Environmental Geology Lab
Case Study of Mountain Fir Lumber Site, Independence, Oregon

INTRODUCTION

The Mountain Fir site is located at 900 F Street in Independence, Oregon. The site is comprised of a total of 14 acres throughout the city. Much of the property is located in the vicinity of low-density residential neighborhoods and city land. Lumber was produced at the Mountain Fir site from approximately 1940 to 1992. Mountain Fir occupied portions of the site from 1953 to present. Historically, the facility included a sawmill and barker, planer, a shop, a dry kiln and cooling shed, a log pond (impoundment of Ash Creek) with log decks on either side, buildings, storage sheds, sawdust and shavings bunkers, and lumber storage yards (refer to Figure 1). The Mountain Fir property is zoned for heavy industrial use, with adjacent areas zoned for residential and agricultural activities.

SITE HISTORY AND ENVIRONMENTAL CONCERNS

The sawmill was established in 1939 with Ash Creek dammed for use as a log pond. The Oregon Dept. of Environmental Quality has been monitoring the Mountain Fir site since the early 1990's when a Phase 1 property investigation revealed the potential for site soil and water contamination. Further investigation into the historic mill activities revealed the following potential contaminant pathways (refer to Figure 3 for site locations):

(1) Sawmill / Barker Area - historical use of hydraulic oil and lubricants
(2) Planer Shed Area - historical use of Permatox lumber anti-stain agent (pentachlorophenate)
(3) Shop Area - historical use of petroleum products and cleaning solvents
(4) Transformer Area - use of transformer oils (PCB's)
(5) Rein Mill Area - use of petroleum products
(6) Gravel Roads - use of petroleum products and waste fluids for dust suppression
(7) Log Pond Areas - hydraulic sink and surface drainage collection point

The Mountain Fir site has been investigated by a number of environmental consulting companies since the early 1990's. Assessment activities include monitoring well installation, test borings, soil sampling, groundwater quality analysis, and surface water quality analysis. Figures 1, 2, and 3 are location maps showing the site configuration, monitoring well locations, and sampling points. Tables 1, 2, 3, 4, and 5 summarize data including city well construction, monitoring well construction, ground water quality, well hydraulics, and static groundwater levels. Figures 2 and 3 are available as "dxf" files (fig2.dxf, fig3.dxf) that can be imported into Surfer as base maps. Tables 1-5 are available as Excel spreadsheets (mtnfirdata.xls) in the "Lab Data" section of the class website.

Summary of Available Data

Figures
Fig. 1 - City Location Map
Fig. 2 - Neighborhood Location Map
Fig. 3 - Mountain Fir Site Location Map

Tables
Table 1 - City Well Completion Data
Table 2 - Mountain Fir Monitoring Well Data
Table 3 - Water Quality Analysis Data
Table 4 - Well Hydraulics Data
Table 5 - Groundwater Elevation Data

INSTRUCTIONS FOR MOUNTAIN FIR SITE INVESTIGATION LAB
Background Information

B-1. In 3-4 well-organized paragraphs, characterize the site geologic conditions
- hydrology (rainfall, river / stream conditions, discharge)
- geologic materials / regional geology
- topographic setting, topographic conditions (landforms, slope, etc.)

***Reference Materials Available: Climate book, internet, wall maps in lab, topographic maps in lab, field notes from Independence field trip..*

B-2. In 1-2 well-organized paragraphs, provide an overview of the likely hydrogeologic conditions

-based on your answers in (1) above, what are the likely characteristics of aquifers beneath the site (e.g. relationship to rivers/streams, type of aquifer, hydraulic properties of aquifers, etc.)

***Reference Materials Available: Climate book, internet, wall maps in lab, topographic maps in lab, field notes from Independence field trip..*

Task 1 - Characterization of Monmouth-Independence Well Fields

Examine the data shown in Table 1.

1-1. What is the average total depth of the Monmouth-Independence supply wells?

1-2. What are the average well diameters?

1-3. The "perforated interval" represents the screened interval of the well that provides hydraulic communication with the aquifer. Based on Table 1 data, what are the depths to the water bearing zones in the aquifer that serves as the Monmouth-Independence water supply?

1-4. Examine Figures 1, 2, and 3. How far are the city wells located from the Mountain Fir site? In what direction are the wells located, compared to Mountain Fir? Where do the water supply wells sit with respect to the Mountain Fir site and the Willamette River?

Task 2 - Characterization of the Mountain Fir monitoring wells

Examine the data shown in Table 2. (hints: surface elevation = ground elevation, reference pt. Elevation = measuring point el. on the well for use in determining water depth, "bgs" = below ground surface, Easting and Northing as "X" and "Y" coordinate positions in feet, relative to geographic north, MW = monitoring well, PZ = piezometer, TB = test boring, EW = extraction well, PW = pumping well)

2-1. Using the the blank well log forms in provided in Figure 4, fill in the well log data for monitoring wells MW-2S and MW-2D. Answer the following questions.

2-2. What is the difference between the "S" and "D" monitoring well designations?

2-3. Provide some thoughts on why "S" and "D" monitoring wells would be needed at the Fir Mountain site.

2-4. What is the average depth of the "S" monitoring wells? What is the average depth of the "D" monitoring wells? Based on the screened intervals, where are the likely water-bearing zones beneath the site?

2-5. What diameter pipe was used in the construction of the "MW" monitoring wells? What diameter pipe was used in the construction of the "EW" and "PW" extraction and pumping wells? Provide some thoughts on why the two types would differ in their pipe diameters.

Task 3. Review of the Water Quality Data

Examine Table 3, water quality data for Mountain Fir monitoring wells.

3-1. List the chemical parameters that are shown on Table 3. Based on our class discussion and the site history, provide some thoughts on why the Mountain Fir project would include analysis of these chemical constituents in the groundwater. (i.e. what is the site history and why would we worry about these constituents in the groundwater?)

3-2. The water quality data are listed in units of "mg/L", which represents milligrams of constituent per liter of aqueous fluid, this is also equivalent to "parts per million" or "ppm".

Assuming a density of water at 1 gm/cubic centimeter, and one cubic centimeter of water equals 1 ml volume, what is the mass of 1 L of water? Answer in kg.

Considering a simple system of NaCl dissolved in water, if there is 1 mg of salt dissolved in 1 L of water, rewrite the expression to reflect 1 mg of salt dissolved in an equivalent mass of water in kg. How many "powers of ten" is a "mg" away from kg? What is the concentration of salt in this solution in ppm?

Now consider concentrations of contaminants in "parts per billion". Assume a concentration of 10 ppb, rewrite this unit is terms of mass of contaminant per liter of water.

3-3. If you haven't done so, download a copy of the Mountain Fir Excel files from the class web site (see "Lab Data" section"). Save this file to your floppy, local hard drive, or network folder (this will be your working file).

3-4. Using Excel and the data sort functions, conduct a qualitative review of the water quality data to look for general spatial trends in any site groundwater contamination.

Procedure: (i) select all data in columns and rows, but not column titles or footnotes, (ii) from the top menu, use the following mouse clicks "Data-Sort-select column to sort by-click the ascending order option", (iii) repeat this task for each of the four chemical parameters and perform a qualitative analysis as to which wells are contaminated, and which are not.

3-5. A signigicant "action level" for pentachorophenol in drinking water is on the order of about 1-2 ppm (actually 0.5-1, but let's assume 2 ppm is a "significant" release to the environment. Using the Excel data sort tools, identify which Mountain Fir wells are the "hottest" with respect to contamination. Compare these wells to Figures 2 and 3, which milling facilities are the hot areas most closely associated with?

Task 4 - Groundwater Contour Map of Mountain Fir Site

Examine the groundwater elevation data provided in Table 5. Note that groundwater depth data has been collected for each of the monitoring wells over a select range of dates. Notations: Reference Point Elevation = elevation of the meausring point on the wells, DTW = depth to water from the Reference point, SWL elev = elevation of the static water level in the well.

4-1. Calculate the groundwater elevations for each monitoring well for all dates. Using excel and the copy-paste cell equation function, fill in the "SWL elev" column (i.e. given the data, calculate the static water level elevations for the water table at each of the dates).

4-2. Insert two new columns on Table 5, and "Easting" and "Northing" column. Copy the Easting and Northing well locations from Table 2, make sure you assign the correct easting and northing to the appropriate well, this will form the basis of your X,Y,Z data for surfer.

4-3. Sort all Table 5 data by "date in asending order", then by "well I.D. in ascending order".

4-4. You will now create two new separate Excel files so that you can contour the groundwater data in sufer. Copy and paste the well i.d., easting, northing, and groundwater elevation data for the "06/95" and "11/95" dates, respectively. Paste the data in separate files, with unique names so that you can grid them in surfer.

4-5. Using surfer, grid the 06/95 and 11/95 groundwater elevation data respectively (you will create two separate grid files). X = easting, Y = northing, and Z = SWL elevation. Use the default "Kriging" method and parameters.

4-6. Using surfer, create two different groundwater contour maps for the 06/95 and 11/95 data. Make sure you put a title, name, project name, etc. Try a 1 foot contour interval, if it's too messy, adjust to a 2 foot and see how that looks.

4-7. Download the "fig2.dxf" base map file from the class web site ("Lab Data Section"). Save this file to the same directory as your surfer maps, grid data, etc.

4-8. With your contour map plots open, use the "map-load basemap" command in surfer to open the "fig2.dxf" file. This should open a template of Figure 2, as shown in your handout. Now use the "Edit-Select All" and "Overlay Maps" command to properly overlay and align your groundwater contour map and base maps. There, you should now have a groundwater contour map superimposed, in the appropriate geographic coordinatesj, on the base map. Repeat procedure for both maps, use colors and nice fonts, make it look professional and print out your groundwater maps.

Task 5 - Contaminant Contour Maps

Now repeat the steps in Task 4 using the the water quality data in Table 3. Create two maps using the Pentachlorophenol data only, with maps for 07/95 data and 10/95 data respectively. Here are some other guidelines:

Remember the process for contouring in surfer: you need X, Y, and Z data in an Excel spreadsheet, grid the data and create a *.grd file, map the *.grd data.

Try a contour interval of 10 ppm and see how that works, it it is too messy then try 100, 200, etc. until you find a reasonable looking contour pattern.

Make sure you label the lines

Create 2 maps, one for the 07/95 data and one for the 10/95 data, remember to overlay the concentration contours on the base map ("fig2.dxf").

Print the maps at the same scale as your groundwater contour maps in Task 4 above.

Task 6 - Final Summary

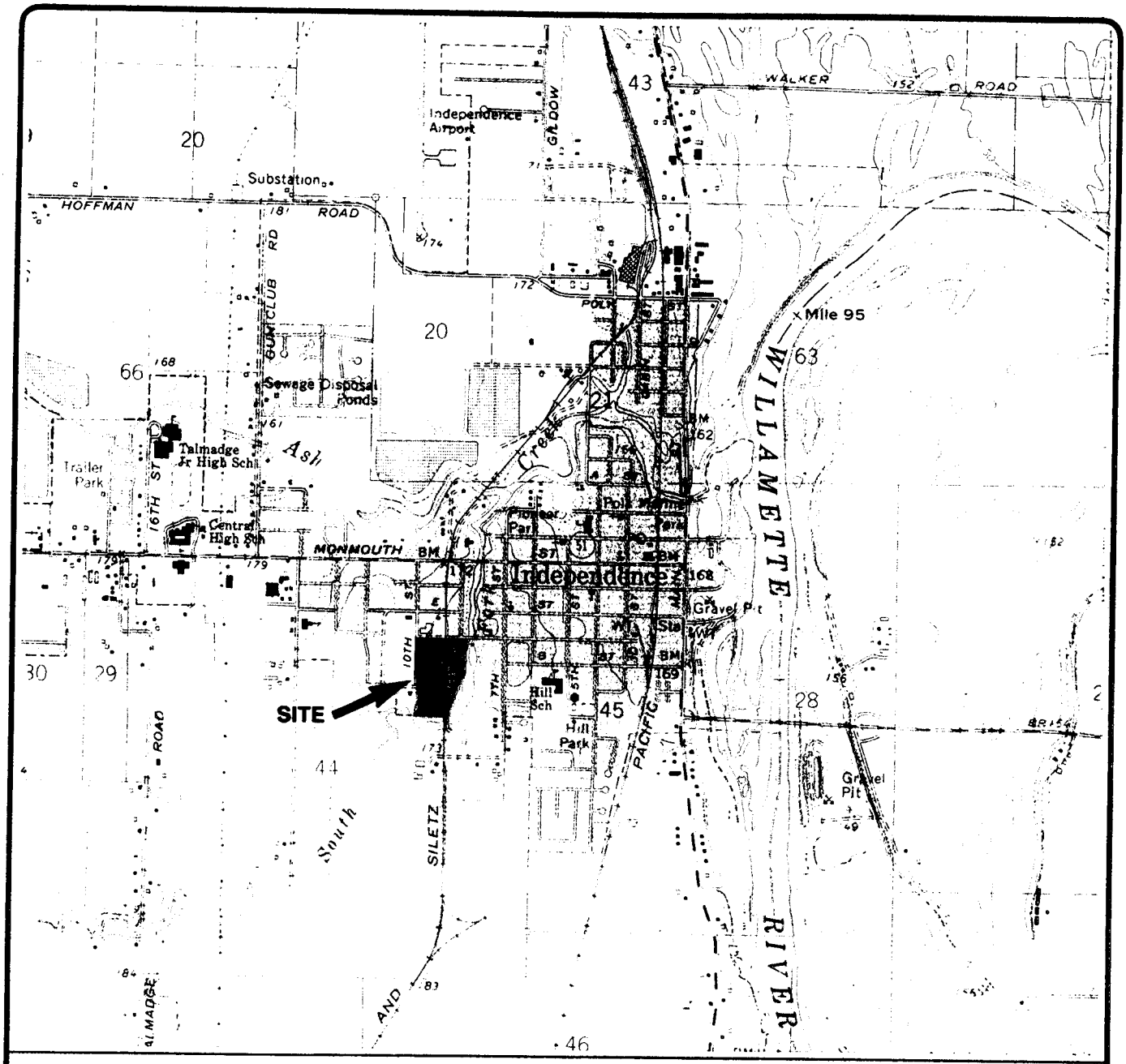
Using the Oregon Guide to Hydrogeologic Reports on the class web site (http://www.wou.edu/las/physci/taylor/g473/hydrogeology_report_guidelines_2005.pdf) write a 3-5 page environmental site summary for the Mountain Fir facility. Use the following outline format / report headings:

I. Title Page (Project Name, Student Name, Date)
II. Introduction
    A. Purpose of Report
    B. Site Location
    C. Statement of Problem
IV. Description of Hydrogeologic Systems
    A. Bedrock Geology
    B. Surficial Geology and Geomorphology
    C. Identified Aquifers and Aquitards
    D. Groundwater Use and Development
V. Methods and Analytical Procedures
VIII. Hydrogeologic Assessment
    A. Water Table Configuration / Groundwater Contour Maps
    B. Confined vs. Unconfined Conditions
    C. Groundwater Flow Direction
    D. Porosity and Permeability
    E. Groundwater Flow Velocities
IX. Water Quality
    A. Background Water Quality
    B. Contamination / Water Quality Degradation
X. Recommendations and Conclusion
    A. Risk to Human Health and Property
    B. Recommended Remediation Strategies.

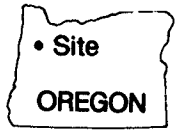
Items to include: identification of high-risk environmental contamination problems, how does the groundwater data relate to the Monmouth-Ind well fields. Are they up gradient or down gradient of the site? What is the potential for contamination of city drinking water based on your data analysis? What are your recommendations to the Mountain Fir company? Provide some ideas of how you would proceed with a remediation strategy.

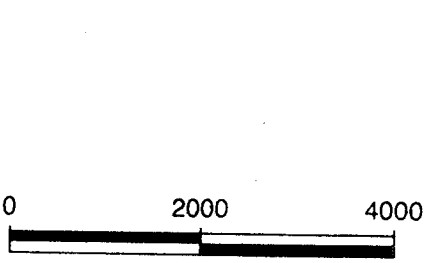
Mountain Fir Lab Checklist

- □ Background Information
- □ Task 1 questions (1-4)
- □ Task 2-1 well logs for MW-2S and MW-2D
- □ Task 2 questions (2-5)
- □ Task 3 questions (1-5)
- □ Task 3 data sort exercise
- □ Task 4 06/95 Groundwater Contour Map
- □ Task 4 11/95 Groundwater Contour Map
- □ Task 5 07/95 Pentachlor Concentration Map
- □ Task 5 10/95 Pentachlor Concentration Map
- □ Task 6 Environmental Site Assessment / Report



Base Map From: **USGS 7.5' quad. MONMOUTH, OREG. (1986)**

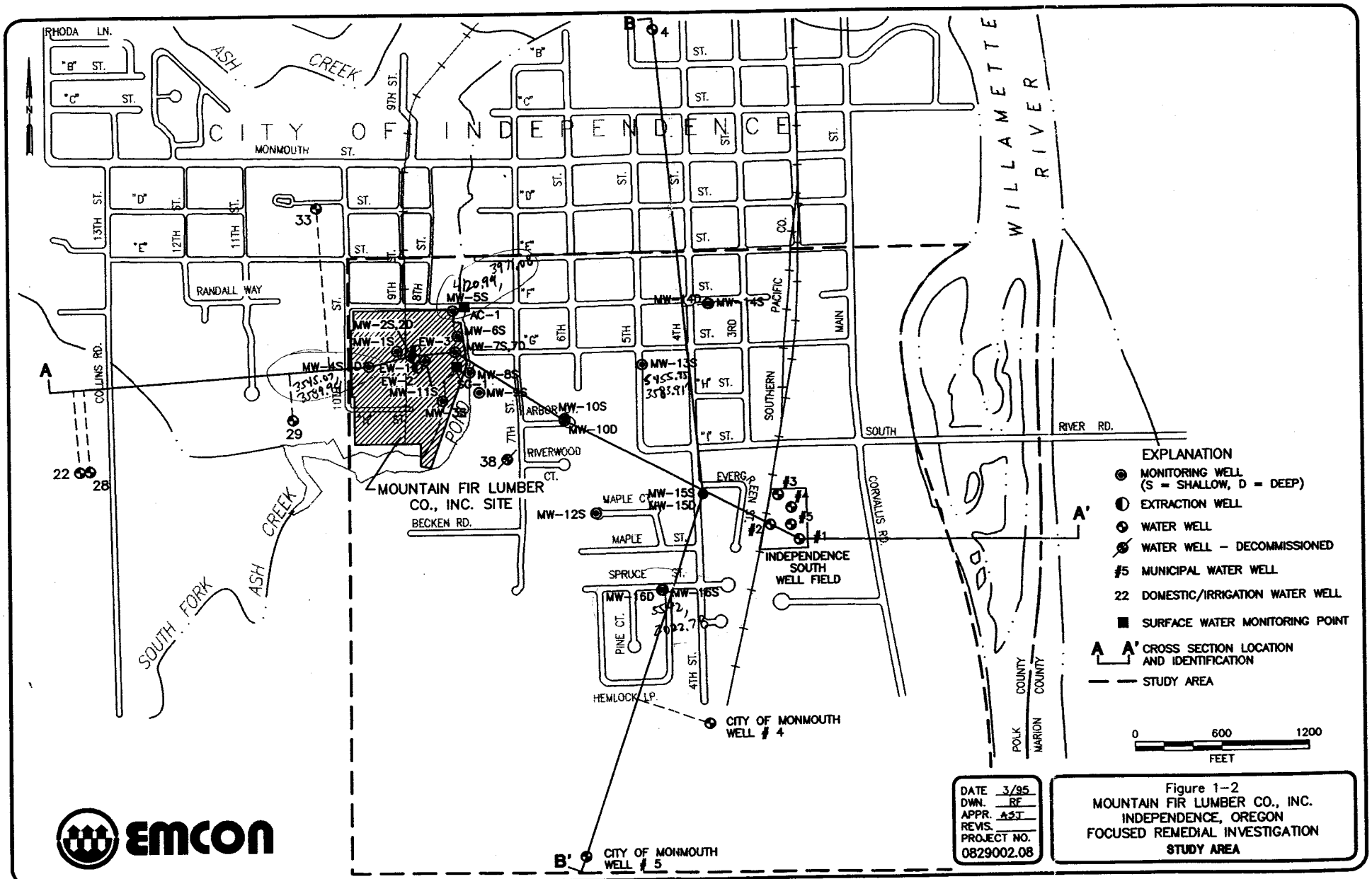


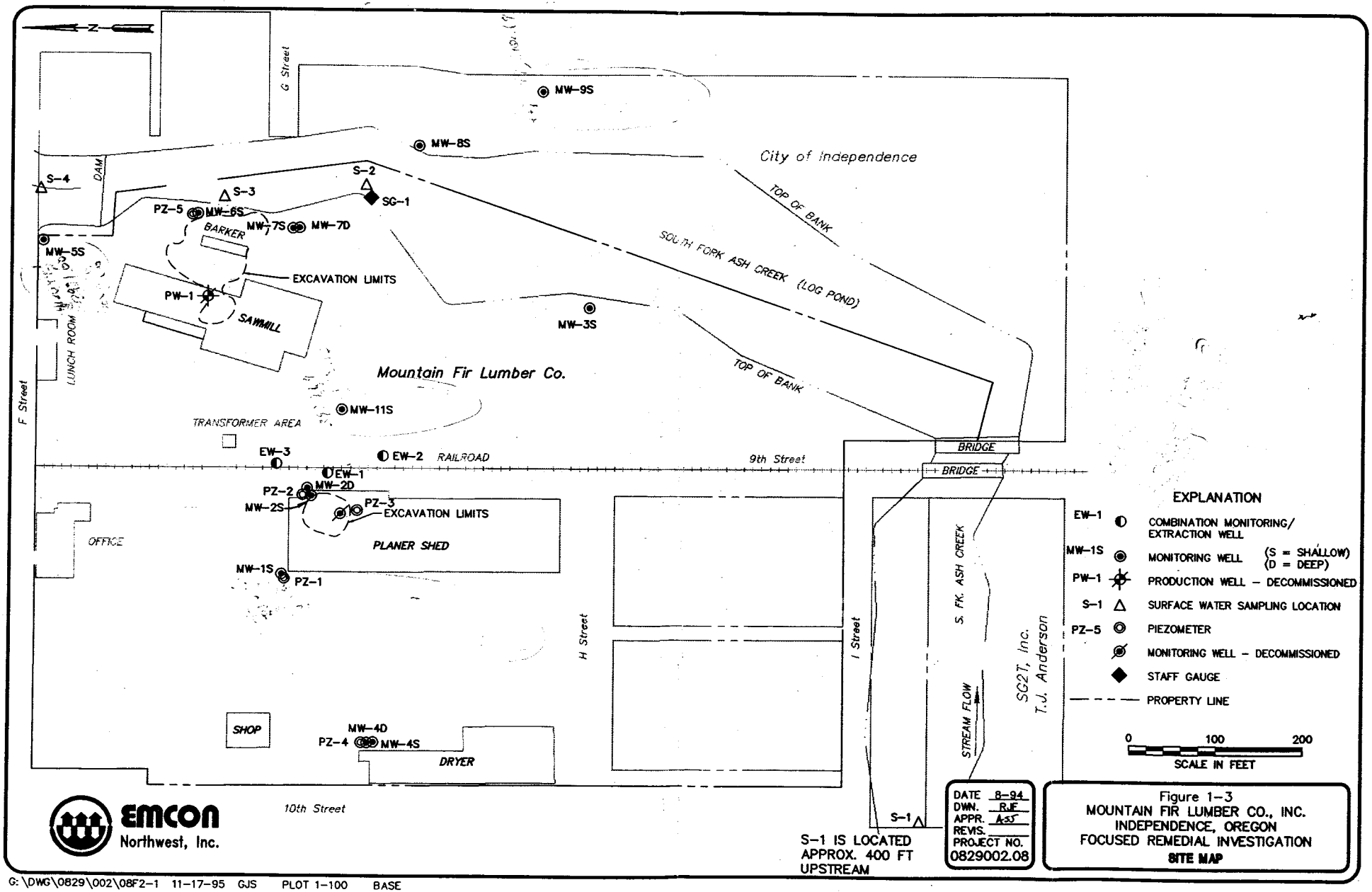


Emcon Northwest, Inc.

DATE 2/94
DWN mk
APPR CEC
REVIS.
PROJECT NO 0829002.03

Figure 1-1
MOUNTAIN FIR LUMBER CO., INC.
INDEPENDENCE, OREGON
FOCUSED REMEDIAL INVESTIGATION
LOCATION MAP


CITY OF INDEPENDENCE
WILLAMETTE RIVER
ASH CREEK
SOUTH FORK ASH CREEK
RHODA LN.
MONMOUTH ST.
RANDALL WAY
COLLINS RD.
MOUNTAIN FIR LUMBER CO., INC. SITE
BECKEN RD.
MAPLE CT.
MAPLE ST.
SPRUCE ST.
PINE CT.
HEMLOCK LP.
4TH ST.
RIVERWOOD CT.
ARBOR
EVERGREEN
SOUTHERN
PACIFIC
MAIN
CORVALLIS RD.
SOUTH RIVER RD.
POLK COUNTY
MARION COUNTY
INDEPENDENCE SOUTH WELL FIELD
CITY OF MONMOUTH WELL # 4
CITY OF MONMOUTH WELL # 5
MW-1S
MW-2S,2D
MW-4S,4D
MW-5S
MW-6S
MW-7S,7D
MW-8S
MW-9S
MW-10S
MW-10D
MW-11S
MW-12S
MW-13S
MW-14S
MW-14D
MW-15S
MW-15D
MW-16S
MW-16D
AC-1
EW-1
EW-2
EW-3
SC-1
A
A'
B
B'
EXPLANATION
MONITORING WELL (S = SHALLOW, D = DEEP)
EXTRACTION WELL
WATER WELL
WATER WELL – DECOMMISSIONED
#5 MUNICIPAL WATER WELL
22 DOMESTIC/IRRIGATION WATER WELL
SURFACE WATER MONITORING POINT
A A' CROSS SECTION LOCATION AND IDENTIFICATION
STUDY AREA
0 600 1200
FEET
DATE 3/95
DWN. RF
APPR. ASJ
REVIS.
PROJECT NO. 0829002.08
Figure 1-2
MOUNTAIN FIR LUMBER CO., INC.
INDEPENDENCE, OREGON
FOCUSED REMEDIAL INVESTIGATION
STUDY AREA
EMCON
G:\DWG\0829\002\BASEMAP 12-01-95 GJS
PLOT AT 1 = 600



EMCON Northwest, Inc.

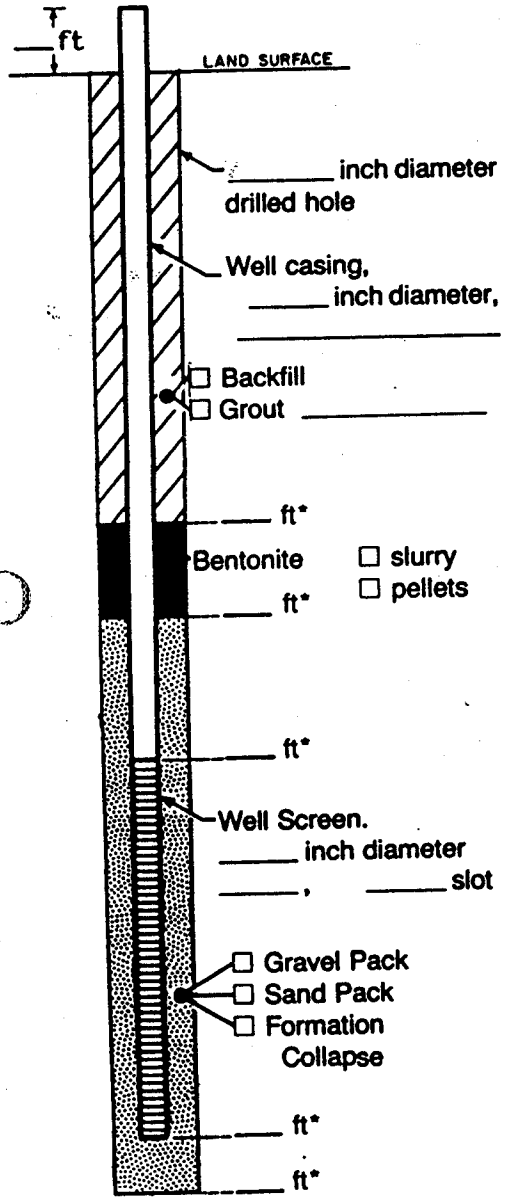
S-1 IS LOCATED APPROX. 400 FT UPSTREAM

DATE 8-94
DWN. RJE
APPR. ASS
REVIS.
PROJECT NO. 0829002.08

Figure 1-3
MOUNTAIN FIR LUMBER CO., INC.
INDEPENDENCE, OREGON
FOCUSED REMEDIAL INVESTIGATION
SITE MAP

G:\DWG\0829\002\08F2-1 11-17-95 GJS PLOT 1-100 BASE

WELL CONSTRUCTION LOG



Measuring Point is Top of Well Casing Unless Otherwise Noted.

*Depth Below Land Surface

Project _____ Well _____

Town/City _____

County _____ State _____

Permit No. _____

Land-Surface Elevation

and Datum _____ feet ☐ surveyed

_____ ☐ estimated

Installation Dates(s) _____

Drilling Method _____

Drilling Contractor _____

Drilling Fluid _____

_____

Development Techniques(s) and Date(s)

_____

_____

_____

Fluid Loss During Drilling _____ gallons

Water Removed During Development _____ gallons

Static Depth to Water _____ feet below M.P.

Pumping Depth to Water _____ feet below M.P.

Pumping Duration _____ hours

Yield _____ gpm Date _____

Specific Capacity _____ gpm/ft

Well Purpose _____

_____

_____

Remarks _____

_____

_____

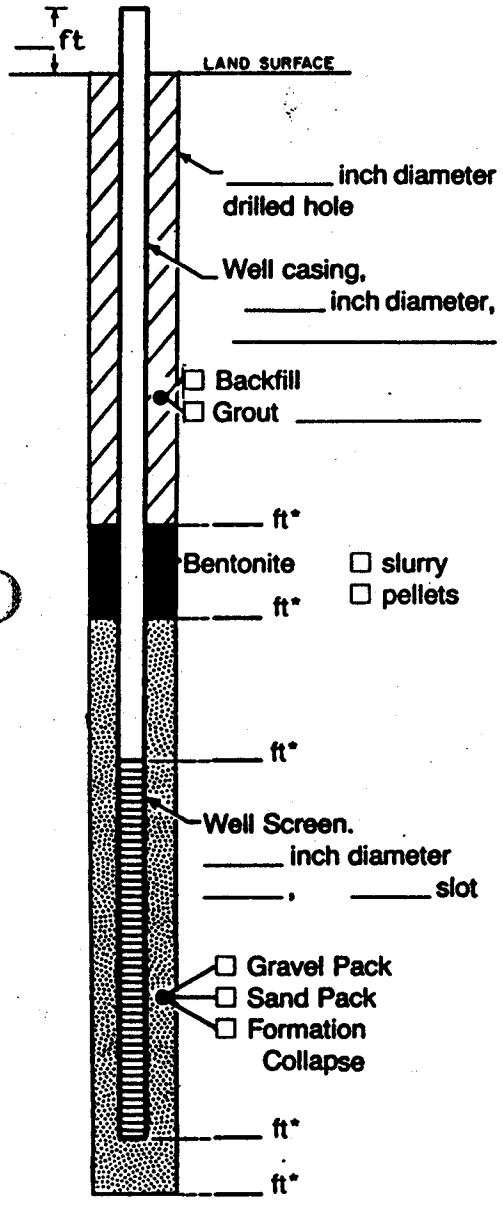
_____

_____

_____

Prepared by _____

WELL CONSTRUCTION LOG



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Drilling Fluid _____

_____

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_____

_____

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Specific Capacity _____ gpm/ft

Well Purpose _____

_____

_____

Remarks _____

_____

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Prepared by _____