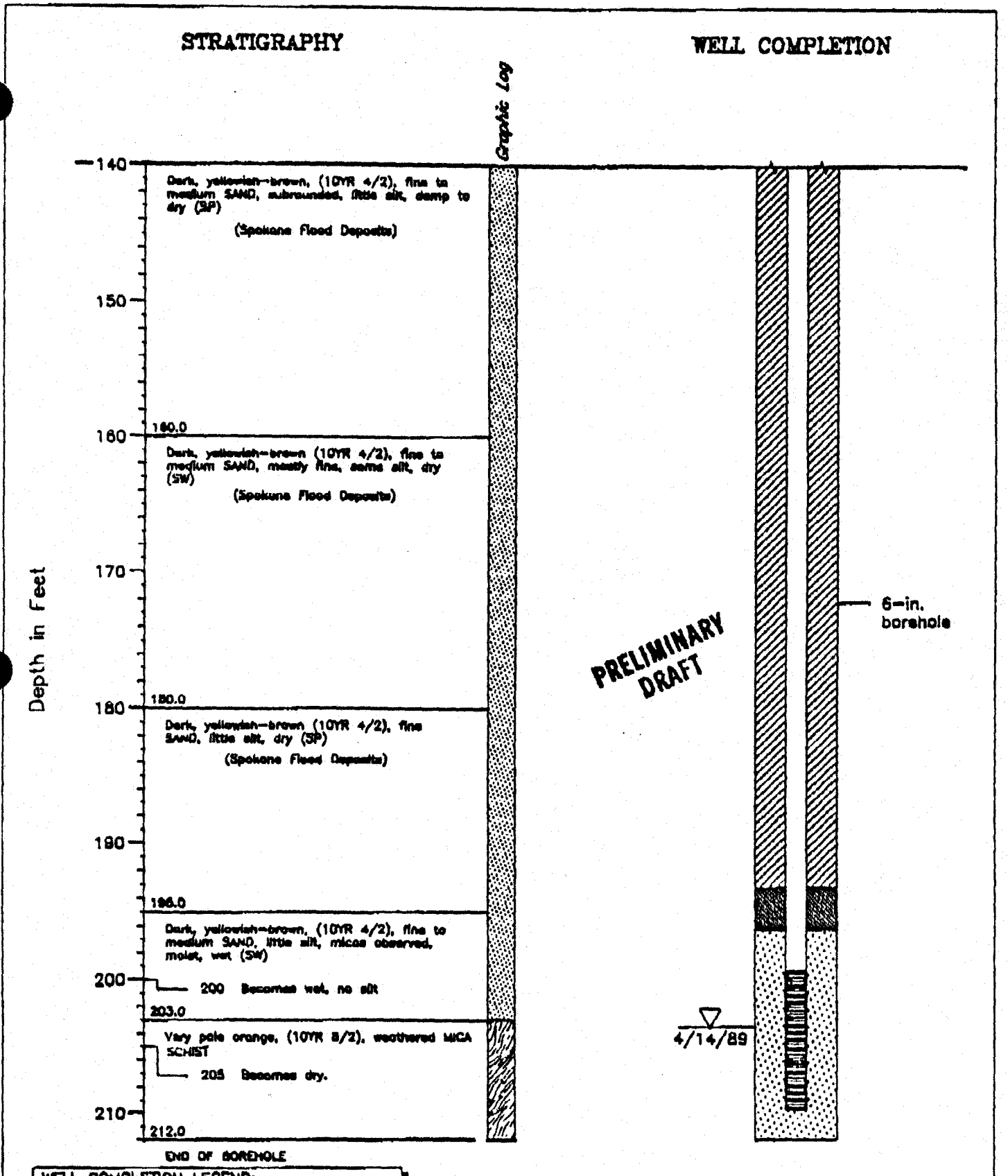


FIGURE A-18A
BORING M-1A
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

PROJECT NO 893-1033.008 DWG NO 7706 DATE 7/7/89 DRAWN RLM APPROVED DPF

Golder Associates
3 of 3

STRATIGRAPHY

Graphic Log

GROUND SURFACE (2173.1)*

0.0 — Dark, yellowish-brown, (10YR 4/2), fine to coarse SAND, trace gravel, subrounded grains, trace silt, moist (SW). (Spokane Flood Deposits)

10.0 — Dark, yellowish-brown, (10YR 4/2), fine to medium SAND, little coarse sand, damp to dry (SP). (Spokane Flood Deposits)

12.0 Becomes dry

18.0 Becomes damp

30.0 Trace of coarse sand

36.0 — Fine to coarse SAND, trace gravel, dry (SW) (Spokane Flood Deposits)

40.0 — Dusky, yellowish-brown, (10YR 2/2), fine to medium SAND, mostly fine, little coarse sand, trace gravels and silt, damp (SW-SP). (Spokane Flood Deposits)

60.0 — Dark, yellowish-brown, (10YR 4/2), fine to medium SAND, trace silt, moist (SP). (Spokane Flood Deposits)

68.0 — Dusky, yellowish-brown, (10YR 2/2), fine to medium SAND, little coarse sand, moist (SW). (Spokane Flood Deposits)

68.0 Becomes wet

Depth in Feet

0 10 20 30 40 50 60 70

See Next Page

WELL COMPLETION

Locking cover

6-in. casing

Sand

Concrete

Bentonite seal

6-in. steel casing

80.9 4/14/89

PRELIMINARY DRAFT

WELL COMPLETION LEGEND:

- Concrete Grout
- Grout - Bentonite
- Bentonite Pellets (0.5-in.)
- Sandpack (#10-20)
- Water Level
- 2.0-in. Sch. 40 PVC Well Casing, Flush-Threaded
- 2.0-in. Sch. 40 PVC Well Screen, 0.020-in. Flush Threaded
- 3/8" Voclay tablets

NOT TO SCALE

Date: 3/27/89
Ground Elevation: 2173.1
T.O.C. (PVC) Elevation: 2175.6
Drill Rig: CP 650 W.S.
Drill Method: Air Rotary
Sampling Method:
1) Cyclone grab sample

FIGURE A-19
BORING M-2
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

* Elevations above mean sea level.

PROJECT NO 883-1033.008 DWG NO 7713 DATE 7/7/89 DRAWN RLM APPROVED DPF

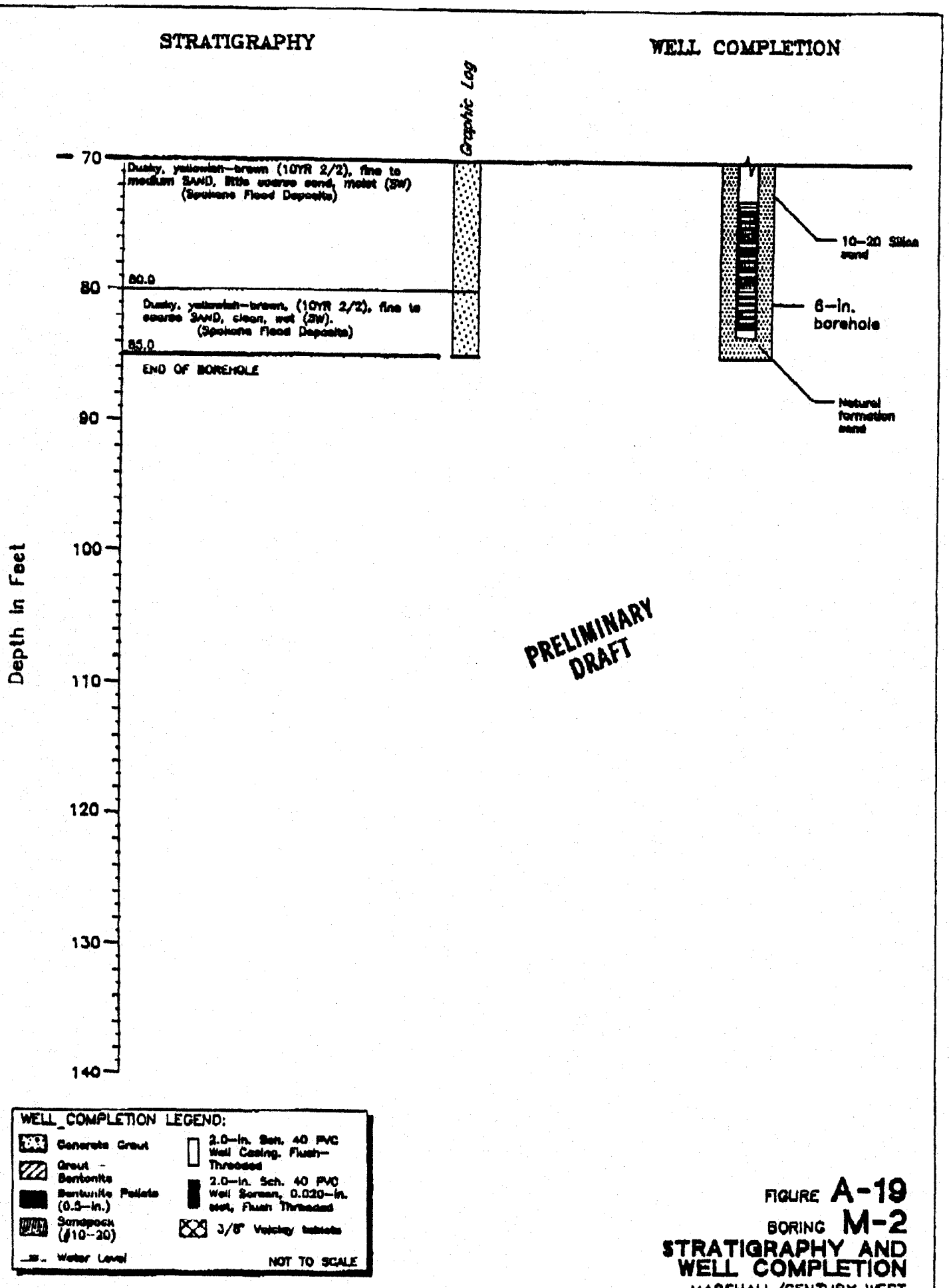


FIGURE A-19
BORING M-2
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

PROJECT NO 883-1033.008 DWG NO 7714 DATE 7/7/89 DRAWN RLM APPROVED DPF

Golder Associates

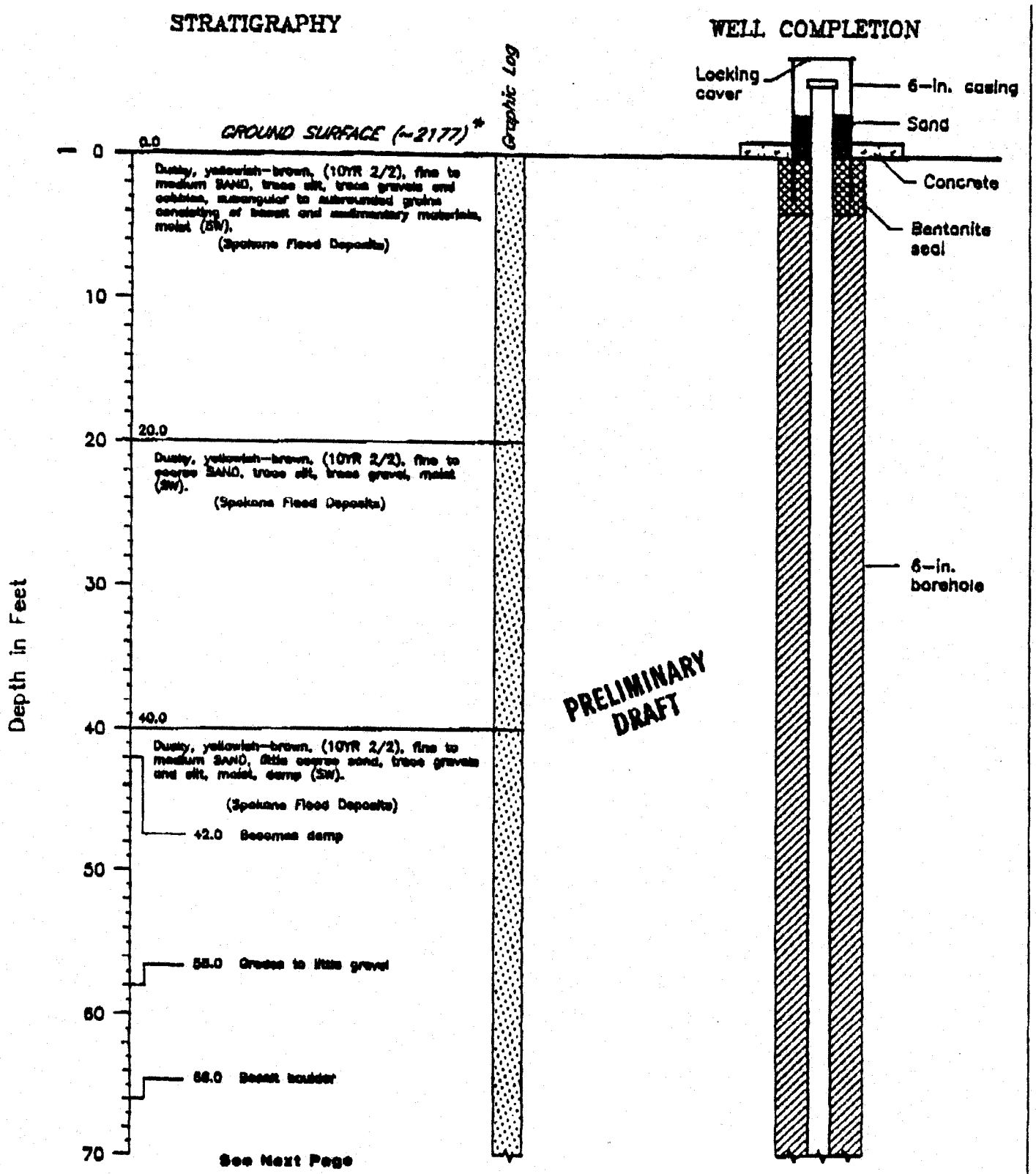


FIGURE A-20
BORING M-3
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

*Elevations above mean sea level.

PROJECT NO 883-1033.002 DWG NO 7715 DATE 3/4/89 DRAWN RLM APPROVED DPF

Golder Associates

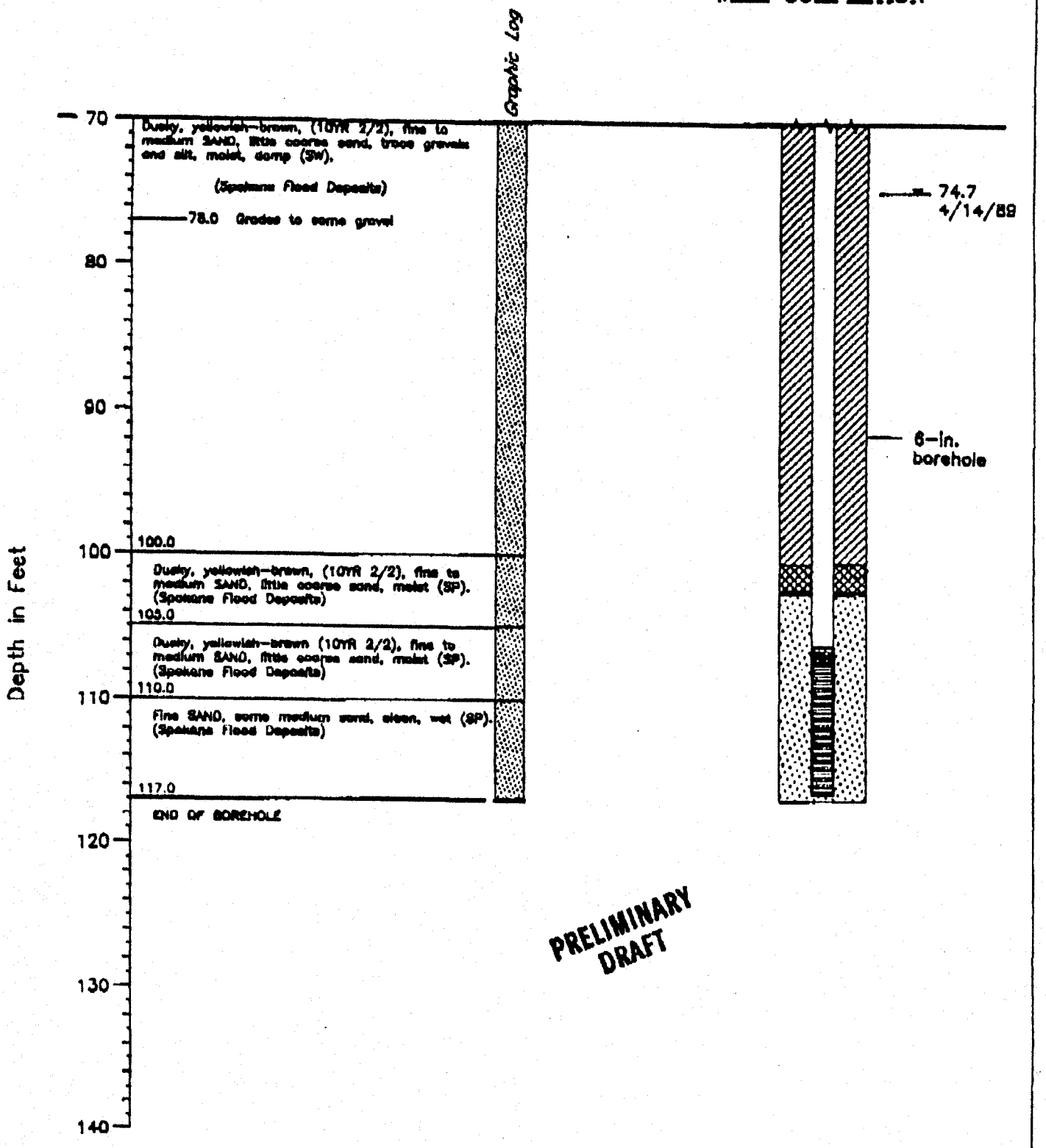
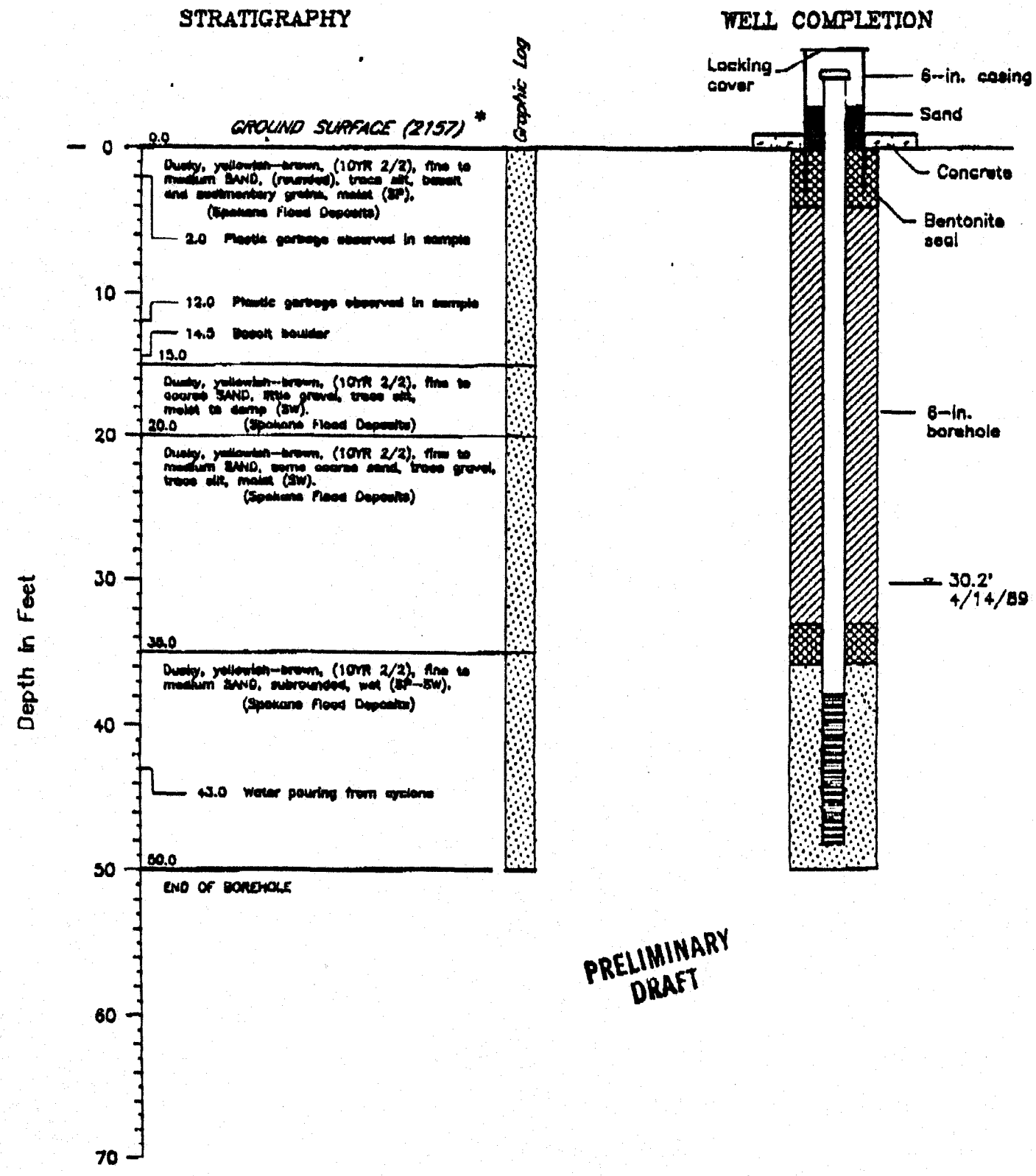


FIGURE A-20
BORING M-3
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

PROJECT NO 883-1033.008 DWG NO 7718 DATE 7/7/89 DRAWN RLM APPROVED DPF

Golder Associates

2 of 2



WELL COMPLETION LEGEND:

- Concrete Grout
- Grout - Bentonite
- Bentonite Pellets (0.3-in.)
- Sandpack (#10-20)
- Water Level
- 2.0-in. Sch. 40 PVC Well Casing, Flush-Threaded
- 2.0-in. Sch. 40 PVC Well Screen, 0.020-in. slot, Flush Threaded
- 3/8" Volclay tablets

NOT TO SCALE

Date: 3/21/89/
Ground Elevation: 2157
T.O.C. (PVC) Elevation: 2159.5
Drill Rig: CP 650 W.S.
Drill Method: Air Rotary
Sampling Method:
1)Cyclone grab sample

*Elevations above mean sea level.

FIGURE A-21
BORING M-4
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WEST

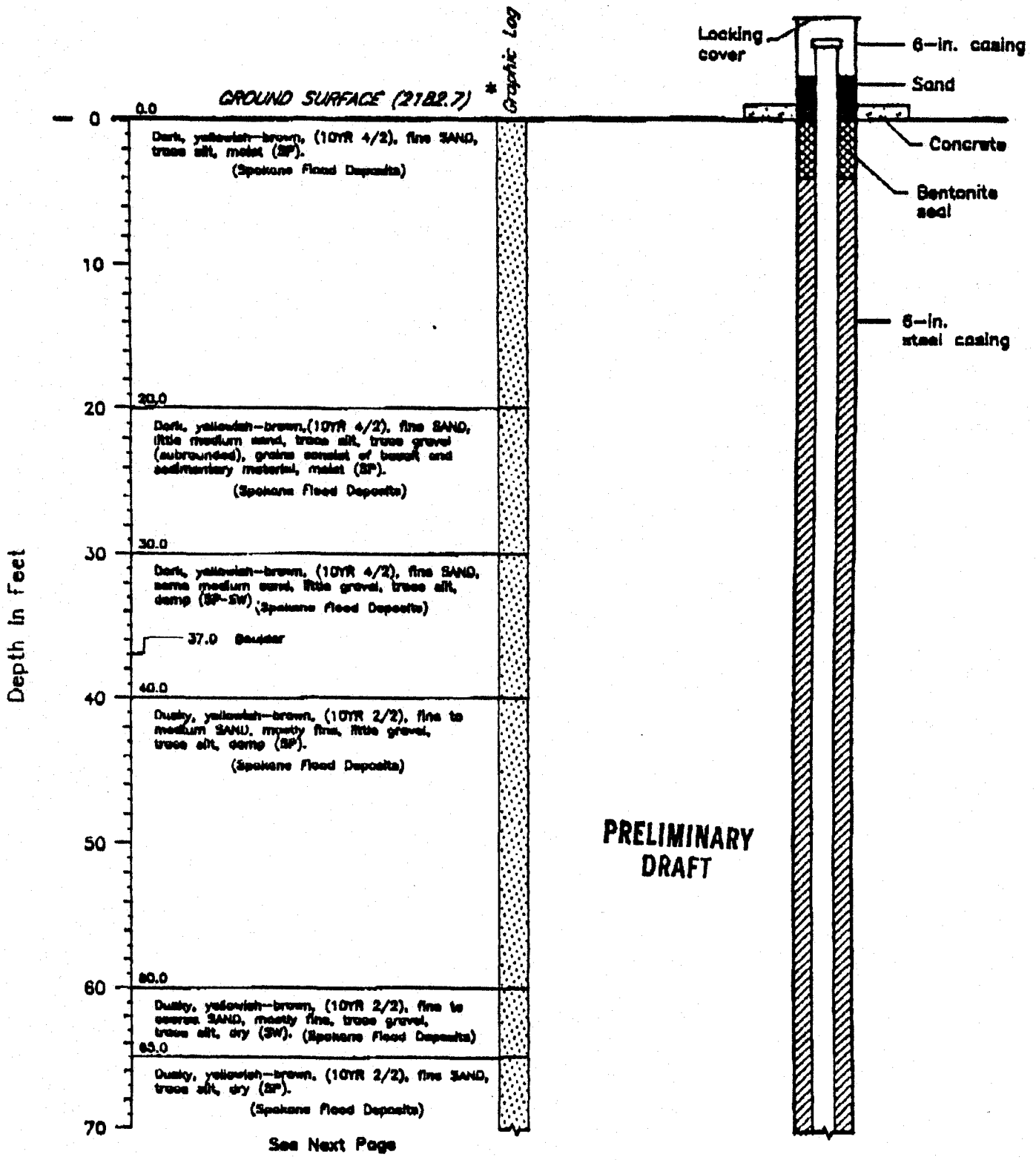


FIGURE A-22
BORING M-5
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WE

*Elevations above mean sea level.

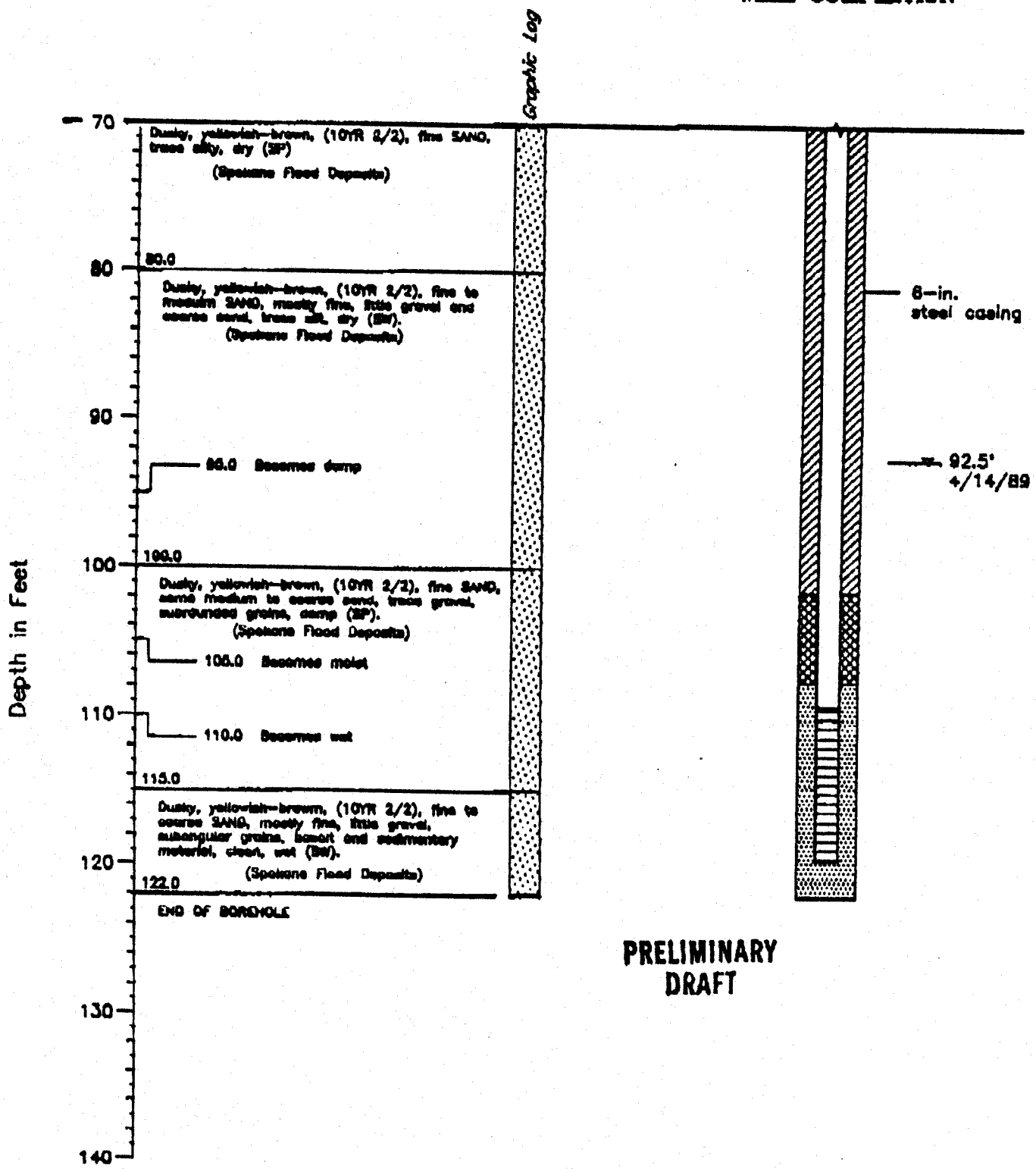


FIGURE A-22
BORING M-5
STRATIGRAPHY AND WELL COMPLETION
MARSHALL/CENTURY WES

APPENDIX B

WATER BALANCES
- **THORNTHWAITE-MATHER METHOD**
- **FENN MODEL**
- **HELP MODEL**

TABLE OF CONTENTS

MONTHLY WATER BALANCE; THORNTHWAITE-MATHER METHOD SPOKANE, WASHINGTON CLAY SOILS CAP

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMP	47.18333	25.7	32.4	37.6	45.8	54.3	61.7	69.7	68.1	59.4	47.6	34.9	29
I/I HEAT INDEX	37.27	0	0.01	0.48	1.91	3.95	6.1	8.75	8.19	5.4	2.3	0.18	0
UNADJ PET	0.68	0	0	0.02	0.04	0.08	0.11	0.14	0.13	0.1	0.05	0.01	0
SUN FACTOR	30.975	22.9	23.8	30.6	34.2	39.2	39.8	40.1	36.8	31.5	27.9	23.2	21.7
PET	24.669	0	0	0.612	1.368	3.136	4.378	5.614	4.784	3.15	1.395	0.232	0
PRECIP	16.71	2.47	1.61	1.36	1.08	1.38	1.23	0.5	0.74	0.71	1.08	2.06	2.49
PRECIP-PET	-7.959	2.47	1.61	0.748	-0.288	-1.756	-3.148	-5.114	-4.044	-2.44	-0.315	1.828	2.49
ACC. POT. WL	-66.075	0	0	0	-0.288	-2.044	-5.192	-10.306	-14.35	-16.79	-17.105	0	0
RET. TABLE VAL	23.51				7.71	6.19	4.17	2.2	1.32	0.98	0.94		
PROV. STOR	58.688	7.728	9.338	10.086	7.71	6.19	4.17	2.2	1.32	0.98	0.94	2.768	5.258
STOR	55.264	7.728	8	8	7.71	6.19	4.17	2.2	1.32	0.98	0.94	2.768	5.258
DELTA STOR.	0	2.47	0.272	0	-0.29	-1.52	-2.02	-1.97	-0.88	-0.34	-0.04	1.828	2.49
ACT. EVAPO.	14.624	0	0	0.612	1.37	2.9	3.25	2.47	1.62	1.05	1.12	0.232	0
DEFICIT	10.045	0	0	0	-0.002	0.236	1.128	3.144	3.164	2.1	0.275	0	0
SURPLUS	2.086	0	1.338	0.748	0	0	0	0	0	0	0	0	0
RUNOFF	2.086	0.000000	1.070400	0.812480	0.162496	0.032499	0.006499	0.001299	0.000259	0.000051	0.000010	0.000002	0.000000
SNOW RUNOFF	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL RUNOFF	2.086	0.000000	1.070400	0.812480	0.162496	0.032499	0.006499	0.001299	0.000259	0.000051	0.000010	0.000002	0.000000
MOIST. DETENT.	55.7855	7.728000	8.267600	8.203120	7.750624	6.198124	4.171624	2.200324	1.320064	0.980012	0.940002	2.768000	5.258000
RECHARGE	0	0	0	0	0	0	0	0	0	0	0	0	0
SOIL CAP.		8											
RO FACTOR		0.8											

MONTHLY WATER BALANCE; THORNTHWAITE-MATHER METHOD SPOKANE, WASHINGTON CLAY SOILS CAP

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMP	47.18333	25.7	32.4	37.6	45.8	54.3	61.7	69.7	68.1	59.4	47.6	34.9	29
i/I HEAT INDEX	37.27	0	0.01	0.48	1.91	3.95	6.1	8.75	8.19	5.4	2.3	0.18	0
UNADJ PET	0.68	0	0	0.02	0.04	0.08	0.11	0.14	0.13	0.1	0.05	0.01	0
SUN FACTOR	30.975	22.9	23.8	30.6	34.2	39.2	39.8	40.1	36.8	31.5	27.9	23.2	21.7
PET	24.669	0	0	0.612	1.368	3.136	4.378	5.614	4.784	3.15	1.395	0.232	0
PRECIP	16.71	2.47	1.61	1.36	1.08	1.38	1.23	0.5	0.74	0.71	1.08	2.06	2.49
PRECIP-PET	-7.959	2.47	1.61	0.748	-0.288	-1.756	-3.148	-5.114	-4.044	-2.44	-0.315	1.828	2.49
ACC. POT. WL	-66.075	0	0	0	-0.288	-2.044	-5.192	-10.306	-14.35	-16.79	-17.105	0	0
RET. TABLE VAL	23.51				7.71	6.19	4.17	2.2	1.32	0.98	0.94		
PROV. STOR	58.688	7.728	9.338	10.086	7.71	6.19	4.17	2.2	1.32	0.98	0.94	2.768	5.258
STOR	55.264	7.728	8	8	7.71	6.19	4.17	2.2	1.32	0.98	0.94	2.768	5.258
DELTA STOR.	0	2.47	0.272	0	-0.29	-1.52	-2.02	-1.97	-0.88	-0.34	-0.04	1.828	2.49
ACT. EVAPO.	14.624	0	0	0.612	1.37	2.9	3.25	2.47	1.62	1.05	1.12	0.232	0
DEFICIT	10.045	0	0	0	-0.002	0.236	1.128	3.144	3.164	2.1	0.275	0	0
SURPLUS	2.086	0	1.338	0.748	0	0	0	0	0	0	0	0	0
RUNOFF	2.086	0.000692	0.669346	0.708673	0.354336	0.177168	0.088584	0.044292	0.022146	0.011073	0.005536	0.002768	0.001384
SNOW RUNOFF	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL RUNOFF	2.086	0.000692	0.669346	0.708673	0.354336	0.177168	0.088584	0.044292	0.022146	0.011073	0.005536	0.002768	0.001384
MOIST. DETENT.	57.35	7.728692	8.669346	8.708673	8.064336	6.367168	4.258584	2.244292	1.342146	0.991073	0.945536	2.770768	5.259384
RECHARGE	0.396653	0	0.396653	0	0	0	0	0	0	0	0	0	0
SOIL CAP.		8											
RO FACTOR		0.5											

MONTHLY WATER BALANCE; THORNTHWAITE-MATHER METHOD SPOKANE, WASHINGTON NATIVE SANDY SOIL

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMP	47.18333	25.7	32.4	37.6	45.8	54.3	61.7	69.7	68.1	59.4	47.6	34.9	29
i/I HEAT INDEX	37.27	0	0.01	0.48	1.91	3.95	6.1	8.75	8.19	5.4	2.3	0.18	0
UNADJ PET	0.68	0	0	0.02	0.04	0.08	0.11	0.14	0.13	0.1	0.05	0.01	0
SUN FACTOR	30.975	22.9	23.8	30.6	34.2	39.2	39.8	40.1	36.8	31.5	27.9	23.2	21.7
PET	24.669	0	0	0.612	1.368	3.136	4.378	5.614	4.784	3.15	1.395	0.232	0
PRECIP	16.71	2.47	1.61	1.36	1.08	1.38	1.23	0.5	0.74	0.71	1.08	2.06	2.49
PRECIP-PET	-7.959	2.47	1.61	0.748	-0.288	-1.756	-3.148	-5.114	-4.044	-2.44	-0.315	1.828	2.49
ACC. POT. WL	-66.075	0	0	0	-0.288	-2.044	-5.192	-10.306	-14.35	-16.79	-17.105	0	0
RET. TABLE VAL	8.03				3.71	2.36	1.06	0.29	0.22	0.2	0.19		
PROV. STOR	39.458	6.978	8.588	9.336	3.71	2.36	1.06	0.29	0.22	0.2	0.19	2.018	4.508
STOR	26.048	4	4	4	3.71	2.36	1.06	0.29	0.22	0.2	0.19	2.018	4
DELTA STOR.	0	0	0	0	-0.29	-1.35	-1.3	-0.77	-0.07	-0.02	-0.01	1.828	1.982
ACT. EVAPO.	11.374	0	0	0.612	1.37	2.73	2.53	1.27	0.81	0.73	1.09	0.232	0
DEFICIT	13.295	0	0	0	-0.002	0.406	1.848	4.344	3.974	2.42	0.305	0	0
SURPLUS	5.336	2.47	1.61	0.748	0	0	0	0	0	0	0	0	0
RUNOFF	5.335746	0.514655	0.624190	0.636571	0.572914	0.515622	0.464060	0.417654	0.375888	0.338300	0.304470	0.274023	0.508
SNOW RUNOFF	0	0	0	0	0	0	0	0	0	0	0	0	0.297395
TOTAL RUNOFF	5.335746	0.514655	0.624190	0.636571	0.572914	0.515622	0.464060	0.417654	0.375888	0.338300	0.304470	0.274023	0.297395
MOIST. DETENT.	74.06971	8.631902	9.617712	9.729141	8.866226	7.000604	5.236543	4.048889	3.603000	3.244700	2.930230	4.484207	6.676558
RECHARGE	2.941153	1.955344	0.985809	0	0	0	0	0	0	0	0	0	0
SOIL CAP.		4											
RO FACTOR		0.1											

MONTHLY WATER BALANCE; THORNTHWAITE-MATHER METHOD SPOKANE, WASHINGTON CLAY CAP SOIL

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMP	47.18333	25.7	32.4	37.6	45.8	54.3	61.7	69.7	68.1	59.4	47.6	34.9	29
I/I HEAT INDEX	37.27	0	0.01	0.48	1.91	3.95	6.1	8.75	8.19	5.4	2.3	0.18	0
UNADJ PET	0.68	0	0	0.02	0.04	0.08	0.11	0.14	0.13	0.1	0.05	0.01	0
SUN FACTOR	30.975	22.9	23.8	30.6	34.2	39.2	39.8	40.1	36.8	31.5	27.9	23.2	21.7
PET	24.669	0	0	0.612	1.368	3.136	4.378	5.614	4.784	3.15	1.395	0.232	0
PRECIP	16.71	2.47	1.61	1.36	1.08	1.38	1.23	0.5	0.74	0.71	1.08	2.06	2.49
PRECIP-PET	-7.959	2.47	1.61	0.748	-0.288	-1.756	-3.148	-5.114	-4.044	-2.44	-0.315	1.828	2.49
ACC. POT. WL	-66.075	0	0	0	-0.288	-2.044	-5.192	-10.306	-14.35	-16.79	-17.105	0	0
RET. TABLE VAL	23.51				7.71	6.19	4.17	2.2	1.32	0.98	0.94		
PROV. STOR	58.688	7.728	9.338	10.086	7.71	6.19	4.17	2.2	1.32	0.98	0.94	2.768	5.258
STOR	55.264	7.728	8	8	7.71	6.19	4.17	2.2	1.32	0.98	0.94	2.768	5.258
DELTA STOR.	0	2.47	0.272	0	-0.29	-1.52	-2.02	-1.97	-0.88	-0.34	-0.04	1.828	2.49
ACT. EVAPO.	14.624	0	0	0.612	1.37	2.9	3.25	2.47	1.62	1.05	1.12	0.232	0
DEFICIT	10.045	0	0	0	-0.002	0.236	1.128	3.144	3.164	2.1	0.275	0	0
SURPLUS	2.086	0	1.338	0.748	0	0	0	0	0	0	0	0	0
RUNOFF	2.086	0.000004	0.936601	0.804580	0.241374	0.072412	0.021723	0.006517	0.001955	0.000586	0.000175	0.000052	0.000015
SNOW RUNOFF	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL RUNOFF	2.086	0.000004	0.936601	0.804580	0.241374	0.072412	0.021723	0.006517	0.001955	0.000586	0.000175	0.000052	0.000015
MOIST. DETENT.	56.158	7.728002	8.401400	8.344820	7.813446	6.221033	4.179310	2.202793	1.320837	0.980251	0.940075	2.768022	5.258006
RECHARGE	0.129398	0	0.129398	0	0	0	0	0	0	0	0	0	0
SOIL CAP.		8											
RO FACTOR		0.7											

Recharge Rate Calculations Using the Fenn Water Balance Method HARD INPUT SPOKANE, WASHINGTON CLAY SOIL CAP

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	
PET	0.00	0.00	0.61	1.37	3.14	4.38	5.61	4.78	3.15	1.40	0.23	0.00	24.67	PET
PRECIP	2.47	1.61	1.36	1.08	1.38	1.23	0.50	0.74	0.71	1.08	2.06	2.49	16.71	PRECIP
RUNOFF COEF	0.25	0.15	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.15		RUNOFF COEF
R/O	0.62	0.24	0.14	0.05	0.07	0.06	0.03	0.04	0.04	0.05	0.10	0.37	1.81	R/O
INFILT. (I)	1.85	1.37	1.22	1.03	1.31	1.17	0.48	0.70	0.67	1.03	1.96	2.12	14.90	INFILT. (I)
I-PET	1.85	1.37	0.61	-0.34	-1.83	-3.21	-5.14	-4.08	-2.48	-0.37	1.73	2.12	-9.77	I-PET
SUM-(I-PET)	0.00	0.00	0.00	-0.34	-2.17	-5.38	-10.52	-14.60	-17.07	-17.45	0.00	0.00		SUM-(I-PET)
TABLE VAL.			0.00	7.66	6.09	4.07	2.14	1.28	0.94	0.90				
SOIL MSTR	6.60	7.96	8.00	7.66	6.09	4.07	2.14	1.28	0.94	0.90	2.63	4.74		SOIL MSTR
CHG.SM	1.85	1.37	0.04	-0.34	-1.57	-2.02	-1.93	-0.86	-0.34	-0.04	1.73	2.12		CHG.SM
ACT.ET	0.00	0.00	0.61	1.37	2.88	3.19	2.41	1.56	1.01	1.07	0.23	0.00	14.33	ACT.ET
RECH	.00	.00	0.58	.00	.00	.00	.00	.00	.00	.00	.00	.00	0.58	RECH

PET = POTENTIAL EVAPOTRANSPIRATION
PRECIP = MEAN MONTHLY PRECIPITAION
RUNOFF COEF. = SURFACE RUNOFF COEFFICIENT (RATIONAL METHOD)
R/O = SURFACE RUNOFF (PRECIP * RUNOFF COEF)
INFILT. = INFILTRATION (PRECIP - R/O)
SOIL MOISTURE = MAXIMUM SOIL MOISTURE STORAGE CAPACITY 8.00
CHG.SM = CHANGE IN SOIL MOISTURE STORAGE
ACT.ET = ACTUAL EVAPOTRANSPIRATION (IF I-PET)=0 THEN =PET,
IF NOT I-PET = PET + (I-PET - CHG.SM)
RECH = RECHARGE (PRECIP - R/O - CHG.SM - ACT.ET)

GAL/ACRE/YR 15653

AVG USE G/AC/YR 365000

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MARSHALL LANDFILL
NATIVE SOILS
AUGUST, 1989

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0674 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0174000002444 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.3339 VOL/VOL
FIELD CAPACITY	=	0.0529 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0530 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000289999963 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	55.25
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	32.00 INCHES
UPPER LIMIT VEG. STORAGE	=	13.9840 INCHES
INITIAL VEG. STORAGE	=	3.8314 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR SPOKANE WASHINGTON

MAXIMUM LEAF AREA INDEX = 1.60
START OF GROWING SEASON (JULIAN DATE) = 138
END OF GROWING SEASON (JULIAN DATE) = 267

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.60	32.40	37.60	45.80	54.30	61.70
69.70	68.10	59.40	47.60	34.90	29.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.82	1.64	1.45	1.14	1.09	1.13
	0.55	0.73	0.70	1.14	2.00	2.49
STD. DEVIATIONS	0.94	0.65	0.61	0.58	0.57	0.76
	0.33	0.55	0.49	0.66	0.92	0.66
RUNOFF						
TOTALS	0.004	0.000	0.000	0.000	0.000	0.001
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.015	0.000	0.000	0.000	0.000	0.005
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.430	1.079	1.675	1.224	1.132	1.610
	1.149	0.751	0.560	0.783	0.693	0.441
STD. DEVIATIONS	0.095	0.111	0.604	0.562	0.550	0.548
	0.429	0.526	0.452	0.432	0.194	0.091
PERCOLATION FROM LAYER 2						
TOTALS	0.0264	0.0249	0.0281	0.0281	0.0300	0.0300
	0.0319	0.0328	0.0326	0.0345	0.0342	0.0361
STD. DEVIATIONS	0.0468	0.0441	0.0493	0.0491	0.0522	0.0519
	0.0549	0.0562	0.0555	0.0585	0.0577	0.0606

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	16.86	(2.199)	61216.	100.00
RUNOFF	0.005	(0.016)	19.	0.03
EVAPOTRANSPIRATION	11.525	(1.568)	41835.	68.34
PERCOLATION FROM LAYER 2	0.3697	(0.6368)	1342.	2.19
CHANGE IN WATER STORAGE	4.964	(1.618)	18021.	29.44

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	1.28	4646.4
RUNOFF	0.066	238.2
PERCOLATION FROM LAYER 2	0.0067	24.4
SNOW WATER	2.71	9851.1

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.1650
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0208

FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	93.10	0.1108
2	106.49	0.1268
SNOW WATER	0.72	

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MARSHALL LANDFILL
NATIVE SOIL COVER
AUGUST, 1989

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1402 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0174000002444 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2938 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0001999999949 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.3339 VOL/VOL
FIELD CAPACITY	=	0.0529 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0559 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0002899999963 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	55.25
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	32.00 INCHES
UPPER LIMIT VEG. STORAGE	=	14.6480 INCHES
INITIAL VEG. STORAGE	=	4.8789 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR SPOKANE WASHINGTON

MAXIMUM LEAF AREA INDEX	= 1.60
START OF GROWING SEASON (JULIAN DATE)	= 138
END OF GROWING SEASON (JULIAN DATE)	= 267

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.60	32.40	37.60	45.80	54.30	61.70
69.70	68.10	59.40	47.60	34.90	29.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.44	1.81	1.46	1.17	0.78	1.12
	0.65	0.51	0.72	1.20	2.30	2.12
STD. DEVIATIONS	0.62	0.49	0.81	0.72	0.39	0.61
	0.31	0.48	0.43	0.30	1.03	0.61
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.449	1.073	1.661	1.350	0.746	1.678
	1.494	0.572	0.515	0.886	0.774	

STD. DEVIATIONS	0.0005	0.0004	0.0005	0.0005	0.0005	0.0005
	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	16.29	(1.653)	59147.	100.00
RUNOFF	0.000	(0.000)	0.	0.00
EVAPOTRANSPIRATION	11.708	(1.304)	42500.	71.86
PERCOLATION FROM LAYER 3	0.0085	(0.0069)	31.	0.05
CHANGE IN WATER STORAGE	4.577	(1.242)	16616.	28.09

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	4501.2
RUNOFF	0.000	0.0
PERCOLATION FROM LAYER 3	0.0001	0.2
SNOW WATER	1.04	3781.2

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.1914

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0508

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	78.17	0.0931
2	46.52	0.0554
SNOW WATER	0.33	

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MARSHALL LANDFILL
NATIVE SOIL COVER
AUGUST, 1989

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1402 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0174000002444 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2938 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0001999999949 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.3339 VOL/VOL
FIELD CAPACITY	=	0.0529 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0559 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0002899999963 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	55.25
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	32.00 INCHES
UPPER LIMIT VEG. STORAGE	=	14.6480 INCHES
INITIAL VEG. STORAGE	=	4.8789 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR SPOKANE WASHINGTON

MAXIMUM LEAF AREA INDEX	= 1.60
START OF GROWING SEASON (JULIAN DATE)	= 138
END OF GROWING SEASON (JULIAN DATE)	= 267

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.60	32.40	37.60	45.80	54.30	61.70
69.70	68.10	59.40	47.60	34.90	29.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.44	1.81	1.46	1.17	0.78	1.12
	0.65	0.51	0.72	1.20	2.30	2.12
STD. DEVIATIONS	0.62	0.49	0.81	0.72	0.39	0.61
	0.31	0.48	0.43	0.30	1.03	0.61
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.449	1.073	1.661	1.350	0.746	1.678

STD. DEVIATIONS	0.053	0.134	0.337	0.662	0.303	0.547
	0.450	0.472	0.349	0.211	0.153	0.108

PERCOLATION FROM LAYER 3

TOTALS	0.0006	0.0005	0.0006	0.0006	0.0007	0.0007
	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009
STD. DEVIATIONS	0.0005	0.0004	0.0005	0.0005	0.0005	0.0005
	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	16.29	(1.653)	59147.	100.00
RUNOFF	0.000	(0.000)	0.	0.00
EVAPOTRANSPIRATION	11.708	(1.304)	42500.	71.86
PERCOLATION FROM LAYER 3	0.0085	(0.0069)	31.	0.05
CHANGE IN WATER STORAGE	4.577	(1.242)	16616.	28.09

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	4501.2
RUNOFF	0.000	0.0
PERCOLATION FROM LAYER 3	0.0001	0.2
SNOW WATER	1.04	3781.2

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.1914

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0508

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FINAL WATER STORAGE AT END OF YEAR 5

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	2.89	0.1205
2	254.47	0.3029
3	62.21	0.0741
SNOW WATER	0.33	

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MARSHALL LANDFILL
CLAY TOP CAP
AUGUST, 1989

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2579 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0174000002444 CM/SEC

LAYER 2

BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000001000000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2765 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0001999999949 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.3339 VOL/VOL
FIELD CAPACITY	=	0.0529 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0542 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0002899999963 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	55.25
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	32.00 INCHES
UPPER LIMIT VEG. STORAGE	=	5.2440 INCHES
INITIAL VEG. STORAGE	=	3.0254 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR SPOKANE WASHINGTON

MAXIMUM LEAF AREA INDEX	= 1.60
START OF GROWING SEASON (JULIAN DATE)	= 138
END OF GROWING SEASON (JULIAN DATE)	= 267

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.60	32.40	37.60	45.80	54.30	61.70
69.70	68.10	59.40	47.60	34.90	29.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.44	1.81	1.46	1.17	0.78	1.12
	0.65	0.51	0.72	1.20	2.30	2.12
STD. DEVIATIONS	0.62	0.49	0.81	0.72	0.39	0.61

RUNOFF

TOTALS	0.068	0.580	0.269	0.006	0.005	0.038
	0.018	0.017	0.000	0.007	0.134	0.024
STD. DEVIATIONS	0.027	0.103	0.335	0.014	0.011	0.040
	0.020	0.038	0.000	0.012	0.081	0.040

EVAPOTRANSPIRATION

TOTALS	0.451	1.084	1.644	1.380	0.693	1.699
	3.376	0.560	0.511	0.975	0.774	0.414
STD. DEVIATIONS	0.053	0.132	0.350	0.632	0.272	0.592
	0.338	0.436	0.342	0.199	0.144	0.110

PERCOLATION FROM LAYER 2

TOTALS	0.1416	0.1415	0.1523	0.1425	0.1443	0.1365
	0.1019	0.0000	0.0000	0.0035	0.0592	0.1236
STD. DEVIATIONS	0.0066	0.0022	0.0028	0.0021	0.0006	0.0019
	0.0164	0.0000	0.0000	0.0079	0.0287	0.0119

PERCOLATION FROM LAYER 4

TOTALS	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	16.29	(1.653)	59147.	100.00
RUNOFF	1.167	(0.265)	4236.	7.16
EVAPOTRANSPIRATION	13.561	(1.246)	49225.	83.22
PERCOLATION FROM LAYER 2	1.1469	(0.0296)	4163.	7.04
PERCOLATION FROM LAYER 4	0.0021	(0.0000)	8.	0.01
CHANGE IN WATER STORAGE	1.564	(1.409)	5678.	9.60

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	4501.2
RUNOFF	0.416	1509.5
PERCOLATION FROM LAYER 2	0.0051	18.6
HEAD ON LAYER 2	12.2	
PERCOLATION FROM LAYER 4	0.0000	0.0
SNOW WATER	1.04	3781.2

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0186

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	4.78	0.3987
2	10.32	0.4300
3	232.62	0.2769
4	50.85	0.0605
SNOW WATER	0.33	

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MARSHALL LANDFILL
MEMBRANE TOP CAP
AUGUST, 1989

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2781 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0174000002444 CM/SEC

LAYER 2

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000000100000 CM/SEC
LINER LEAKAGE FRACTION	=	0.00001000

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1400 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	840.00 INCHES
POROSITY	=	0.3339 VOL/VOL
FIELD CAPACITY	=	0.0529 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0324 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0002899999963 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	55.25
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	32.00 INCHES
UPPER LIMIT VEG. STORAGE	=	5.2440 INCHES
INITIAL VEG. STORAGE	=	3.2666 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR SPOKANE WASHINGTON

MAXIMUM LEAF AREA INDEX	= 1.60
START OF GROWING SEASON (JULIAN DATE)	= 138
END OF GROWING SEASON (JULIAN DATE)	= 267

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.60	32.40	37.60	45.80	54.30	61.70
69.70	68.10	59.40	47.60	34.90	29.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.44	1.81	1.46	1.17	0.78	1.12
	0.65	0.51	0.72	1.20	2.30	2.12
STD. DEVIATIONS	0.62	0.49	0.81	0.72	0.39	0.61
	0.31	0.48	0.43	0.30	1.03	0.61
RUNOFF						
TOTALS	0.140	0.941	0.319	0.006	0.004	0.040
	0.018	0.017	0.000	0.007	0.134	0.024
STD. DEVIATIONS	0.112	0.177	0.380	0.014	0.009	0.042
	0.020	0.038	0.000	0.012	0.081	0.040
EVAPOTRANSPIRATION						
TOTALS	0.450	1.077	1.638	1.384	0.653	1.754
	3.875	0.709	0.491	1.021	0.763	0.411
STD. DEVIATIONS	0.053	0.134	0.342	0.629	0.195	0.645
	0.150	0.573	0.330	0.136	0.121	0.109
PERCOLATION FROM LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION FROM LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	16.29 (1.653)	59147.	100.00
RUNOFF	1.650 (0.291)	5988.	10.12
EVAPOTRANSPIRATION	14.226 (1.277)	51642.	87.31
PERCOLATION FROM LAYER 2	0.0000 (0.0000)	0.	0.00
PERCOLATION FROM LAYER 4	0.0000 (0.0000)	0.	0.00
CHANGE IN WATER STORAGE	0.418 (1.395)	1517.	2.56

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	1.24	4501.2
RUNOFF	0.485	1760.8
PERCOLATION FROM LAYER 2	0.0000	0.0
HEAD ON LAYER 2	12.1	
PERCOLATION FROM LAYER 4	0.0000	0.0
SNOW WATER	1.04	3781.2
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0187	

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	5.02	0.4183
2	4.80	0.4000
3	117.60	0.1400
4	27.18	0.0324
SNOW WATER	0.33	

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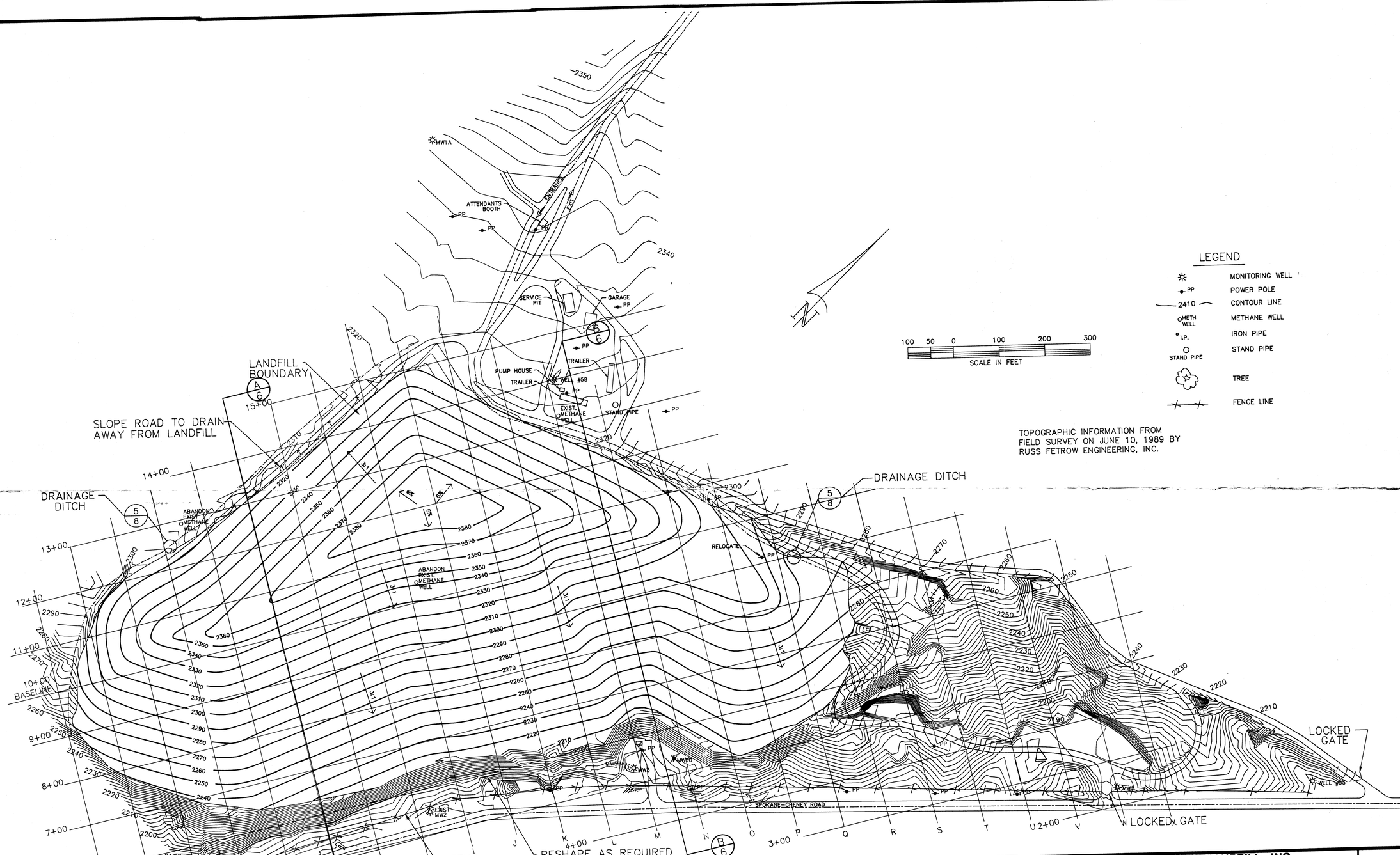

TOPOGRAPHIC INFORMATION FROM FIELD SURVEY ON JUNE 10, 1989 BY RUSS FETROW ENGINEERING, INC.

RUSS FETROW ENGINEERING, INC.

Russell H. Fetrow, Jr., PE, President

RUSSELL H. FETROW JR. STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

MARSHALL LANDFILL, INC.

EXISTING LANDFILL CLOSURE PLAN

FINAL CONTOURS

Scale: 1"=100'	Date: AUGUST, 1989	Revised:
Design: CLB	Russ Fetrow Engineering,Inc.	Job No:
Drawn: RDM	890 Promontory Pl. SE Salem, OR 97302	Sheet 4 / 8
Checked: RHF	PH (503) 363-8760