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Final

Meeting Minutes Transmittal/Approval
Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
2440 Stevens Center, Room 1200, Richland, Washington
May 26, 1994

FROM/APPROVAL: Eric D. Goller Date 6/30/94
Eric D. Goller, 100 Area Unit Manager, RL (A5-19)

APPROVAL: Phillip Stark Date 6/30/94
Jack W. Donnelly, 100 Aggregate Area Unit Manager, WA Department of Ecology

APPROVAL: Dennis Faulk Date 6-30-94
Dennis Faulk, 100 Aggregate Area Unit Manager, EPA (B5-01)

Meeting Minutes are attached. Minutes are comprised of the following:

Attachment #1	-	Meeting Summary
Attachment #2	-	Attendance Record
Attachment #3	-	Agenda
Attachment #4	-	Action Item Status List
Attachment #5	-	April Unit Manager's Meeting 100 Area Status Package
Attachment #6	-	May Unit Manager's Meeting 100 Area Status Package
Attachment #7	-	100 Area Focus Feasibility Studies Approach
Attachment #8	-	100 Area Source OU FFS Process
Attachment #9	-	100 Area Groundwater Operable Unit Feasibility Study Diagram
Attachment #10	-	*XRF Paper* Memorandum dated May 26, 1994
Attachment #11	-	100-HR-3 Pump and Treat Treatability Test Schedule
Attachment #12	-	100-HR-3 Pilot Scale Treatability Test Internal Draft Technical Proposal
Attachment #13	-	100-HR-3 Groundwater Treatability Pilot Test Summary of Items of Agreement

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Prepared by: Kay Kimmel Date: 6-30-94
Kay Kimmel, Bob Scheck GSSC (B1-42)

Concurrence by: R P Henckel Date: 6-30-94
Bob Henckel, WHC Coordinator (H6-02)

Attachment #1
Meeting and Summary of Commitments and Agreements

Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
May 26, 1994

1. **SIGNING OF THE MARCH 100 AREA UNIT MANAGER'S MEETING MINUTES** - Minutes were reviewed and approved with no changes. The April 27 meeting was canceled.

2. **ACTION ITEM UPDATE: (See Attachment 4 for complete status, items listed below indicate the update to Action Items made during the meeting):**

1AAMS.15	No additional information.
1AAMS.16	No additional information.
1AAMS.19	No additional information.

3. **NEW ACTION ITEMS:**

No new action items were initiated.

4. **100 AREA ACTIVITIES:**

100 Area Status

- Operable Unit Status: Attachments #5 and #6 were provided for general information on the 100 Areas Operable Units.

- 100 Area Focused Feasibility Study: Robert Henckel provided the basis of the 100 Area focused feasibility studies (see Attachment #6). He indicated that an FFS is performed only on high priority sites.

    - Roberta Day (IT) presented the details of the FFS process as used in the 100 Area Source Operable Units (see Attachment #7). A discussion on choice of sites, future land use scenarios, and target performance levels followed the presentation, with the outcome that RL and EPA agreed to meet together in order to reach agreement on the various issues to be developed in the 100 Area Focused Feasibility Studies. Dennis Faulk noted that the EPA objects to RL making a unilateral decision regarding a recreational use scenario for 100 area FFSs. He also noted that EPA does not agree that the FFS should only address the high priority units. A meeting was tentatively scheduled for 6/6 or 6/7 at 1:00 pm to further discuss the issues raised.

    - Mary Todd (IT) presented the details of the Groundwater FFS (see Attachment #8). Dennis Faulk indicated that the recreational land use scenario is adequate for use in the 100-BC-5 Operable Unit.

100 Area Treatability Studies

- Status of 100-HR-3 Pilot Scale Treatability Test: Dick Biggerstaff provided the status of activities on the 100-HR-3 pilot scale treatability test (see Attachments #11, #12, and #13). He reviewed the schedule and provided the draft technical proposal for the pilot scale treatability test. A summary of agreements impacting this test was also provided. A meeting was tentatively scheduled to further discuss this treatability test.

5. INFORMATION ITEMS:

- 107 Retention Basin D&D Work: David Smith provided the status of activities at the 107-B and 107-K Retention Basins. EPA requested 5-day advance notification on sandblasting activities.

- XRF Presentation: Joan Woolard presented a white paper comparing XRF and SW-846 methodologies, which Glenn Goldberg transmitted to the regulators (see Attachment #9).

- Reorganization: Eric Goller provided a summary of anticipated reorganization activities. He indicated that Bechtel will officially assume environmental restoration functions on July 1. He also noted that RL is reorganizing, moving from a project administration approach to a project management approach.

- Documents Transmitted: The following documents were transmitted by RL to the regulators. Document WHC-SD-EN-TI-238, *Data Validation Report for the 100-FR-3 Operable Unit, Round 4 Groundwater Samples*; Document DOE/RL-94-19 Draft A, *Codisposal Test Plan*; Document WHC-SD-EN-TI-240, *Vitrification Testing of Soil Fines from Contaminated Hanford 100 Area and 300 Area Soils*.

6. NEXT MEETINGS: The next meetings are scheduled for June 29 and 30, 1994.

100 Aggregate Area Unit Manager's Meeting
Official Attendance Record
May , 1994

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PRINTED NAME	ORGANIZATION	O.U. ROLE	TELEPHONE
Kevin Parnell	Dames & Moore	Meeting Minutes	946-3690
Gary Freedman	Ecology	UM	736-3026
Larry Gadbois	EPA	UM	376-9884
Ted Wooley	Ecology	UM	736-3012
Wayne Soper	Ecology	U.M.	736-3049
Dave Holland	Ecology	UM/suppt	736-3049
Diana Sickle	WHC	ER-Support	372-3141
Eric Goller	DOE-RL	Unit Manager	376-7326
Bob Scheck	Dames + Moore	GSSC-100	946-3688
Glenn Goldberg	DOE-RL	OU Manager	376-9552
JOAN WOOLARD	WHC	TREATABILITY STUDIES	376-2539
Roberta Day	IT Corp.		943-6728
Pamela Innis	EPA	UM	376-4919
Jeff Bruggeman	COE	RARA	376-7121
A.D. Krug	WHC	100-K, N- All source units	376-5634
J.W. Roberts	WHC	BC	376-5764
Dennis Faulk	EPA	UM	376-8631
Phil Staats	Ecology	UM	736-3029
R.L. Biggerstaff	WHC	OU Coor-100H	376 5634
J.K. PATTERSON	WHC	ER Program Office	376-0902
C.L. Bailey	WHC		372 3104
R.P. HENCKEL	WHC	100 AREA	376-2091
N.M. Naiknimbalkar	WHC	100-D	376-8739
CHUCK CLINE	ECOLOGY	HYDROGEO. SUPPORT	(206) 407-7135
William E. Lum II	USGS	EPA Support	206 593-6510

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Attachment #2

100 Aggregate Area Unit Manager's Meeting
Official Attendance Record
May , 1994

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PRINTED NAME	ORGANIZATION	O.U. ROLE	TELEPHONE
Norm Hepner	Ecology	ERDF	736-3048
Ron Belden	WHC	Proj Eng.	372-1226

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Attachment #3
Agenda

Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
May 26, 1994

100 Area General Discussions

* 107 Basin D&D Work

* 100 Area General Status - R. Henckel

  - XRF Presentation

  - 100 Area FFS
    - o Status of current work

  - 100-BC-5
    - o Direction of FFS/Proposed Plan

  - 100 Area scope Proposed Plans
    - o Reorganizations

* 100 Area Treatability Studies - J. Woolard

  - Status of Soil Washing Treatability Test - J. Field

  - 100-HR-3 Treatability Test - D. Biggerstaff

  - Codisposal Test Plan - J. Ludowise

Operable Unit Status - Questions - N. Naiknimbalkar/J. Ayres/
D. Biggerstaff/A. Krug/J. Roberts

Action Item Status

Attachment #4

Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
May 26, 1994

Action Item Status List

ITEM NO.	ACTION	STATUS
1AAMS.15	Provide response to April 2 EPA letter concerning river seeps. Action: Eric Goller (RL) 7/29/92.	Open (7/29/92). In DOE for transmittal (8/26/92). Letter is pending (03/31/94).
1AAMS.16	DOE should transmit Revision 1 of M-30-01.	Open (7/29/92). In DOE for transmittal (8/26/92). Letter is pending (03/31/94).
1AAMS.19	Meet, before the end of the month, with RL, EPA and Ecology concerned parties to discuss ERDF waste acceptance criteria and expected volumes. Action: Bryan Foley	Open 02/23/94.

100 AREA UNIT MANAGERS' MEETING

100-BC, 100-KR, 100-DR, 100-HR, & 100-FR

APRIL 1994

TREATABILITY STUDIES

100 AREA SOIL WASHING TREATABILITY TEST STATUS

Procurement of equipment for the 100-DR-1 test is behind schedule. This places the M-15-07B milestone in jeopardy.

Draft procedures for the 100-DR-1 pilot scale soil washing tests were completed and are being reviewed by WHC and RL. The procedures are scheduled to be submitted to the regulators in June.

Comments from EPA and Ecology were received on the 100 Area bench scale soil washing tests report (DOE/RL-93-107). Responses were prepared and distributed to RL, EPA and Ecology.

116-F-4 rock grinding tests are continuing. Results will be incorporated in the test report. A draft report is expected to be completed for WHC and RL concurrent review by April 30, 1994.

Additional results of 116-F-4 tests, and more up to date status on planning for the pilot test will be presented at the April UMM meeting.

100 AREA EXCAVATION TREATABILITY TEST (116-F-4)

The test report (DOE/RL-94-16) is currently undergoing DOE review. Report is on schedule to be delivered to EPA and Ecology for review May 31.

118-B-1 EXCAVATION TREATABILITY TEST

Test plan (DOE/RL-94-43) is undergoing an internal review and will be issued on schedule for the DOE, EPA and Ecology to review.

100 AREA TREATABILITY TEST STATUS

Co-Disposal

Comments on the test plan from WHC and DOE-RL were received and dispositioned. A revised draft of the document (Draft A) was prepared and sent to DOE-RL for transmittal to the regulatory agencies for review and comment.

Ex Situ Vitrification

PNL Crucible Tests

Tests conducted by PNL demonstrated the applicability of vitrification to the soil washing fines and provided data on the performance of actual, vitrified soil washing fines. The final report has been prepared and comments from DOE-RL have been incorporated. The report is now being routed through the clearance process and should be available by May.

Minimum Additive Waste Stabilization (MAWS) Program

Under the Minimum Additive Waste Stabilization (MAWS) Program Approximately 30 kg of soil fines excavated from the 116-F-4 trench were shipped to the

Vitreous State Laboratory (VSL) located at the Catholic University of America (CUA) in early January. One of the objectives of these tests is to combine soil fines from the ER program with surrogate (non-radioactive) tank waste and to maximize the tank waste loading in the glass. VSL was able to make a durable glass with over a 30% tank waste loading.

<u>Vortec Combustion and Melting System</u>

In early January, Hanford was selected as the site for Phase III testing. By late March, WHC will begin assisting Vortec in developing the test plan and procedures, NEPA and safety documentation. A kickoff meeting with Vortec was held on April 18 and 19, 1994.

INSITU FLOW SENSORS - HR-3

- A Description of Work was completed by WHC, submitted to and approved by DOE and the Regulators. An Activity Agreement Notification form (5 day notice) was submitted to Ecology April 11. Field installation will commence during the week of April 18, 1994 in proximity to the 183-H Basin area in H-Reactor area.

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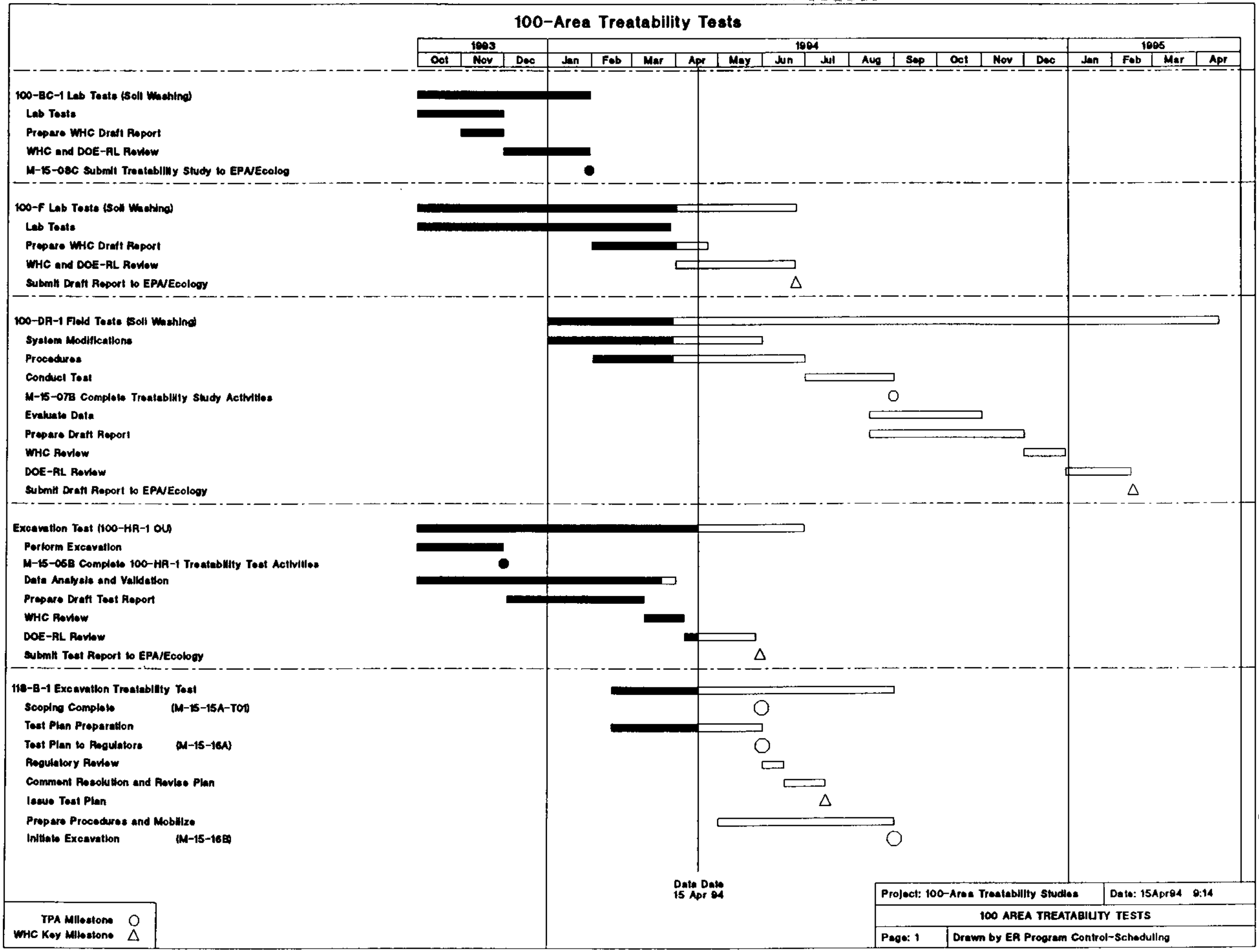

B AREA

100-BC-1 QRA and LFI Reports

TASK 11: 100-BC-1 QRA (WHC-SD-EN-RA-003, Rev. 0) has been reviewed by the regulators. Comment resolutions were agreed upon and are currently being incorporated into the document in the form of errata sheets.

TASK 13: 100-BC-1 LFI (DOE/RL-93-06 Rev. 0) was given to DOE on April 19 for distribution to the regulators.

100-BC-1 FFS Report

Task was initiated in January, 1994 and is currently on schedule.

100-BC-2 QRA and LFI Reports

TASK 11: The 100-BC-2 QRA was initiated in January, 1994 and is currently on schedule. The WHC internal draft has been received and is in review.

TASK 13: The 100-BC-2 LFI was initiated in January, 1994 and is currently on schedule. The WHC internal draft has been received and is in review.

100-BC-5 QRA and LFI Reports

TASK 11: 100-BC-5 QRA (WHC-SD-EN-RA-006, Rev. 0) has been reviewed by the regulators. Comment resolutions were agreed upon and are currently being incorporated into the document.

TASK 13: 100-BC-5 LFI (DOE/RL-93-37 Draft A) has been reviewed by the regulators. Comment resolutions were agreed upon and are currently being incorporated into the document.

100-BC-5 FFS Report

Task was initiated in January, 1994 and is currently on schedule. Discussions are ongoing as to the format and content of the document.

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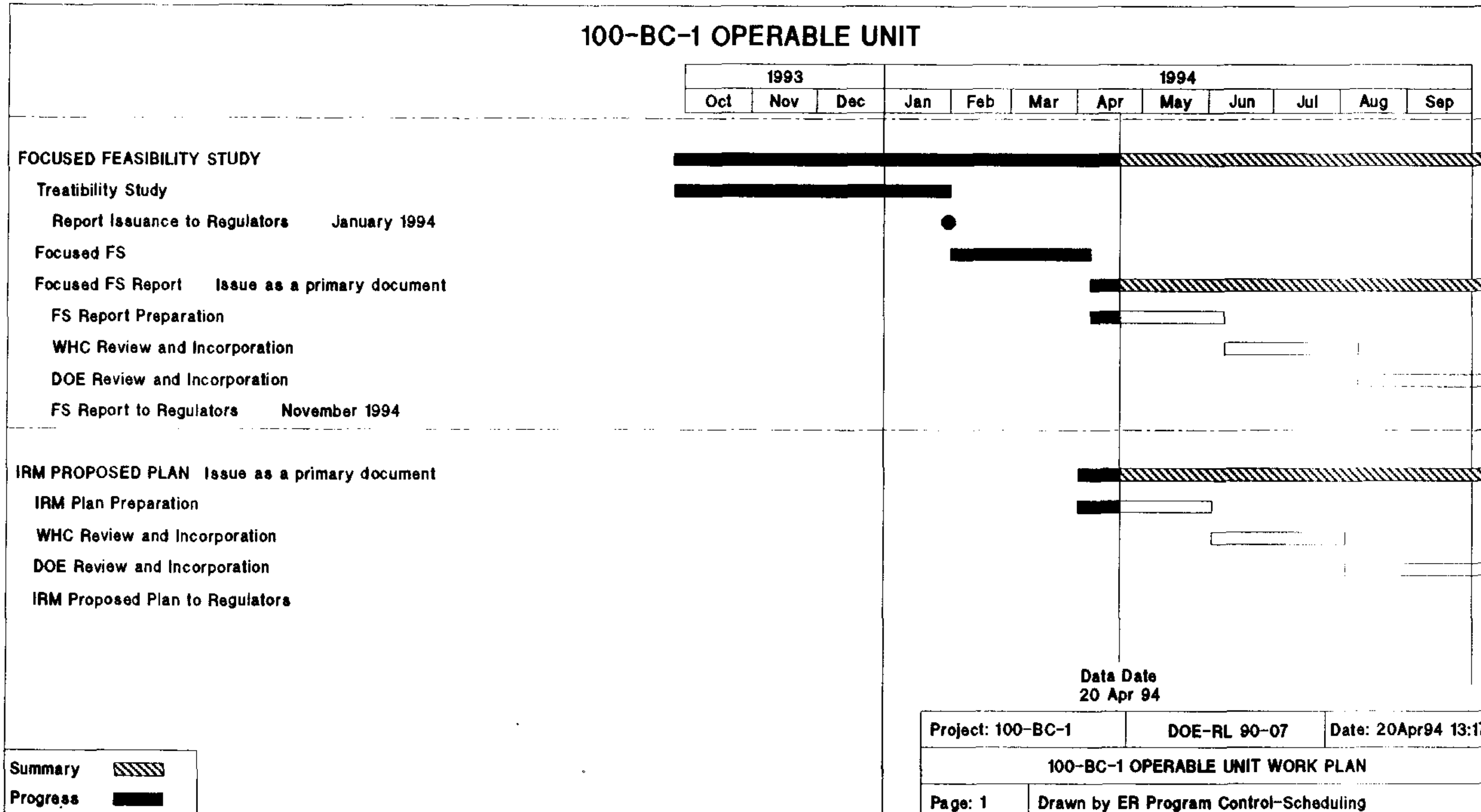

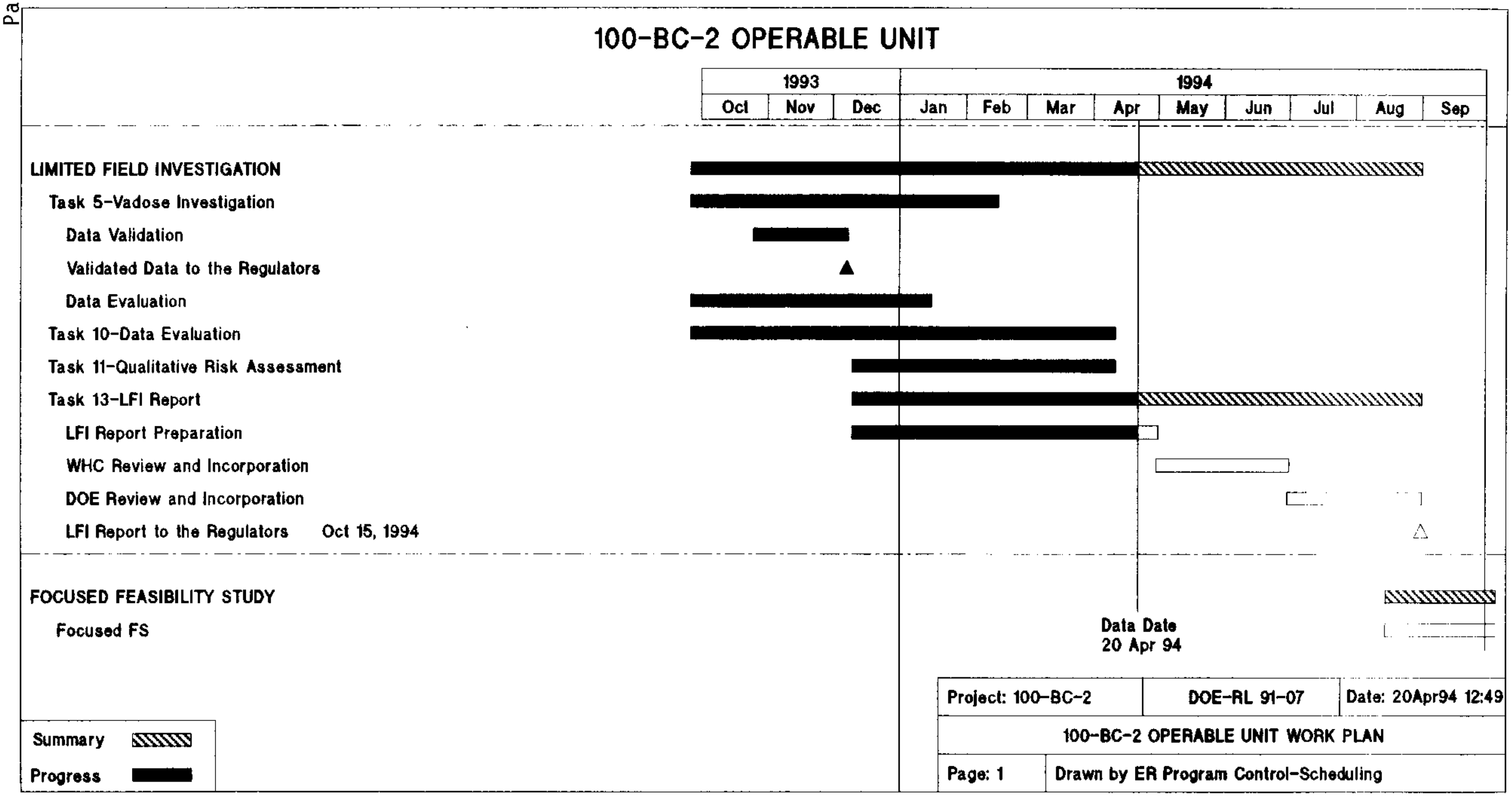
100-BC-2 OPERABLE UNIT
1993
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LIMITED FIELD INVESTIGATION
Task 5-Vadose Investigation
Data Validation
Validated Data to the Regulators
Data Evaluation
Task 10-Data Evaluation
Task 11-Qualitative Risk Assessment
Task 13-LFI Report
LFI Report Preparation
WHC Review and Incorporation
DOE Review and Incorporation
LFI Report to the Regulators Oct 15, 1994
FOCUSED FEASIBILITY STUDY
Focused FS
Data Date
20 Apr 94
Summary
Progress
Project: 100-BC-2
DOE-RL 91-07
Date: 20Apr94 12:49
100-BC-2 OPERABLE UNIT WORK PLAN
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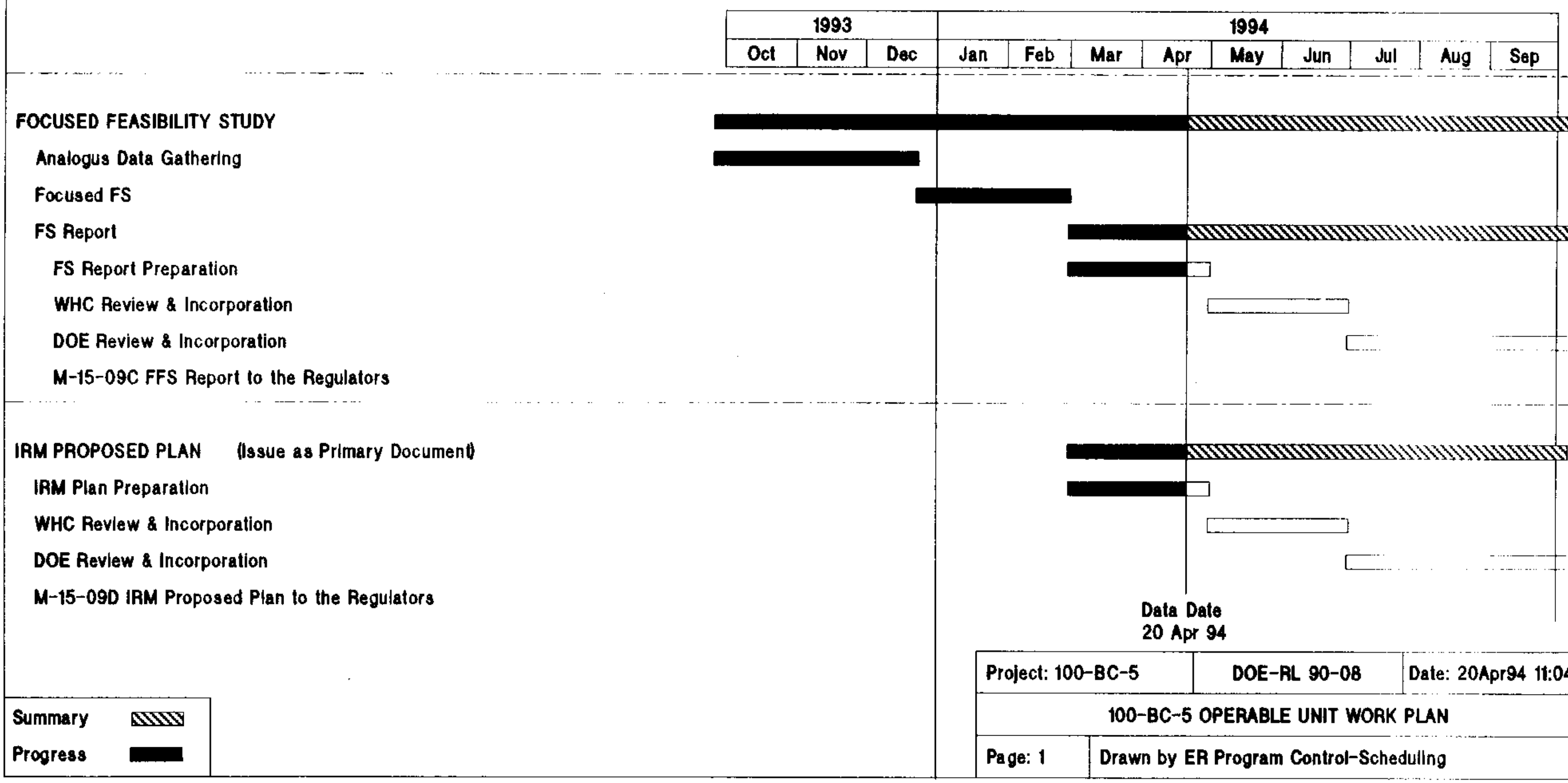
100-BC-5 OPERABLE UNIT



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K AREA

100-KR-1 QRA and LFI Reports

Task 11: Regulator comments on 100-KR-1 QRA (WHC-SD-EN-RA-009, Rev. 0) were received on April 14, 1994. WHC is waiting for DOE direction, prior to developing responses. EPA has requested responses by May 18, 1994.

Task 13: Regulator comments on 100-KR-1 LFI (DOE/RL 93-78, Draft A) were received on April 14, 1994. WHC is waiting for DOE direction, prior to developing responses. EPA has requested responses by May 18, 1994.

Focused Feasibility Study

A Task Order was issued to initiate work on the 100-KR-1 Focused Feasibility Study.

100-KR-4 QRA and LFI Reports

Task 11: A meeting is scheduled with EPA for April 26, 1994 to discuss DOE responses to regulator comments on 100-KR-4 QRA (WHC-SD-EN-RA-010, Rev 0).

Task 13: A meeting is scheduled with EPA for April 26, 1994 to discuss DOE responses to regulator comments on 100-KR-4 LFI (DOE?RL-93-79, Draft A).

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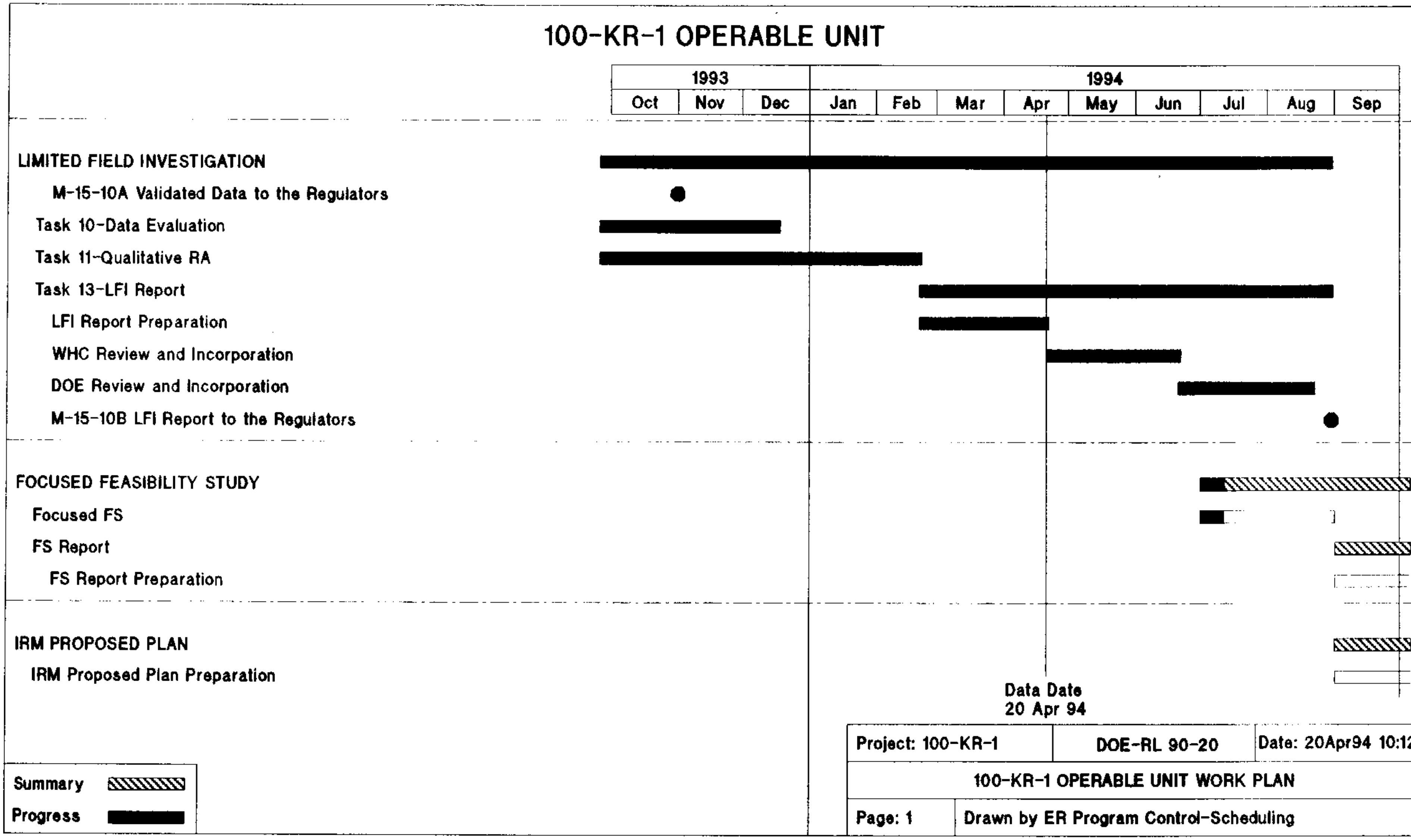

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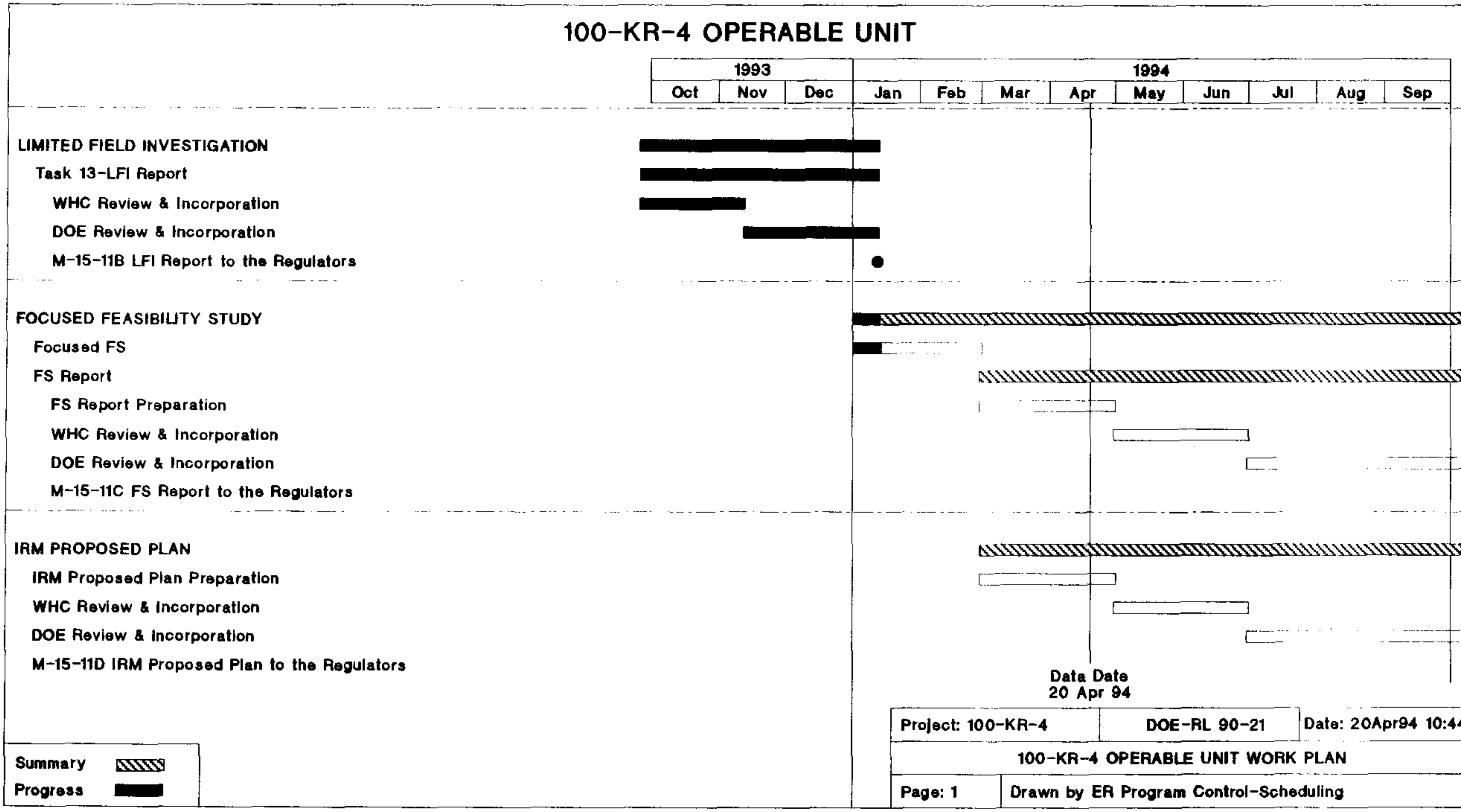

D AREA

100-DR-1

Qualitative Risk Assessment

- Qualitative Risk Assessment report Regulatory comments have been addressed and the final resolutions to specific comments were agreed upon by all parties on March 1, 1994. The Errata sheets will be provided to all parties. No changes will be made to the text in the document.

LFI Report

- Limited Field Investigation (LFI) report Regulatory comments have been addressed and the resolutions to specific comments were agreed upon by all parties during March, 1994. The final report (four copies), DOE/RL-93-29, Rev. 0, was submitted to DOE-RL for distribution to the Regulators. The detail distribution to appropriate parties will be made through the WHC document control system.

100-DR-2

100-DR-2 Work Plan

- A change control form C-93-01 was approved on April 14, 1994, by DOE-RL, Ecology and EPA. The change control combines 100-DR-3 Operable Unit into 100-DR-2 Operable Unit. The new milestone, M-13-09, for the combined document is September 6, 1994.

100-DR-2 LFI Report

- The LFI report was initiated on March 15, 1994, and is progressing

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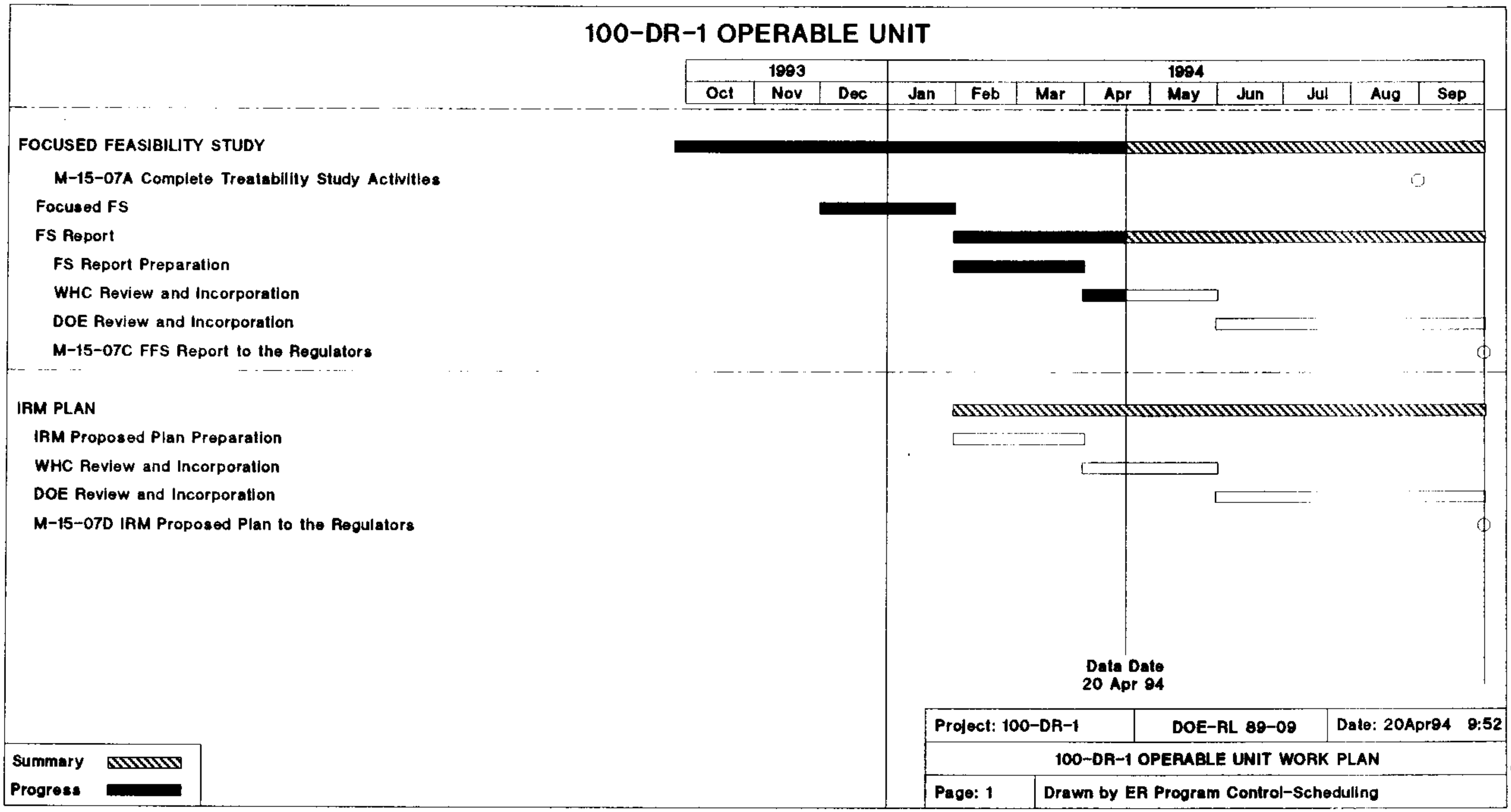

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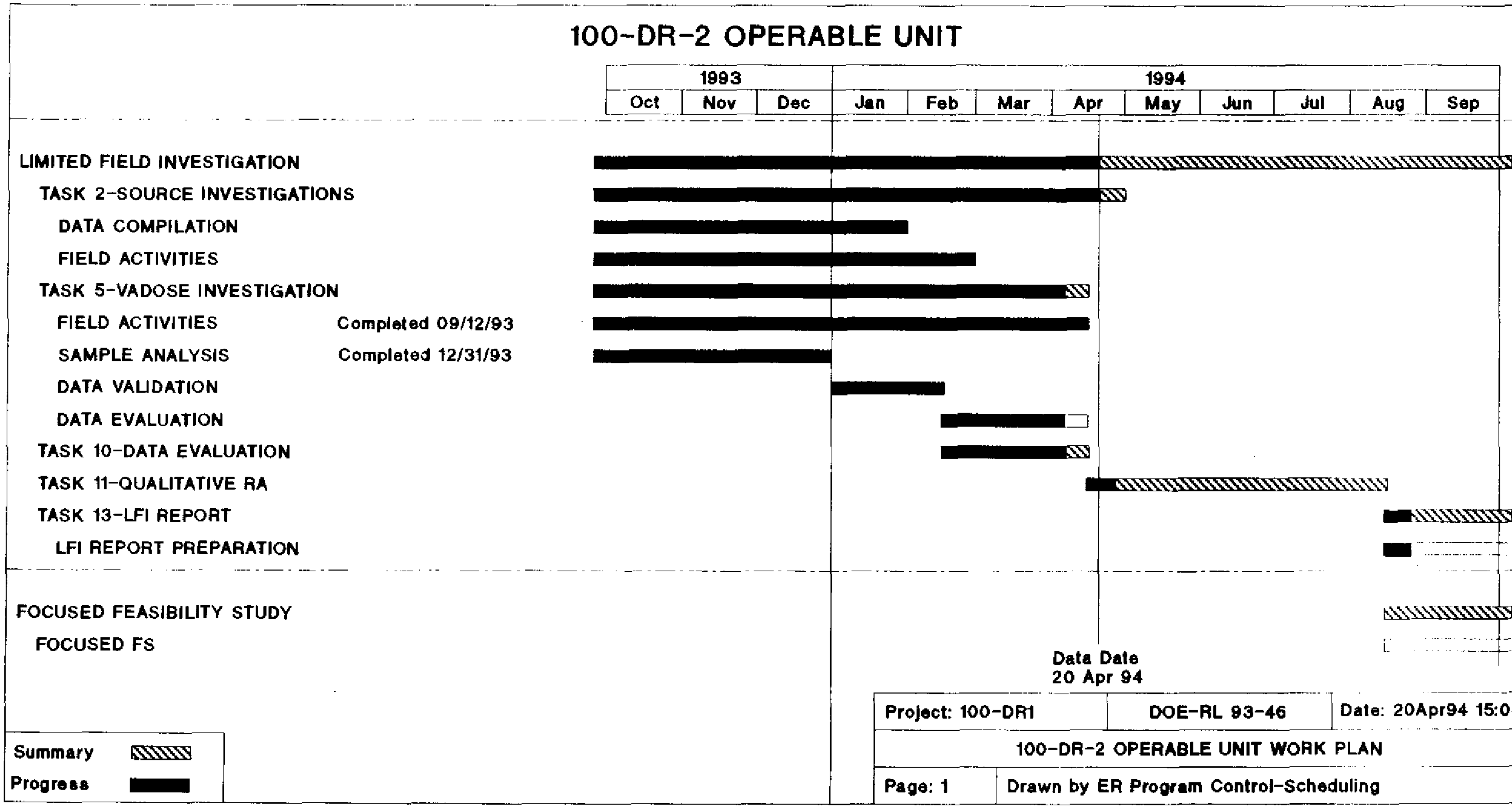

H AREA

100-HR-1

Task 11: QRA Report - Regulator comments on the 100-HR-1 QRA (WHC-SD-EN-RA-004, Rev. 0) have been addressed and an errata sheet is being prepared for incorporation into the document.

Task 13: LFI Report - Regulator comments on the 100-HR-1 LFI (DOE/RL-93-51, Rev 0) have been incorporated and it is to be submitted to DOE/RL in late April.

100-HR-2

PLANNING DOCUMENT: Public review comments were received and responses are being prepared.

100-HR-2 RADIOLOGICAL SURFACE SURVEY: The rad survey for 100-HR-2 is 50% complete.

TASK 11 and TASK 13 - QRA and LFI REPORT: Preparation of the report is in progress and the internal review draft is due out May 2, 1994.

100-HR-3

Task 6- GROUNDWATER INVESTIGATION

- **WHC transmitted responses to 3rd round Regulatory comments on the Qualitative Risk Assessment and Limited Field Investigation Report to DOE on 4/15/94.**

GROUNDWATER TREATABILITY PILOT TEST

- **The ion exchange unit bid was awarded to Resource Technologies Group, Inc. in Lakewood, CO. Delivery is expected in mid-July.**

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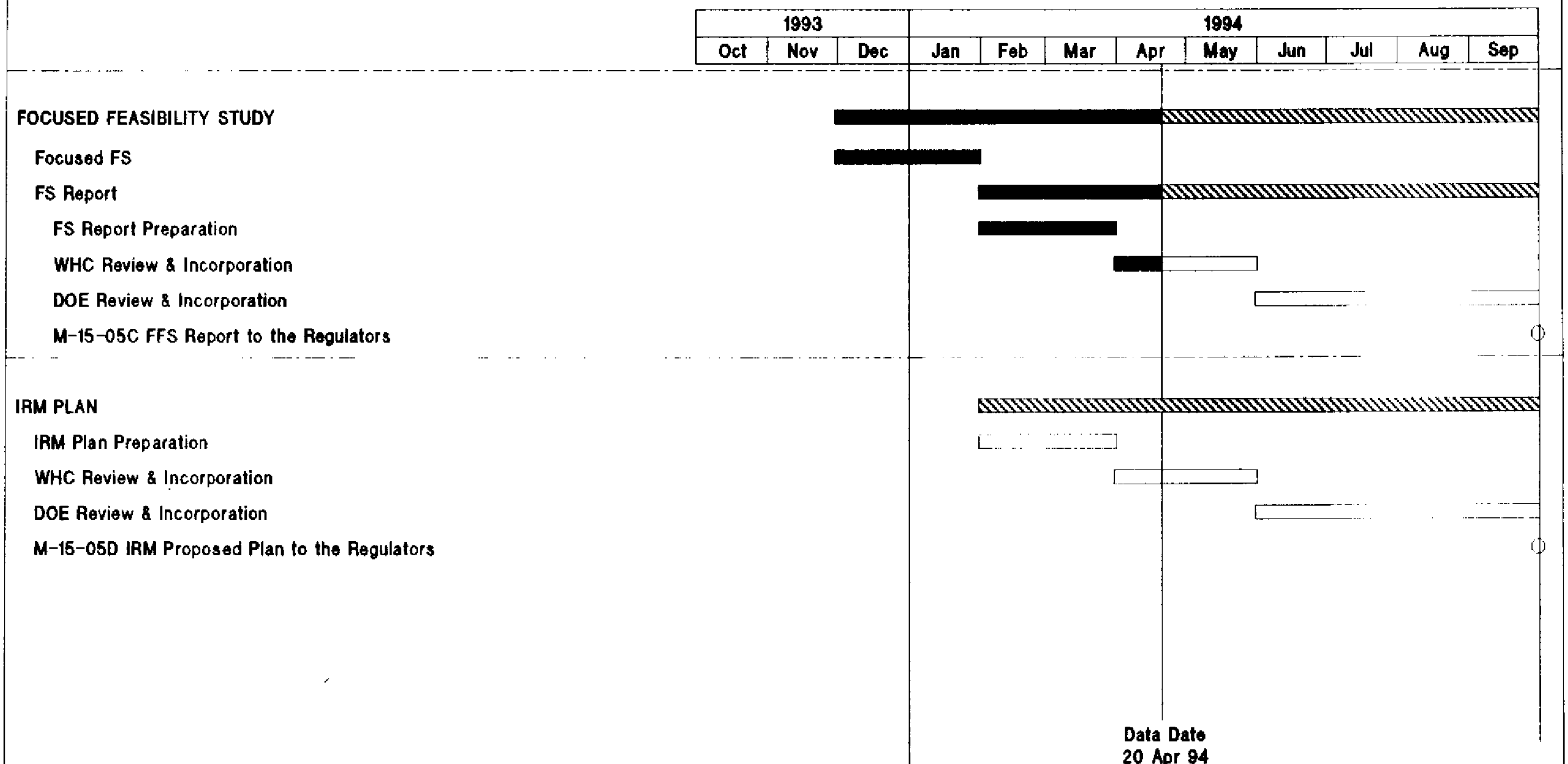
100-HR-1 OPERABLE UNIT



Summary
Progress

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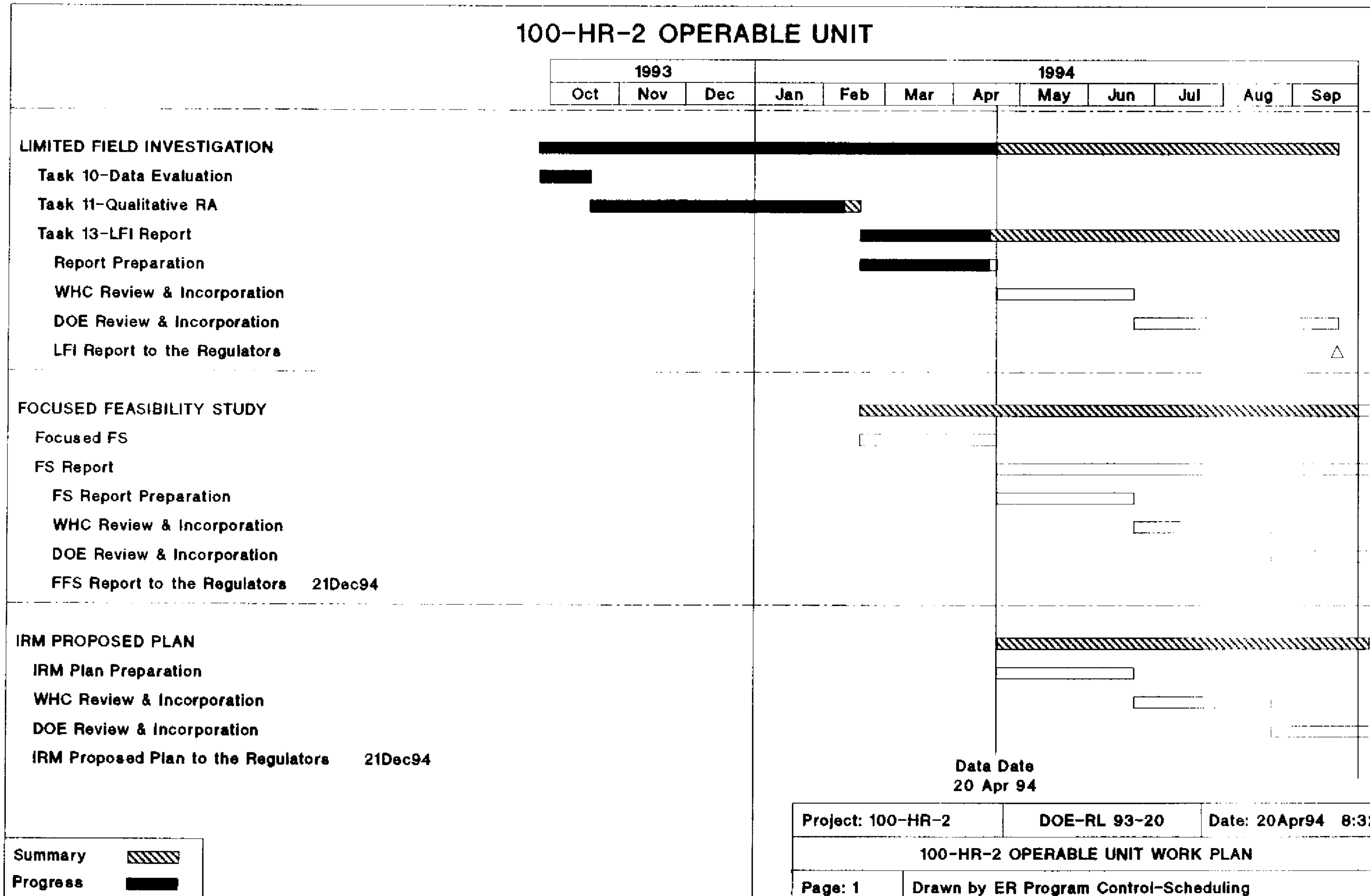

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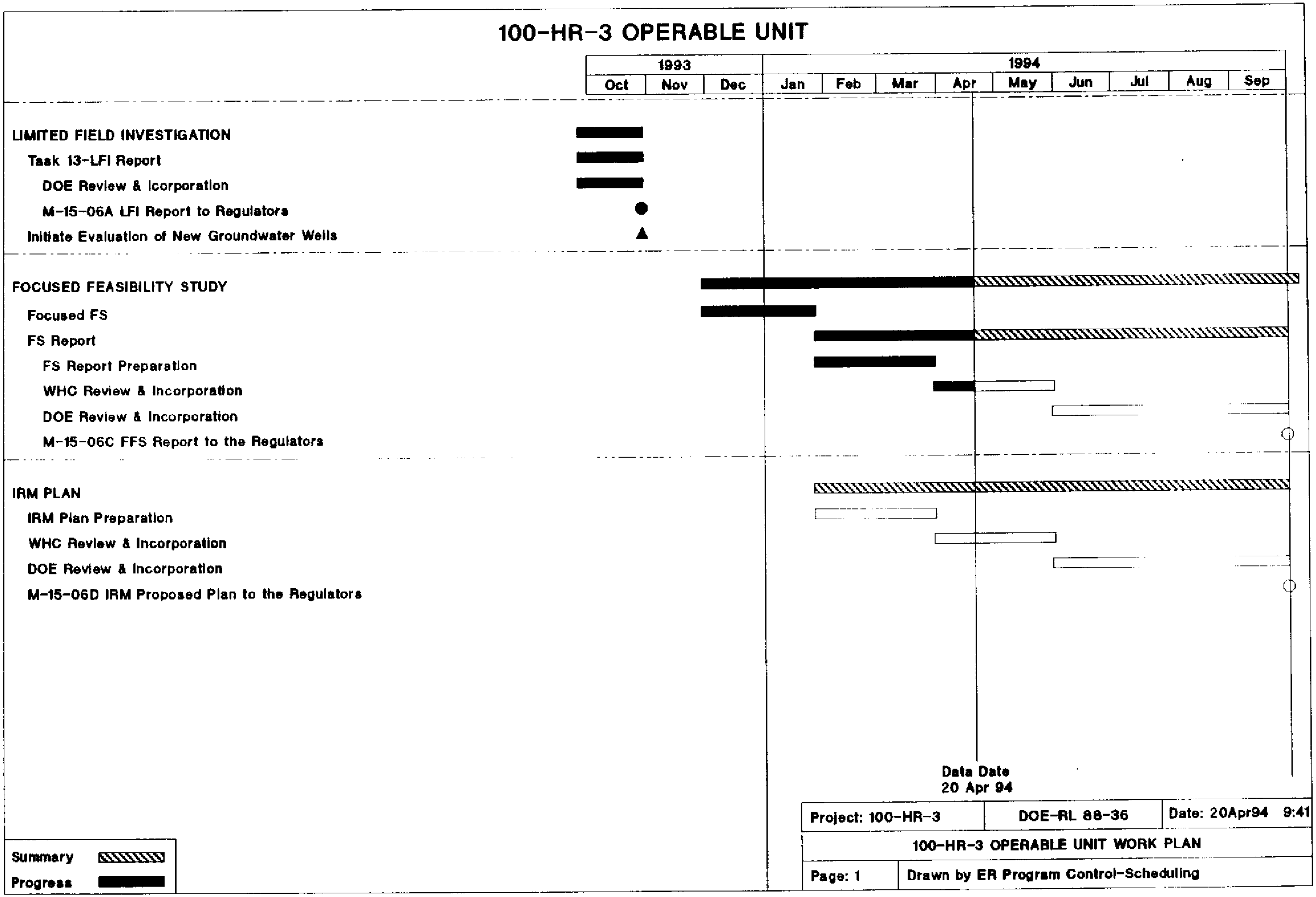

F AREA

100-FR-1

TASK 11: 100-FR-1 QRA (WHC-SD-EN-RA-013, Rev. 0) is in process. The internal WHC review has been completed and the DOE review draft is due on 15 May 1994.

TASK 13: 100-FR-1 LFI (DOE/RL-93-82, Draft A) is in process. The internal WHC review has been completed and the DOE review draft is due on 15 May 1994.

100-FR-3

TASK 6 - GROUNDWATER INVESTIGATION

- The fifth round of groundwater sampling is now scheduled for April 1994.
- The LFI and QRA reports (regulator review drafts) were submitted to DOE on April 11, 1994 to meet milestone M-15-13F (April 14, 1994).

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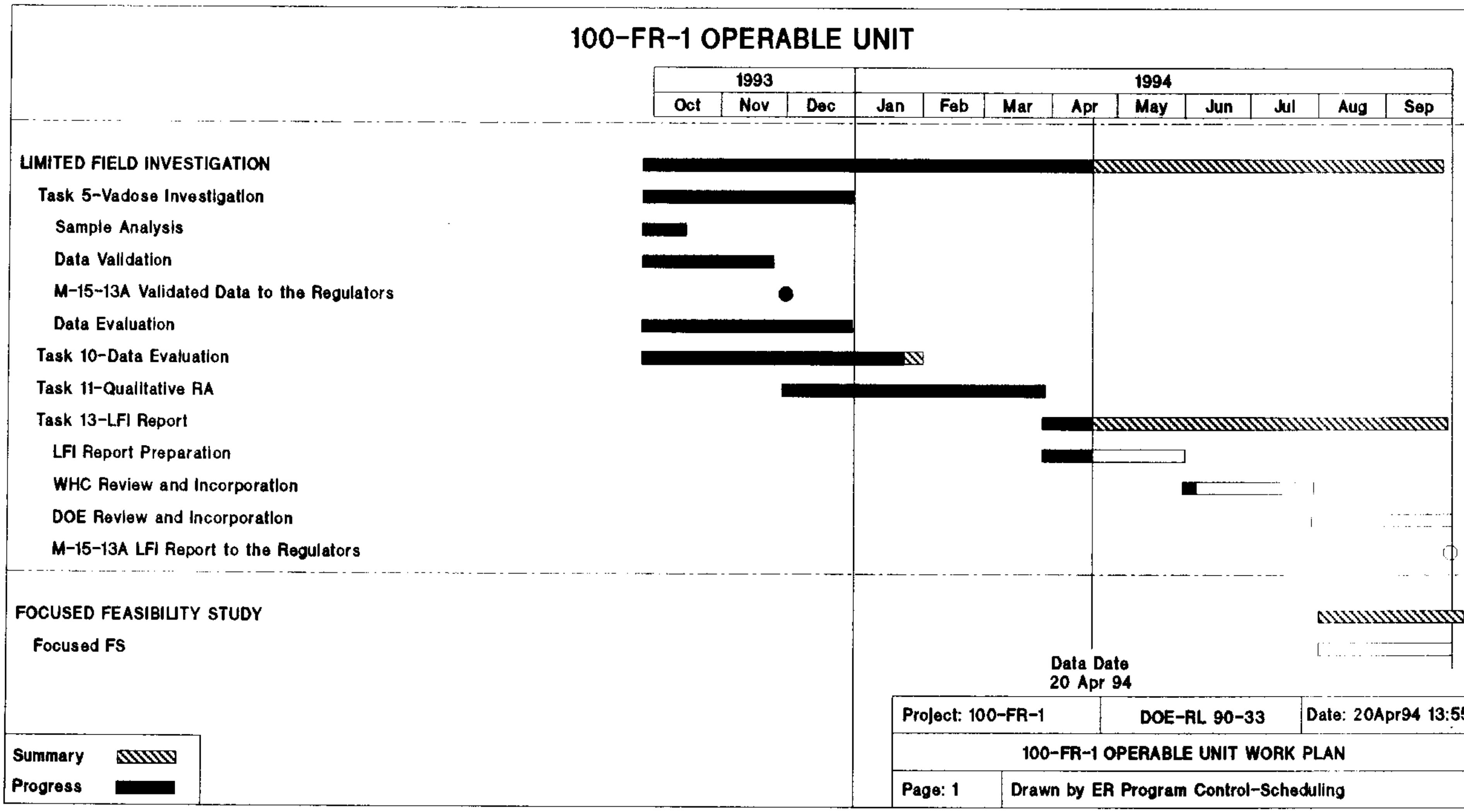

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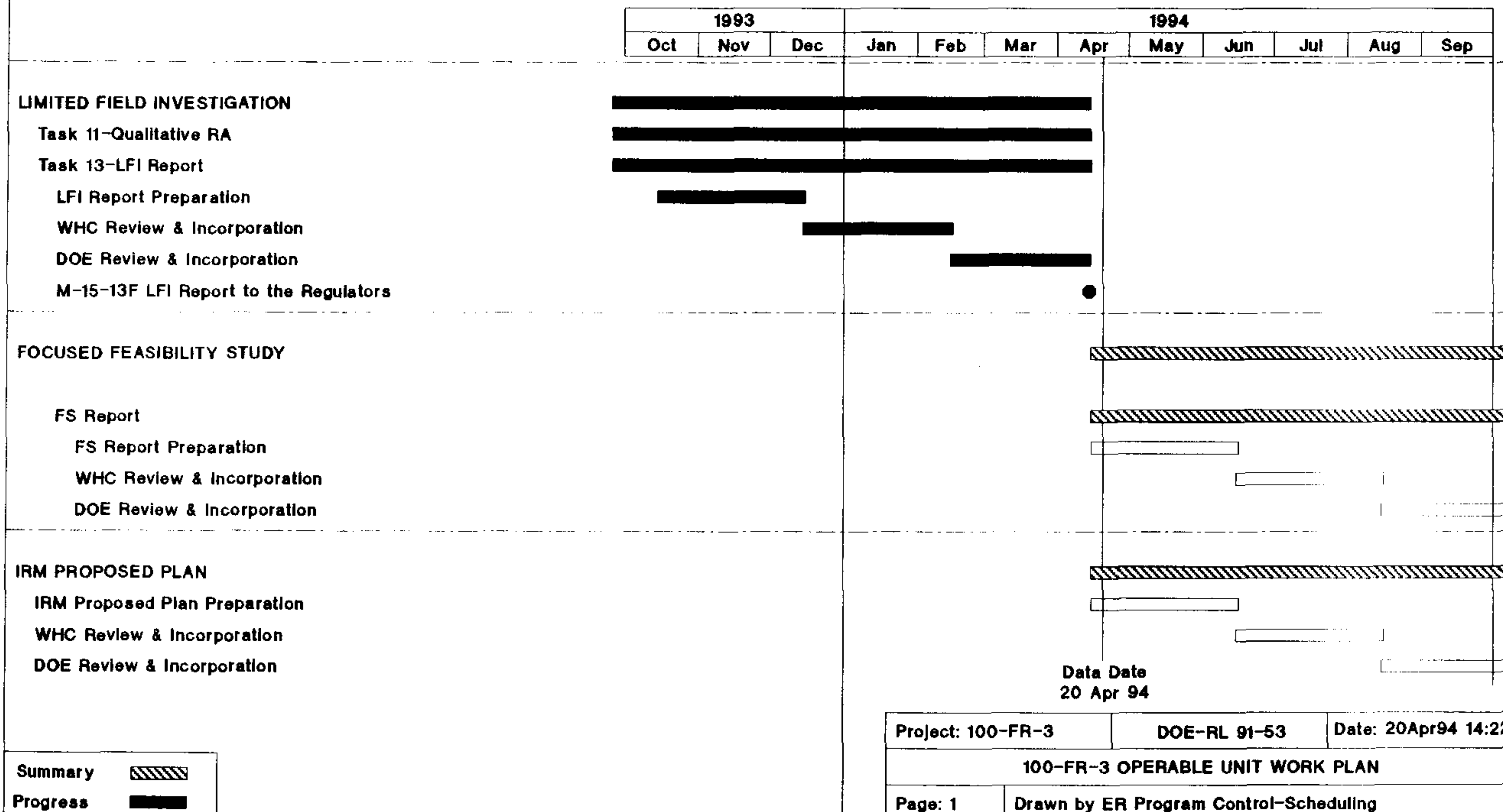

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UNIT MANAGERS' MEETING

MAY 26, 1994

100 B, 100 K, 100 D, 100 H, AND 100 F

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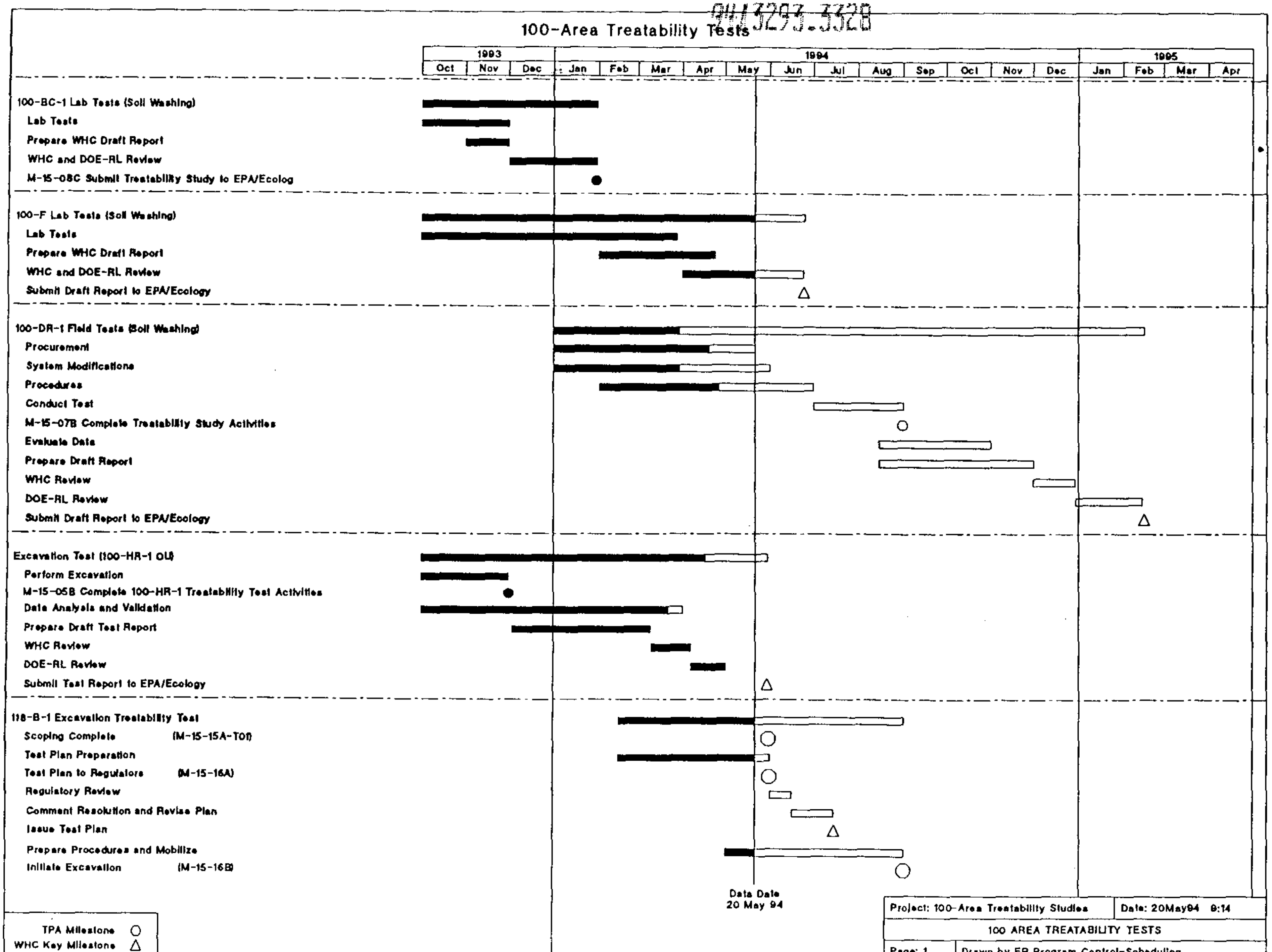

Project: 100-Area Treatability Studies	Date: 20May94 9:14
100 AREA TREATABILITY TESTS	
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Treatability Studies

118-B-1 EXCAVATION TREATABILITY TEST

The DOE review of the test plan has been completed; the document has been revised and transmitted to the regulatory agencies for review meeting TPA milestone M-15-16A.

116-F-4 TREATABILITY TEST PLAN

The DOE review of the test plan has been completed and the document is being revised. The document should be ready for transmittal to the regulatory agencies in late June.

100-HR-3 GROUNDWATER TREATABILITY TEST

The required test documentation is currently being prepared and procurement of miscellaneous equipment has been initiated. The cultural resource review and biological evaluation for the affect area have been completed.

Co-Disposal

A revised draft of the document (Draft A) was transmitted by DOE-RL to the regulatory agencies for review and comment.

Ex Situ Vitrification

Vortec Combustion and Melting System

WHC began working with Vortec Corp. and Roy F. Weston Co. (the design engineering sub-contractor selected by Vortec) to design the combustion and melting system. Specific information concerning the radioactivity, chemical contamination levels and physical properties of soils from potential sites has been sent to Vortec and Weston.

100 Area Soil Washing

Alternative strategies and schedules for the 100-DR-1 soil treatability test are being discussed. A change form is being prepared.

Draft procedures for the 100-DR-1 pilot scale soil washing tests are on schedule for concurrent review by RL and the regulators by June 17.

The 100-F soil washing report was completed and submitted to WHC and RL for review. Comments will be incorporated and the document submitted for regulator review by June 10.

INSITU FLOW SENSORS - HR-3

The installation of insitu flow sensors was completed the first week of May. Sensors were installed adjacent to wells H4-7, H4-12A & B, and H3-2A in proximity to the 183-H Solar Basin in H Reactor area. The proposed completion adjacent to H4-9 was canceled due to a limited saturated zone at that location. The sensor for this location was moved to H4-12B to provide Ringold information adjacent to the planned Hanford formation sensor. The probe installed at this location apparently leaked and failed, so a replacement probe was installed proximate to the original. The proposed completion adjacent to H4-14 was relocated to H3-2A in anticipation of future use on H4-14 as an extraction well for chromium treatment.

The four probes are functioning properly with good signal response. Intermittent problems with the remote access phone modem are currently being worked out.

B AREA

100-BC-1 QRA and LFI Reports

TASK 11: 100-BC-1 QRA (WHC-SD-EN-RA-003, Rev. 0) has been reviewed by the regulators. Comment resolutions were agreed upon and are currently being incorporated into the document for release as Rev. 0.

TASK 13: 100-BC-1 LFI (DOE/RL-93-06 Rev. 0) was given to DOE on April 19 for distribution to the regulators.

100-BC-1 FFS Report

Task was initiated in January, 1994 and is currently on schedule.

100-BC-2 QRA and LFI Reports

TASK 11: The 100-BC-2 QRA was initiated in January, 1994 and is currently on schedule. The WHC internal draft has been received and is in WHC review.

TASK 13: The 100-BC-2 LFI was initiated in January, 1994 and is currently on schedule. The WHC internal draft has been received and is in WHC review.

100-BC-5 QRA and LFI Reports

TASK 11: 100-BC-5 QRA (WHC-SD-EN-RA-006, Rev. 0) has been reviewed by the regulators. Comment resolutions were agreed upon and are currently being incorporated into the document for release as Rev. 0.

TASK 13: 100-BC-5 LFI (DOE/RL-93-37 Draft A) has been reviewed by the regulators. Comment resolutions were agreed upon and are currently being incorporated into the document for release as Rev 0.

100-BC-5 FFS Report

Task was initiated in January, 1994 and is currently on schedule. Discussions are ongoing as to the format and content of the document.

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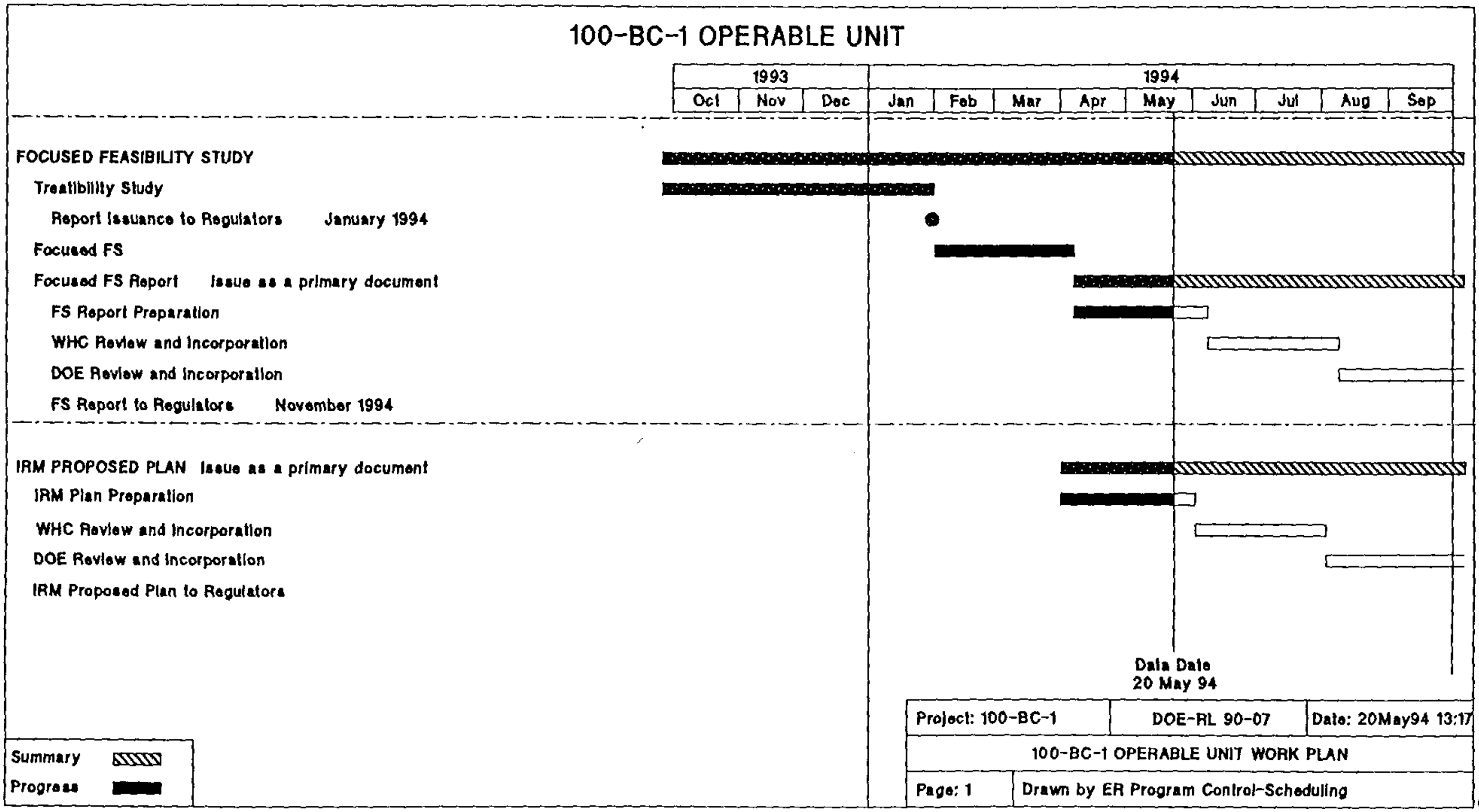

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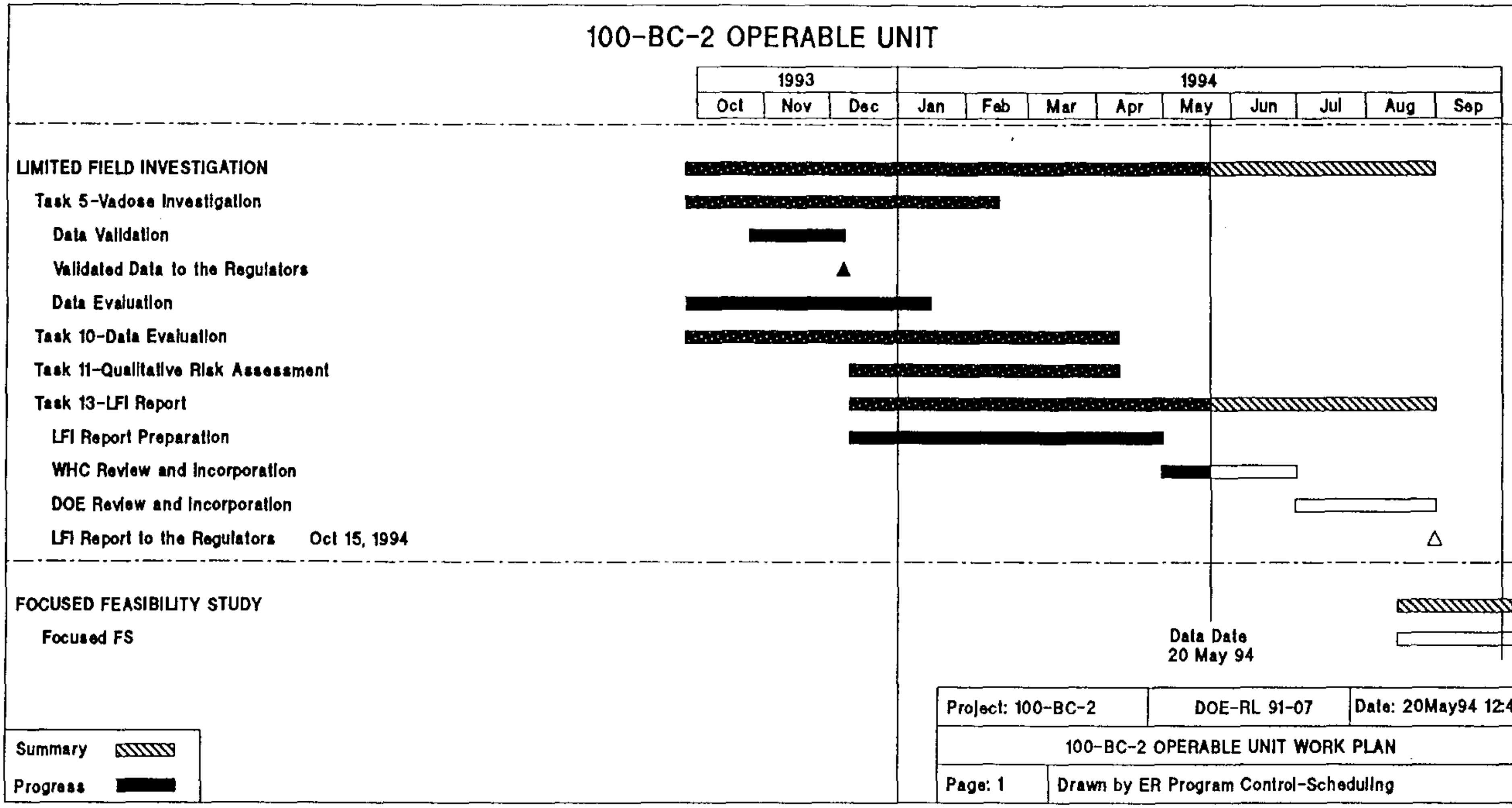

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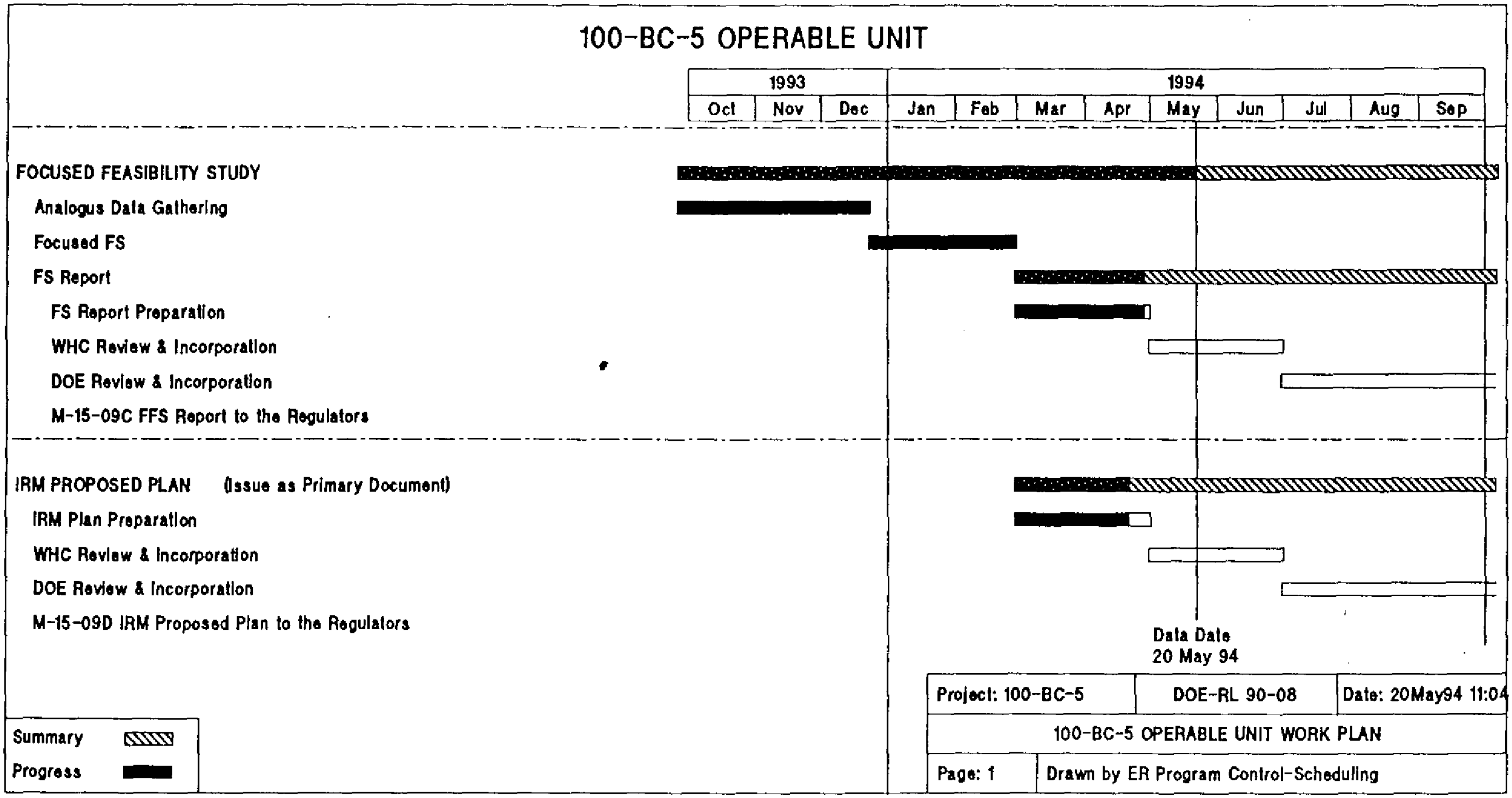


K AREA

100-KR-1 QRA and LFI Reports

Task 11: Regulator comments on 100-KR-1 QRA (WHC-SD-EN-RA-009, Rev. 0) were received on April 14, 1994. DOE provided direction to initiate developing responses on May 10, 1994. EPA has requested responses by May 18, 1994.

Task 13: Regulator comments on 100-KR-1 LFI (DOE/RL 93-78, Draft A) were received on April 14, 1994. DOE provided direction to initiate developing responses on May 10, 1994. EPA has requested responses by May 18, 1994.

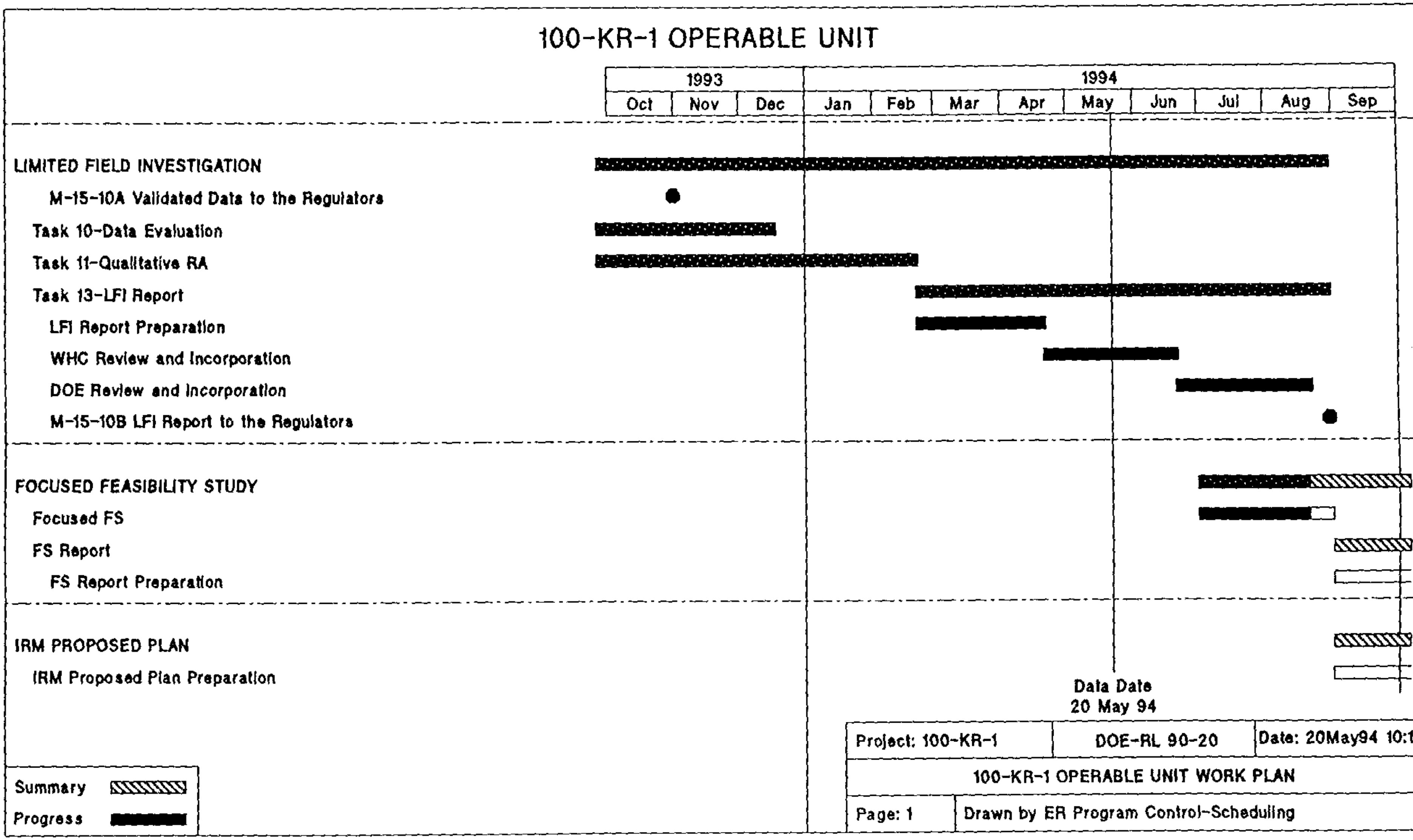
100-KR-4 QRA and LFI Reports

Task 11: A meeting was held with EPA on April 26, 1994 to discuss DOE responses to regulator comments on 100-KR-4 QRA (WHC-SD-EN-RA-010, Rev 0). Agreement was reached on all comments and the QRA is being revised.

Task 13: Meetings were held with EPA on April 26 and 28, 1994 to discuss DOE responses to regulator comments on 100-KR-4 LFI (DOE/RL-93-79, Draft A). Agreement was reached on all comments and the LFI is being revised.

Focused Feasibility Study

Work was initiated on the 100-KR-1 and 100-KR-4 Focused Feasibility Studies.


100-KR-1 OPERABLE UNIT
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LIMITED FIELD INVESTIGATION
M-15-10A Validated Data to the Regulators
Task 10-Data Evaluation
Task 11-Qualitative RA
Task 13-LFI Report
LFI Report Preparation
WHC Review and Incorporation
DOE Review and Incorporation
M-15-10B LFI Report to the Regulators
FOCUSED FEASIBILITY STUDY
Focused FS
FS Report
FS Report Preparation
IRM PROPOSED PLAN
IRM Proposed Plan Preparation
Data Date
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Project: 100-KR-1
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100-KR-1 OPERABLE UNIT WORK PLAN
Page: 1
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Summary
Progress

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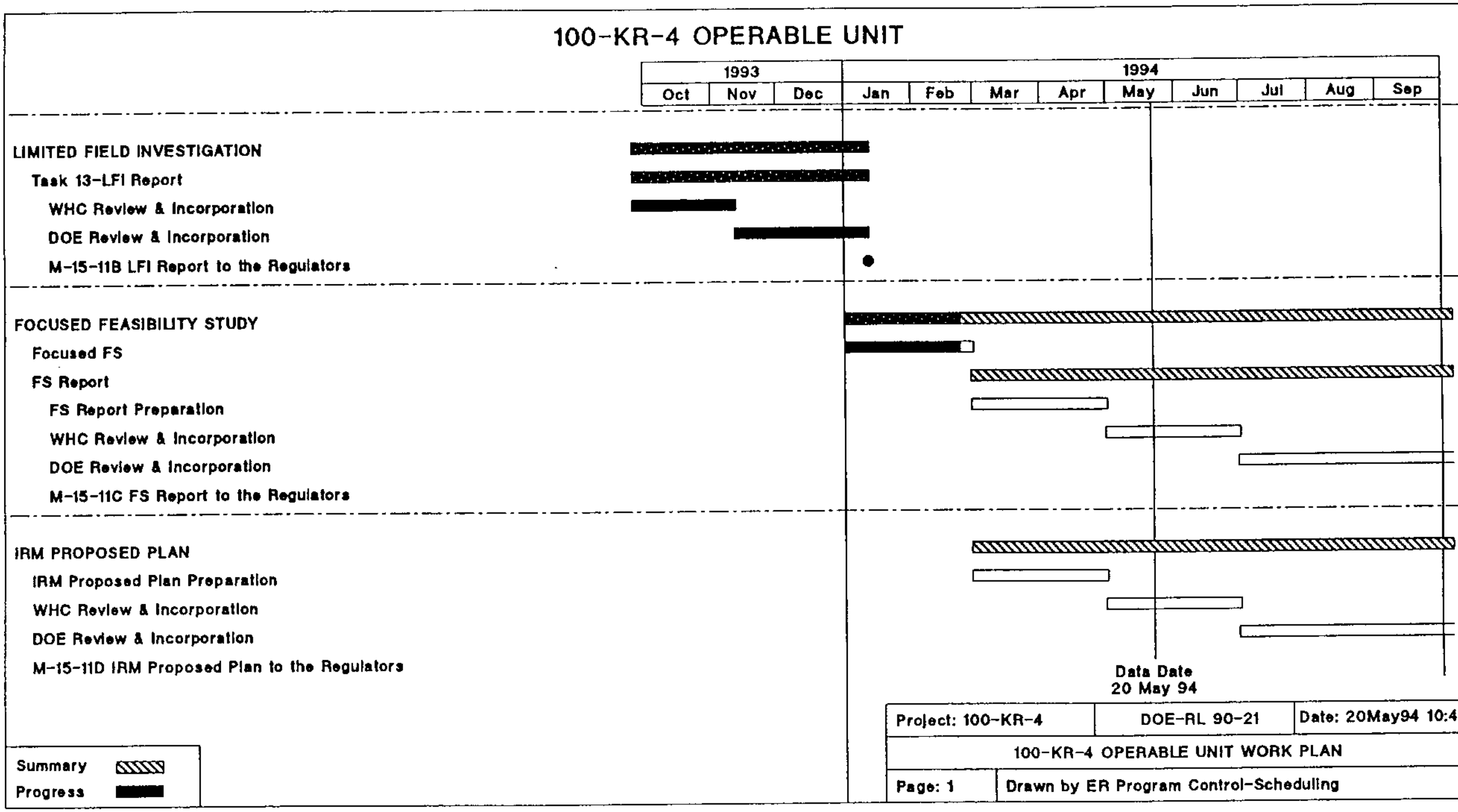

D AREA

100-DR-1

100-DR-1 Focused Feasibility Study

- 100-DR-1 Focused Feasibility Study report is being prepared by IT and is on schedule for mid-June WHC review.

100-DR-2

100-DR-2 Work Plan

- A change control form C-93-01 was approved on April 14, 1994, by DOE-RL, Ecology and EPA. The change control combines 100-DR-3 Operable Unit into 100-DR-2 Operable Unit. The new milestone, M-13-09, for the combined document is September 6, 1994.

  The redlined copy of the changes due to addition of 100-DR-3 into 100-DR-2 are being reviewed by WHC. The document is scheduled for DOE-RL review on 6-24-94.

100-DR-2 LFI Report

- The LFI report was initiated on March 15, 1994, and is progressing on schedule. The document will be a combined LFI/QRA.

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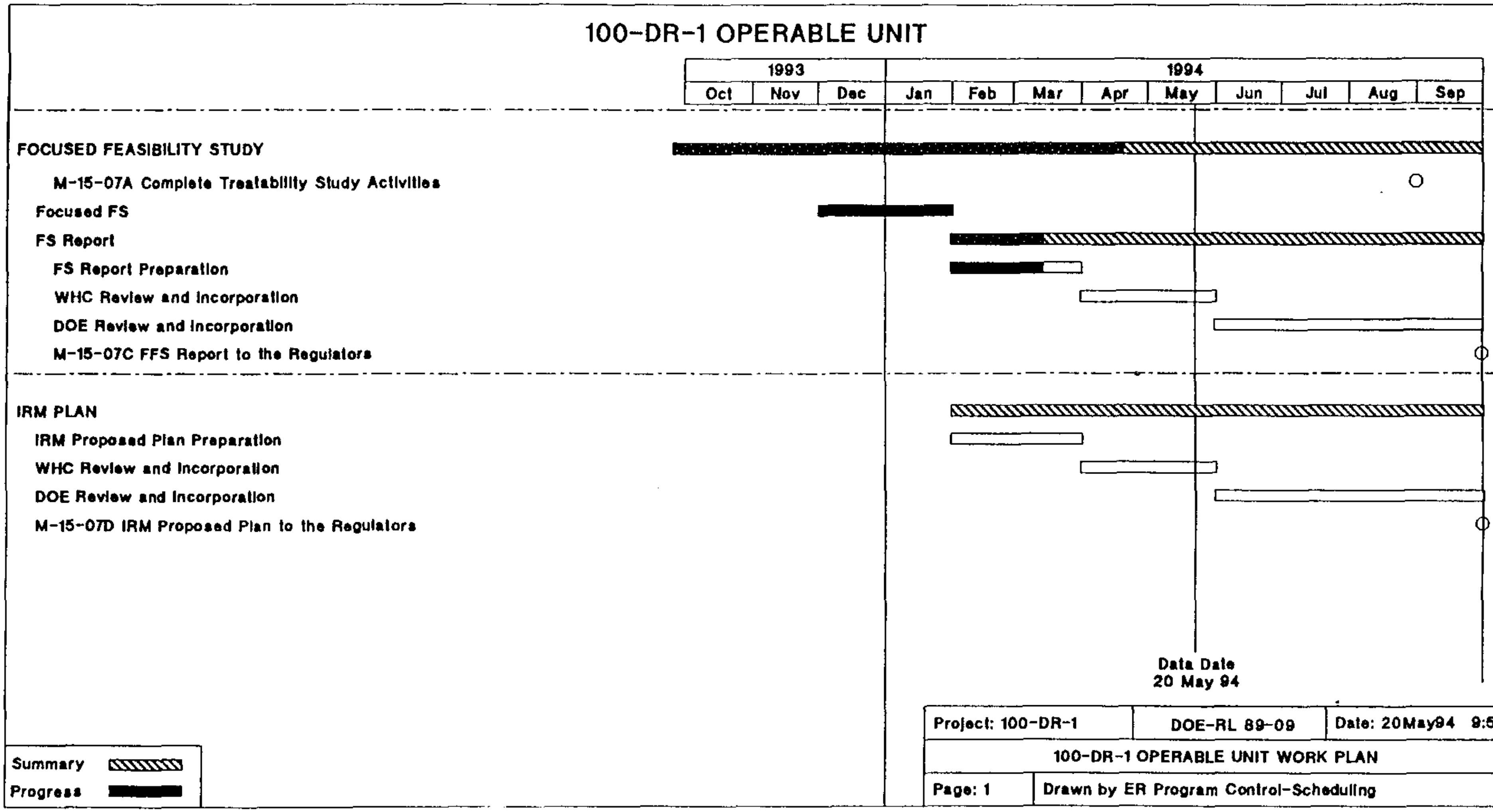

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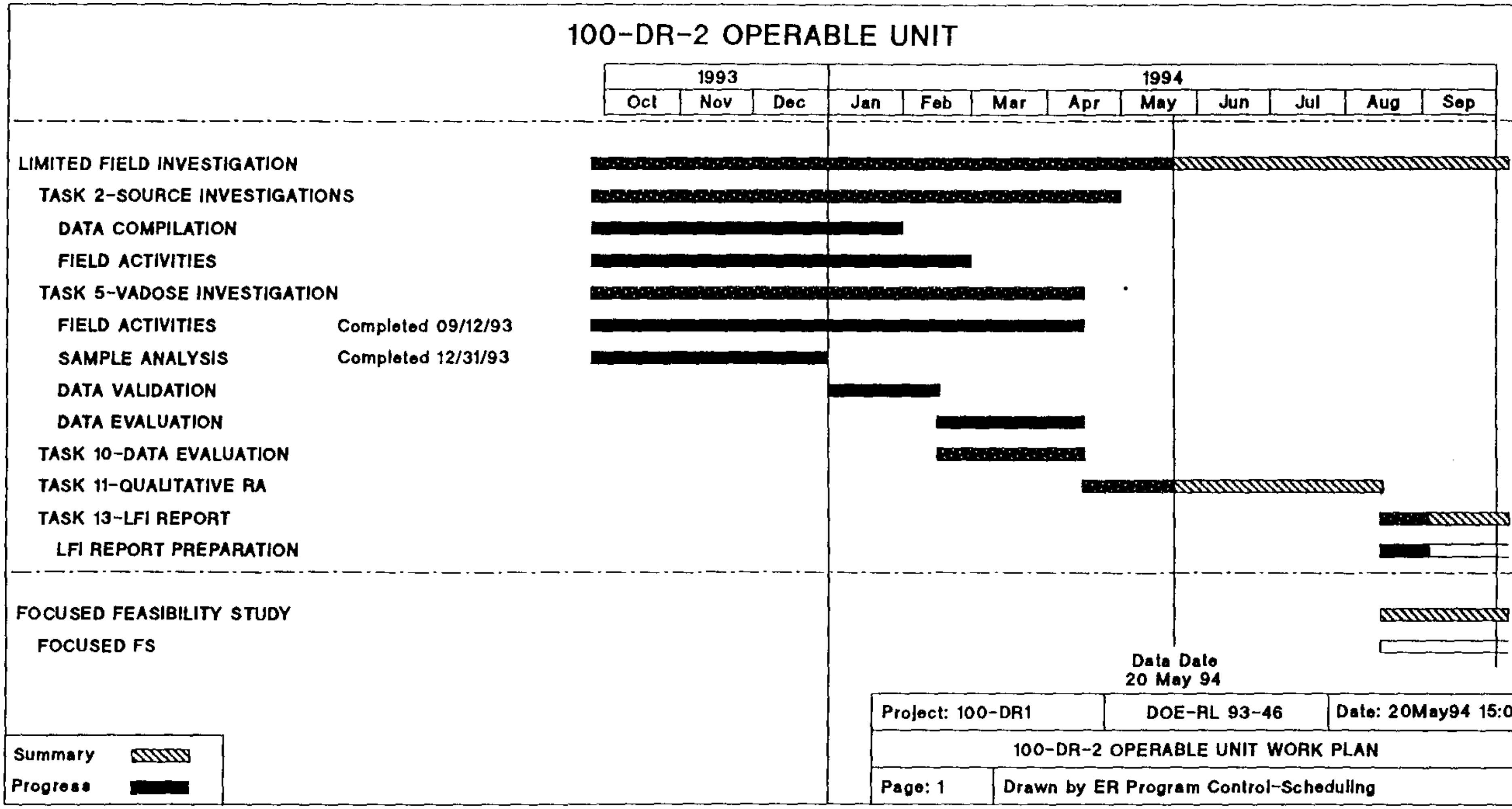

H area

100 HR-1

- Task 11: QRA Report- Work is being completed on an errata sheet for incorporation into the 100-HR-1 QRA (WHC-SD-EN-RA-004, Rev. 0) document.

- Task 12: LFI Report- Regulator comments on the 100-HR-1 LFI (DOE/RL-93-51 Rev. 0) have been incorporated and it will be submitted to DOE/RL in mid-May.

100-HR-2

PLANNING DOCUMENT: Public review comment responses were transmitted to DOE on May 11, 1994.

100-HR-2 RADIOLOGICAL SURFACE SURVEY: The surface rad survey for 100-HR-2 is 95% complete.

TASK 11 and TASK 13 - QRA and LFI REPORT: The report was sent out for internal WHC review May 9, 1994. Comments are due in by May 31, 1994.

FOCUSED FEASIBILITY STUDY REPORT: The preparation of this report began with the kick-off meeting held April 19, 1994

100-HR-3

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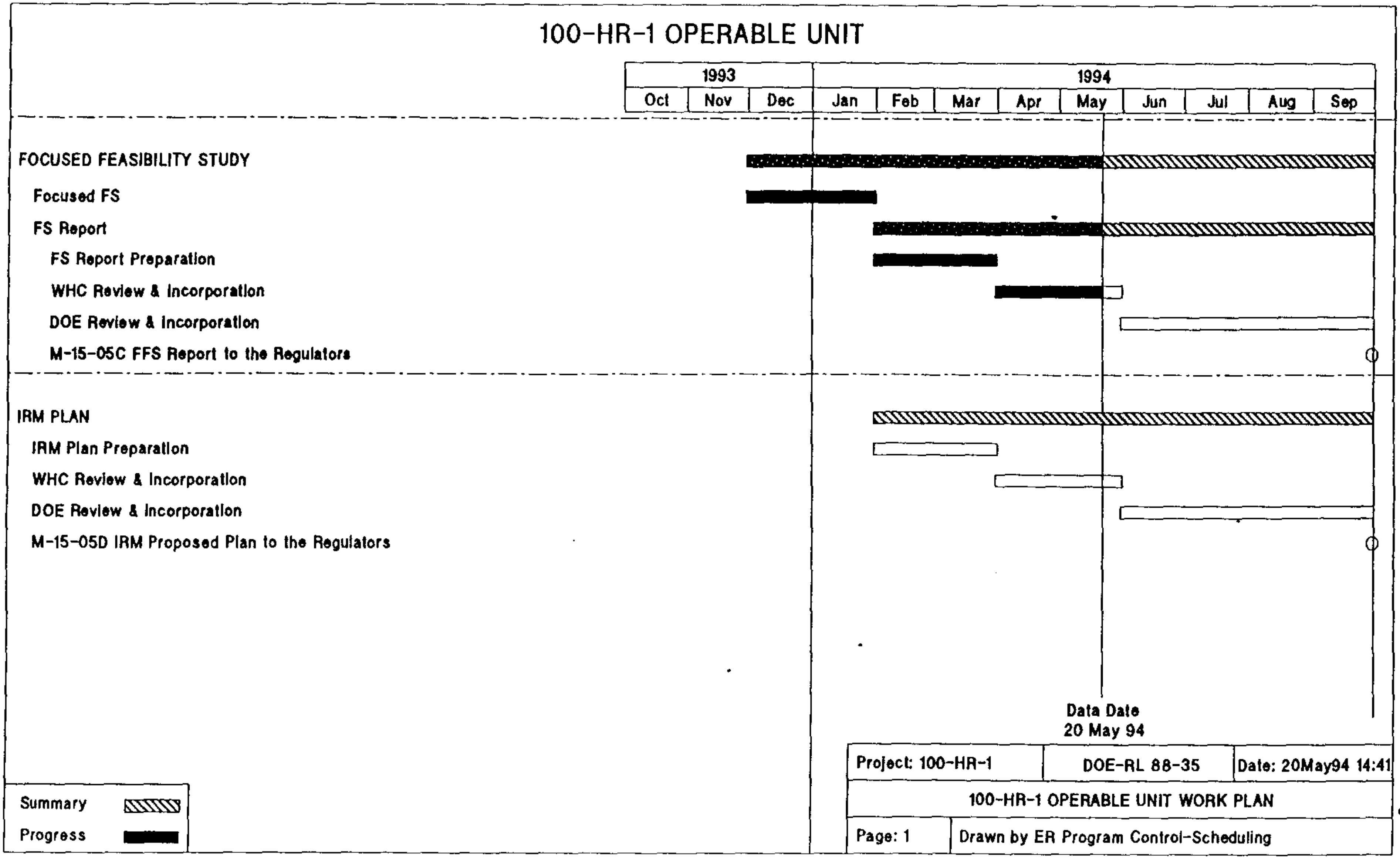

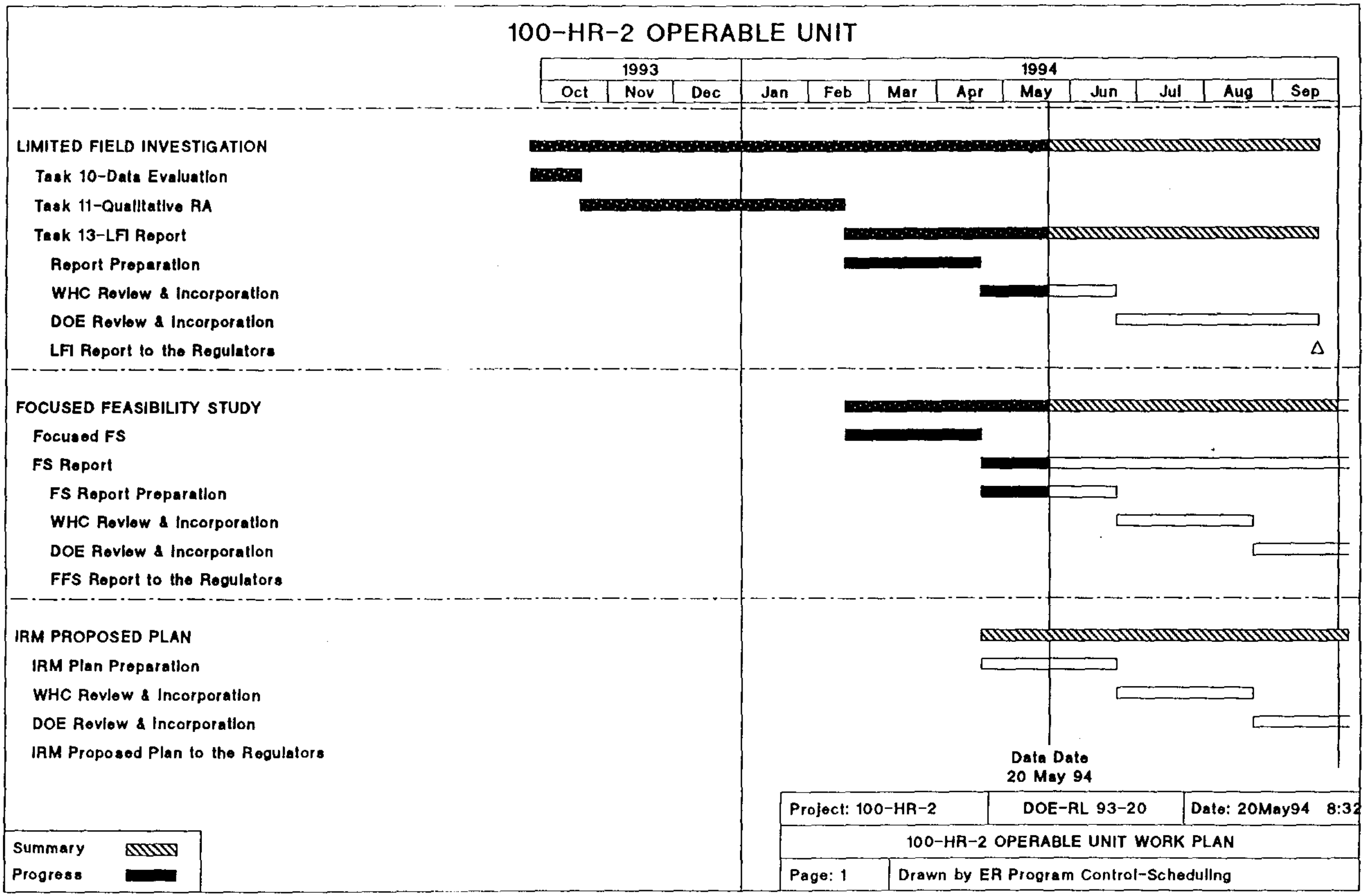
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LIMITED FIELD INVESTIGATION
Task 10-Data Evaluation
Task 11-Qualitative RA
Task 13-LFI Report
Report Preparation
WHC Review & Incorporation
DOE Review & Incorporation
LFI Report to the Regulators
FOCUSED FEASIBILITY STUDY
Focused FS
FS Report
FS Report Preparation
WHC Review & Incorporation
DOE Review & Incorporation
FFS Report to the Regulators
IRM PROPOSED PLAN
IRM Plan Preparation
WHC Review & Incorporation
DOE Review & Incorporation
IRM Proposed Plan to the Regulators
Data Date
20 May 94
Summary
Progress
Project: 100-HR-2
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100-HR-2 OPERABLE UNIT WORK PLAN
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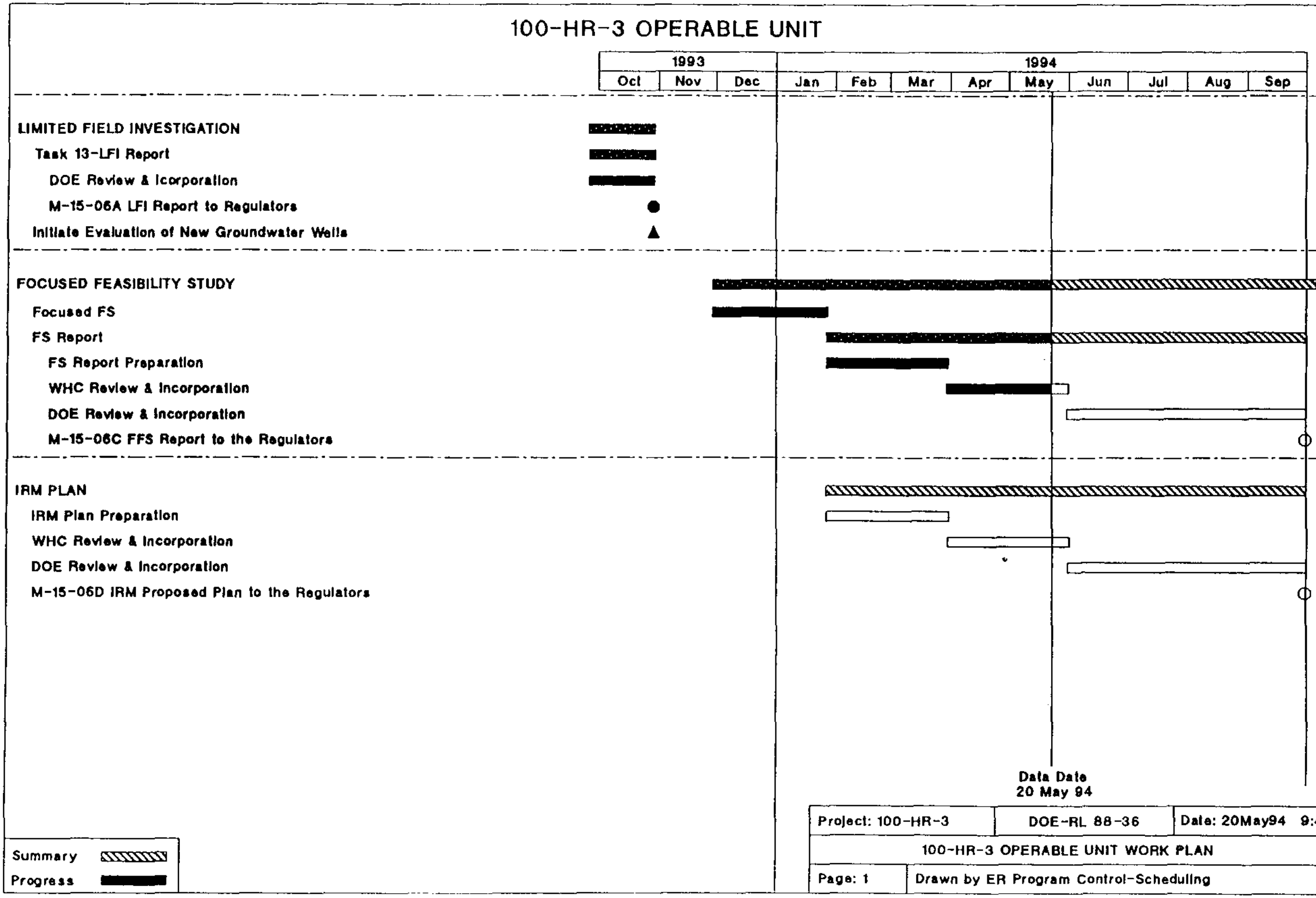

F Area

100-FR-1

TASK 11: 100-FR-1 QRA (WHC-SD-EN-RA-013, Rev. 0) is in process. The internal WHC review has been completed and the DOE review draft is due on 15 May 1994.

TASK 13: 100-FR-1 LFI (DOE/RL-93-82, Draft A) is in process. The internal WHC review has been completed and the DOE review draft is due on 15 May 1994.

100-FR-3

TASK 6 - GROUNDWATER INVESTIGATION

- The fifth round of groundwater sampling is currently in progress and is expected to be completed on May 18, 1994.

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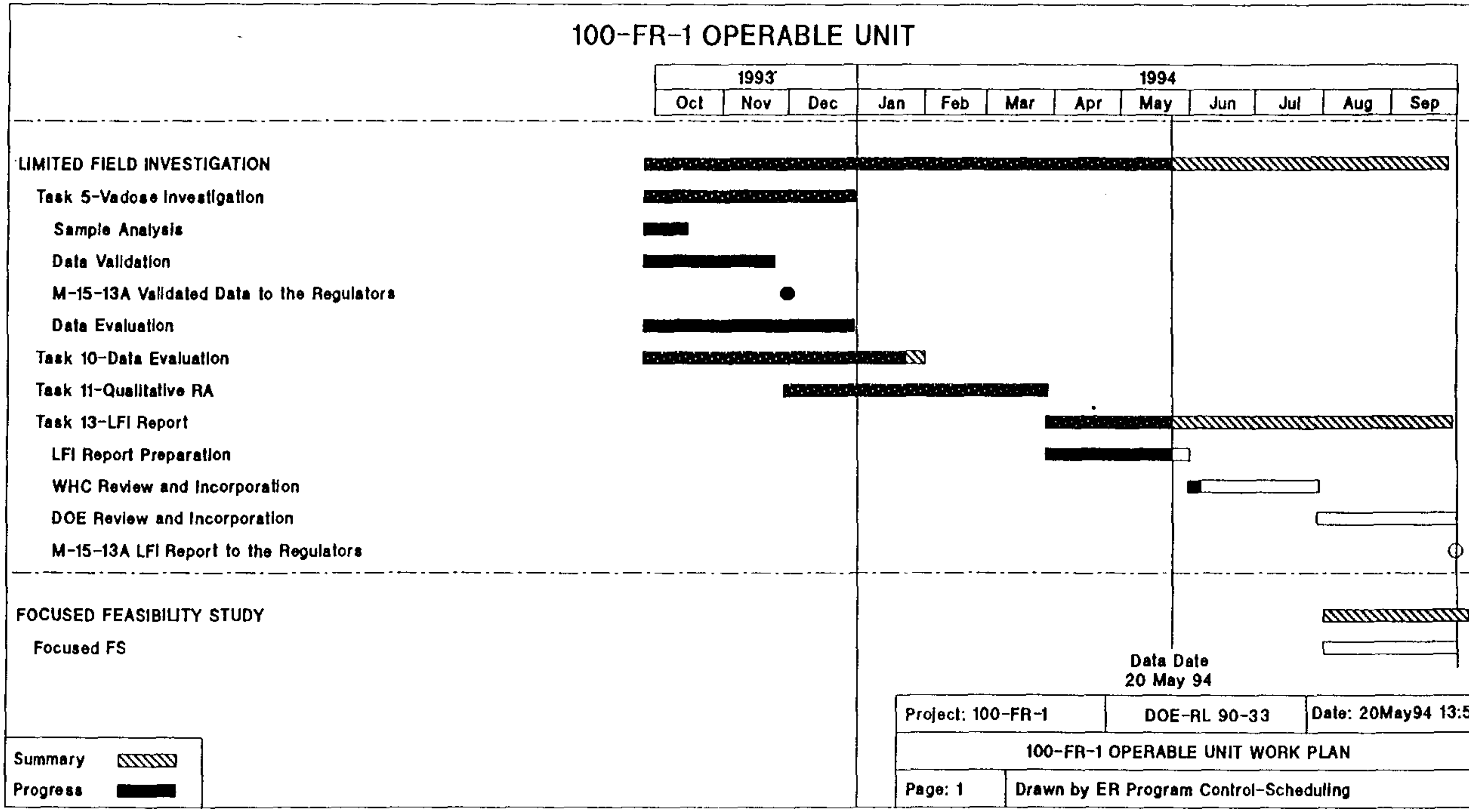

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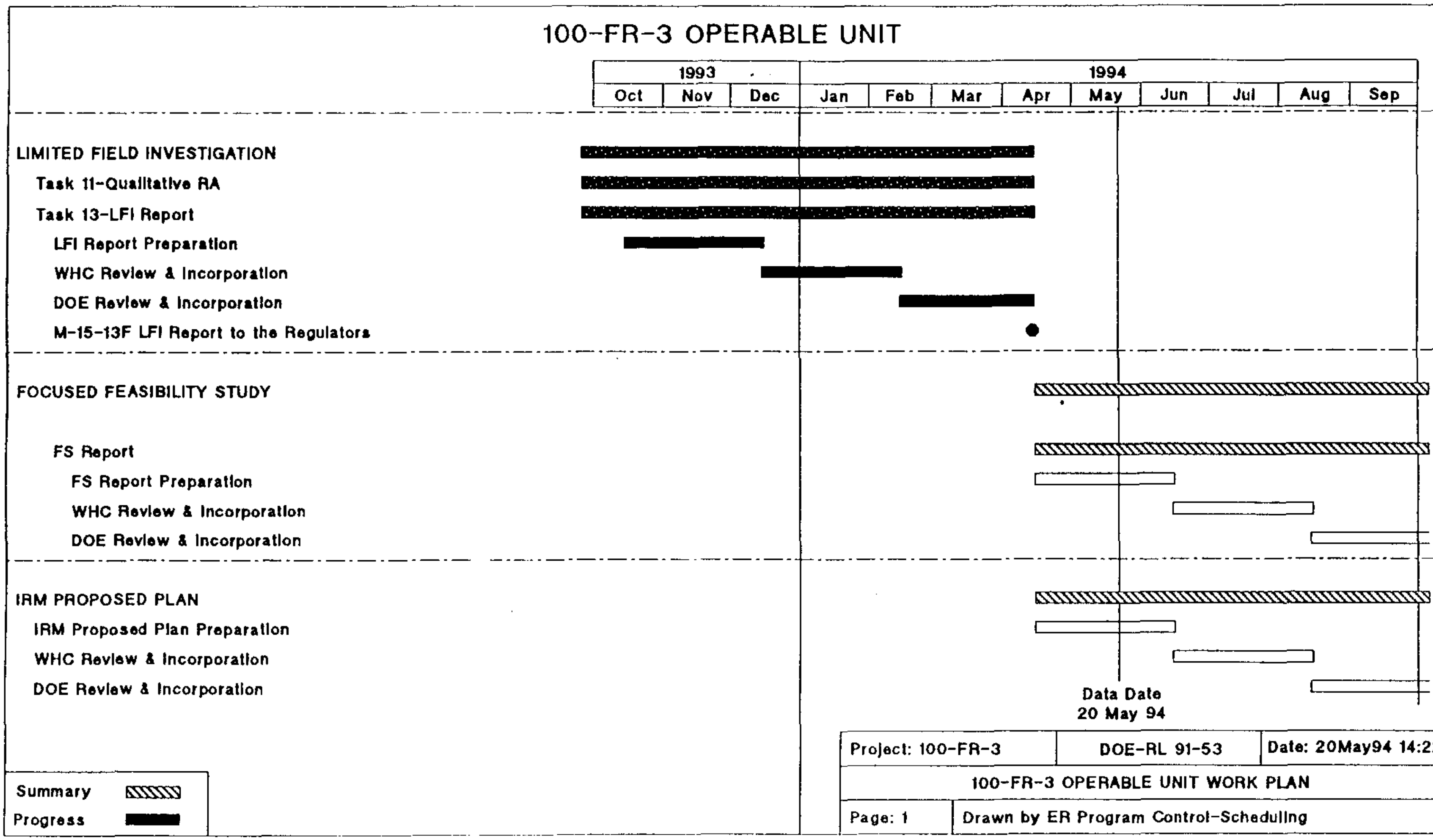

100 AREA FOCUS FEASIBILITY STUDIES APPROACH

BASIS:

- SACM (Superfund Accelerated Cleanup Model)
  - Presumptive Remedy
  - Plug in Approach
- Used for Sites with Similar Characteristics
- Approach is Designed to Reduce Cost of Cleanup Selection at Similar Types of Sites
- 100 Area FFSs Utilizing the Plug in Approach; Not the Presumption Remedy Aspects
- Consistent with HPPS and the Characterization Approach Used to Date in the 100 Area

100 Area Source OU FFS Process

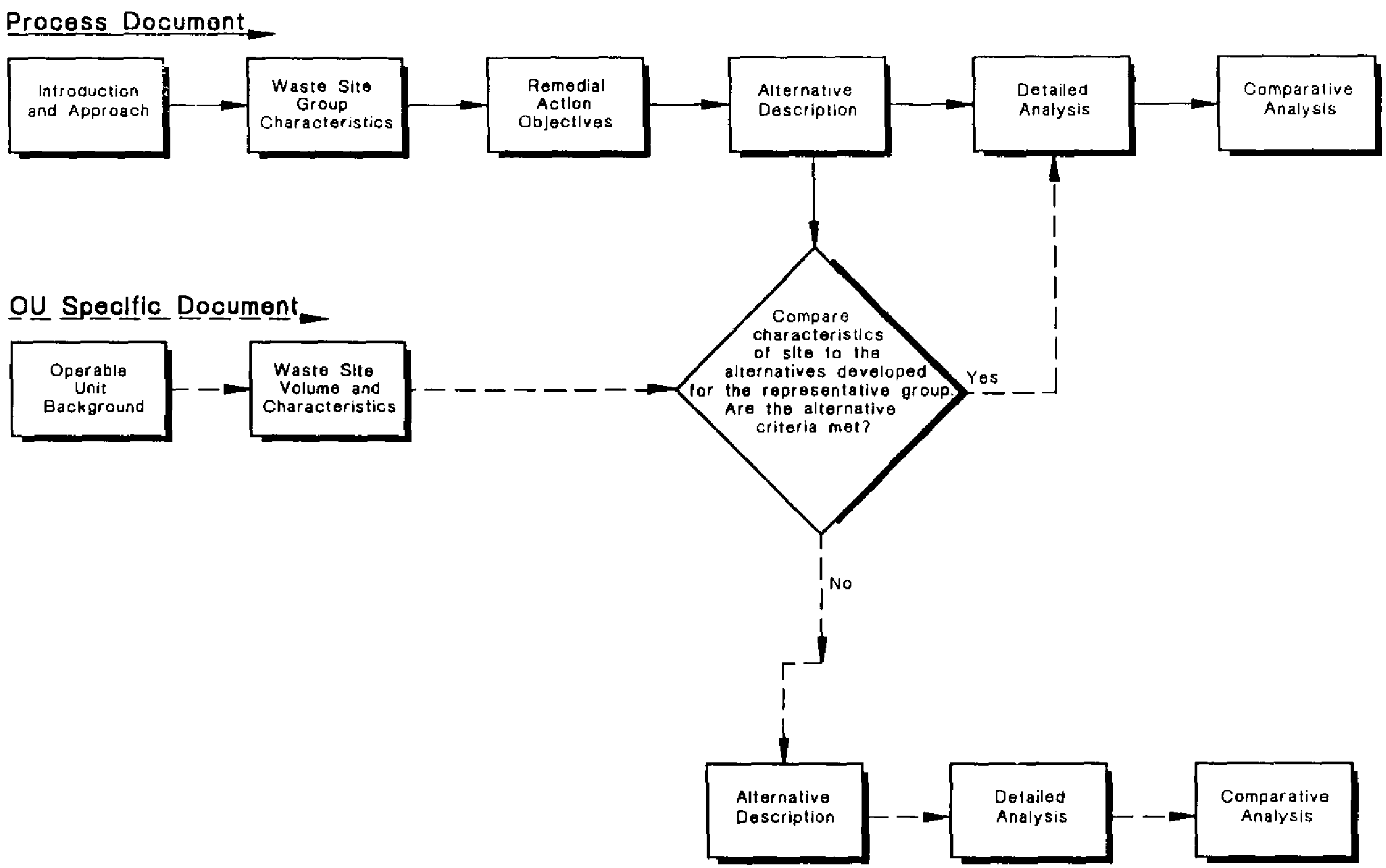

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Figure: **100 Area Source OU FFS Process**

- Process Document

  - **Introduction and Approach:** General discussion on purpose, objective, background information, and approach of focused feasibility studies.

  - **Waste Site Group Characteristics:** Waste site groups are based on media and facility use. The groups are defined as follows:

Soil Sites:	Retention Basins Trenches Cribs/French Drains Outfall Structures Pipelines
Solid Waste Sites:	D&D Sites Burial Grounds

    The group characteristics are determined based on the initial operable units (100-BC-1, 100-DR-1, and 100-HR-1). The group characteristics are meant to provide a general profile for that group.

  - **Remedial Action Objectives:** Discusses the elements required to determine the remedial action objectives and preliminary remediation goals.

  - **Alternative Description:** Brings forward the technologies, process options, and alternatives from the Phase 1 & 2 FS. Provides a discussion on the criteria which must be met for an alternative to be effective for a given waste site group.

  - **Detailed & Comparative Analyses:** The detailed and comparative analyses are accomplished by waste site group. Detailed analysis involves discussion of how each alternative for a waste group meets the nine criteria specified in the EPA RI/FS Guidance Document. Comparative analysis involves discussion the relative performance of each alternative for each waste group with respect to the nine criteria.

- OU Specific Document

  - **OU Background:** Provides specific information with respect the operable unit setting and investigations.

- **Waste Site Volume and Characteristics:** Provides the information on a waste site which is required to determine if its respective groups alternatives are applicable.

- **Comparison Block:** This is the point at which the plug-in occurs.

  The steps in the plug in approach are as follows:

  1. Develop waste site group characteristics.
  2. Identify the alternative criteria.
  3. Perform group-based analysis of alternatives.
  4. Develop waste site-specific profile (characteristics).
  5. Identify representative group for the waste site.
  6. Compare site characteristics to the alternative criteria.

     - if alternative criteria are met, the waste site plugs into the analysis of the alternative for the group; however, site-specific volume and cost estimates will be performed

     - if alternative criteria are not met, the waste site does not plug into the analysis of alternative for the group. Enhancements to the alternative will be documented. A re-evaluation of the alternative is performed and documented in the detailed and comparative analyses

Figure: **100 Area Source OU FFS Decision Diagram**

- This figure represents the thought process and decisions required prior to initiating the focused feasibility studies.

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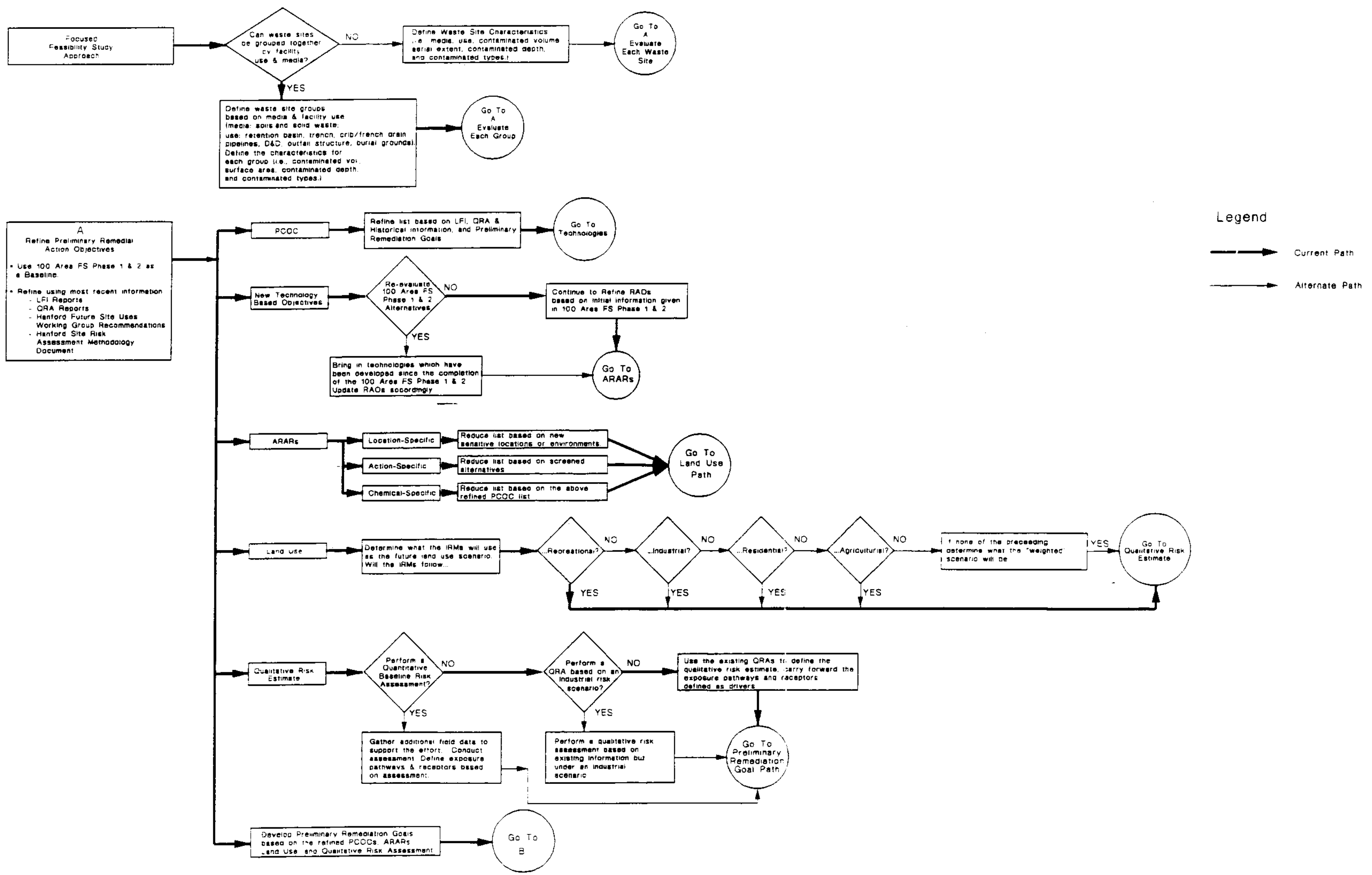
100 Area Source OU FFS Decision Diagram



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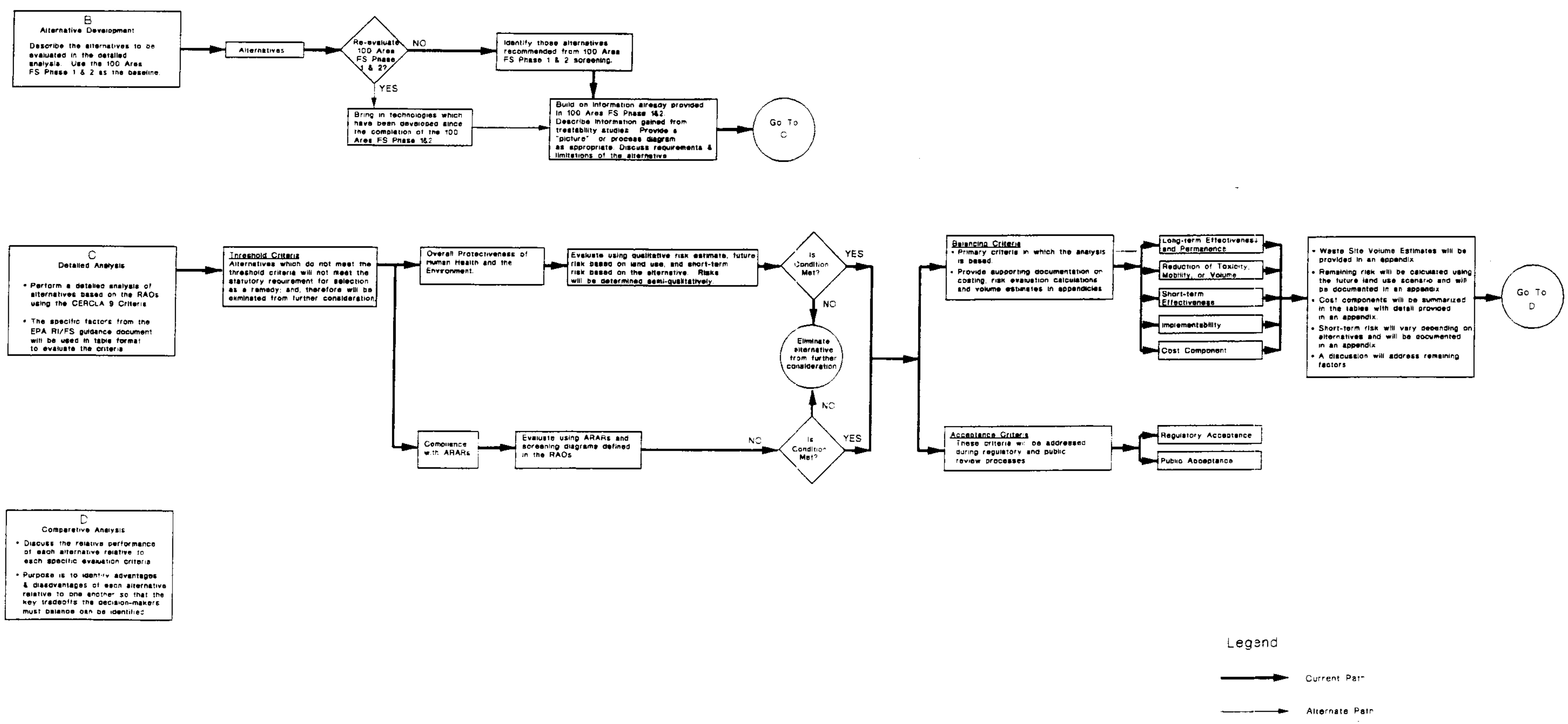
100 Area Source OU FFS Decision Diagram



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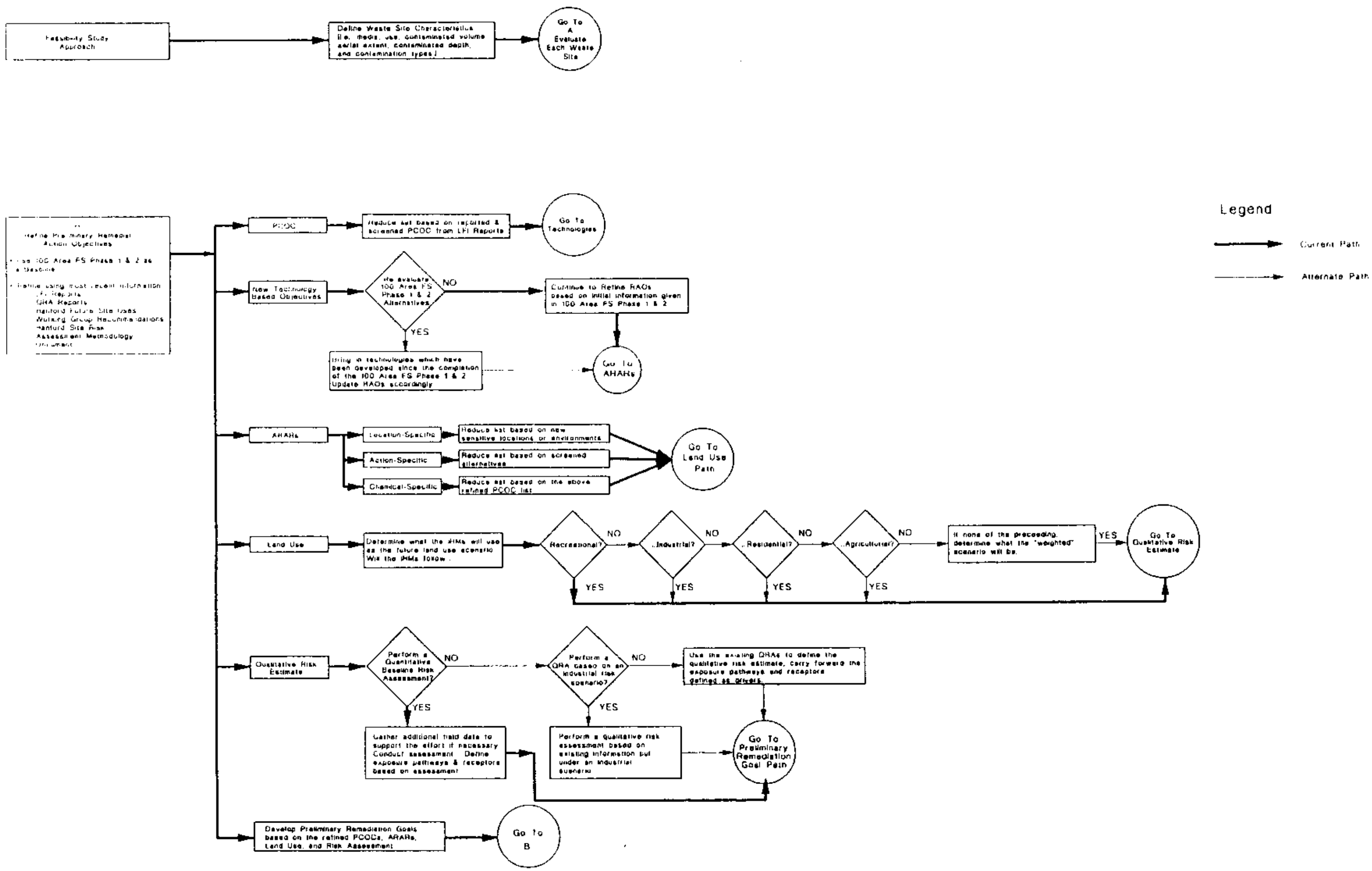
100 Area Groundwater Operable Unit Feasability Study Diagram



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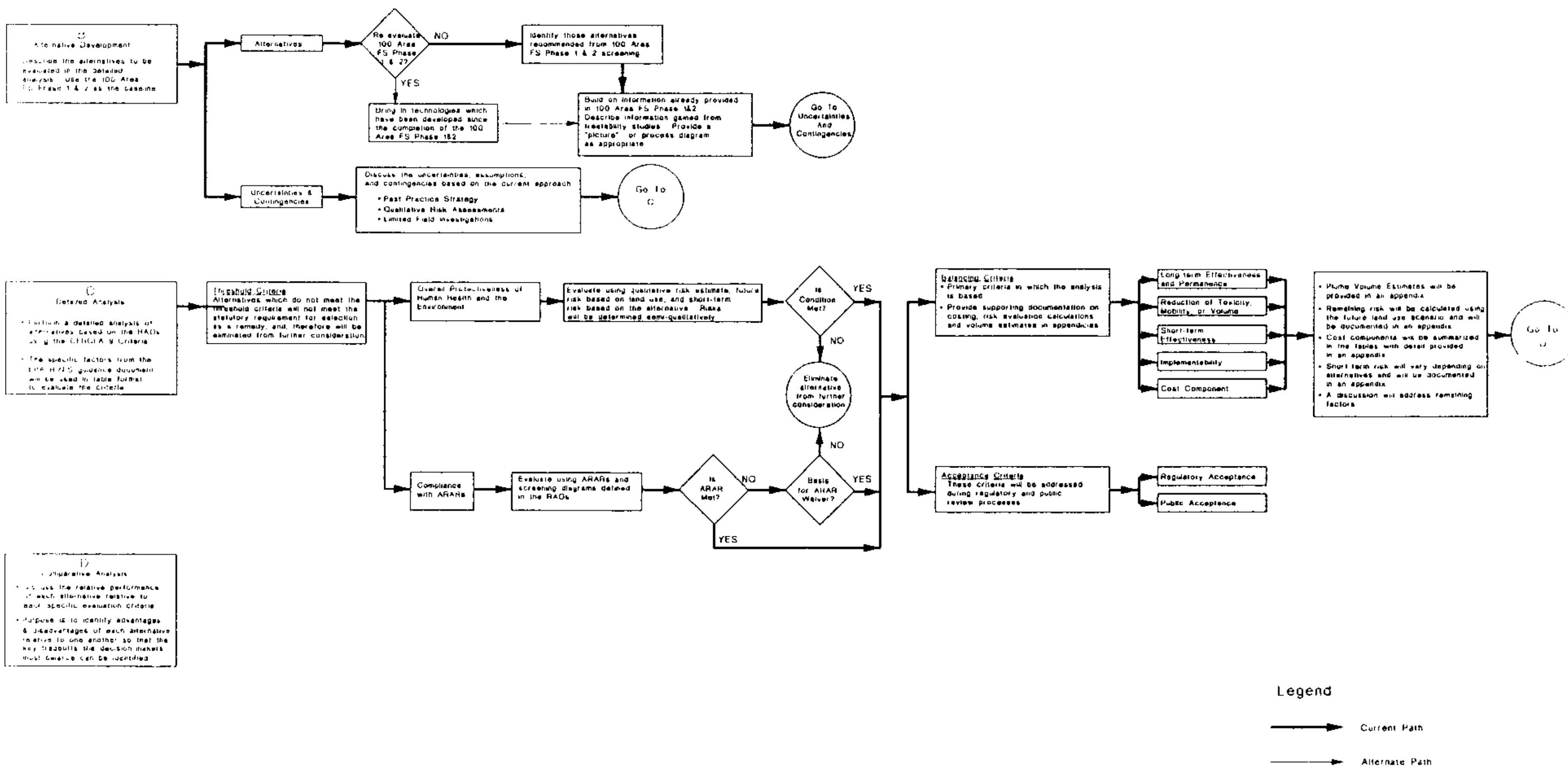
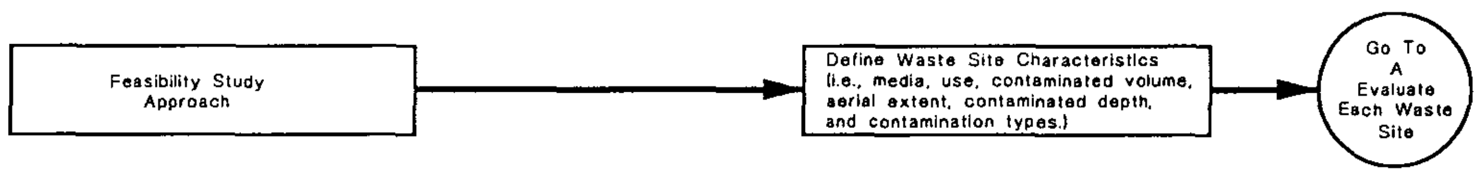
100 Area Groundwater Operable Unit Feasability Study Diagram





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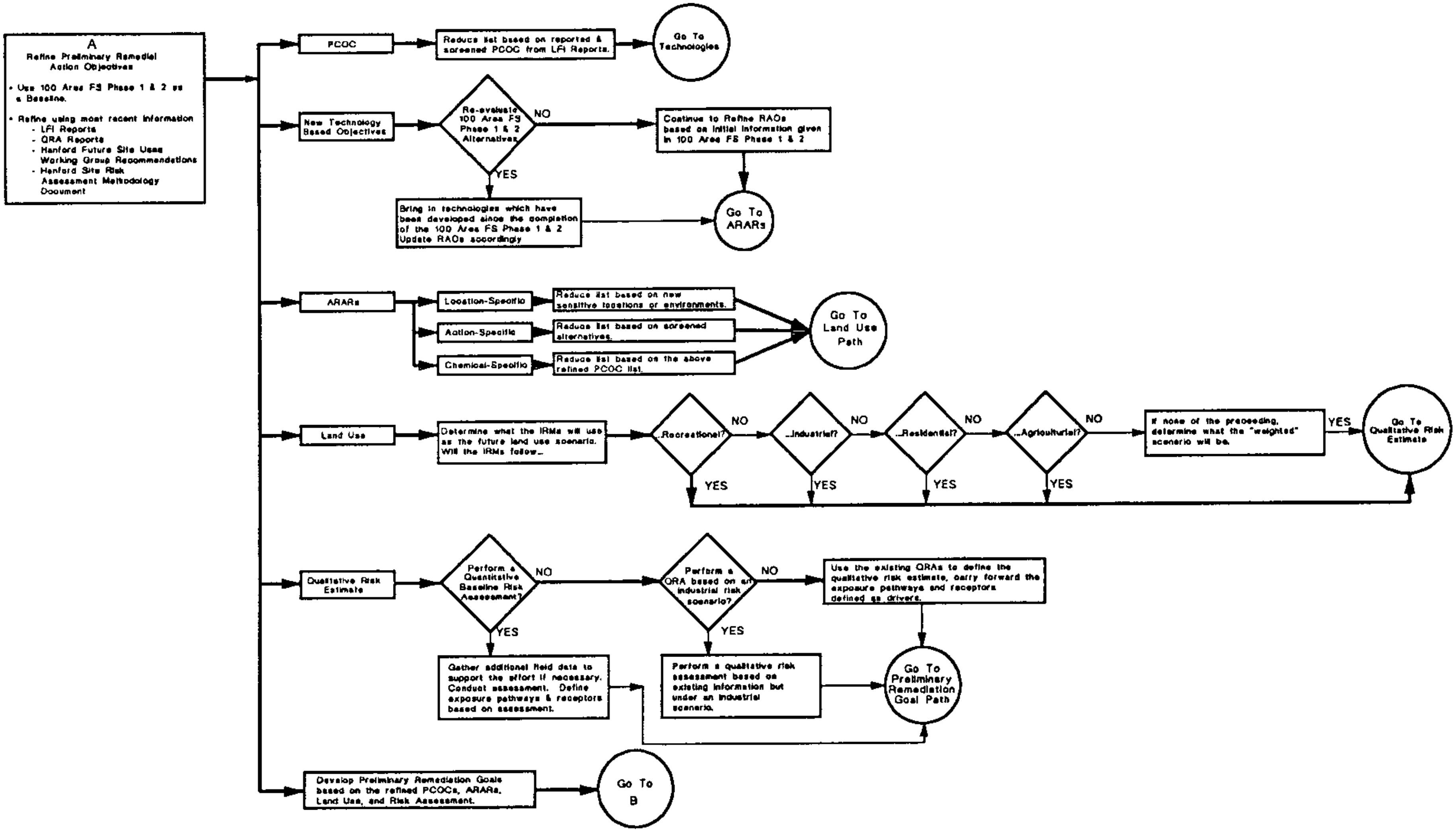

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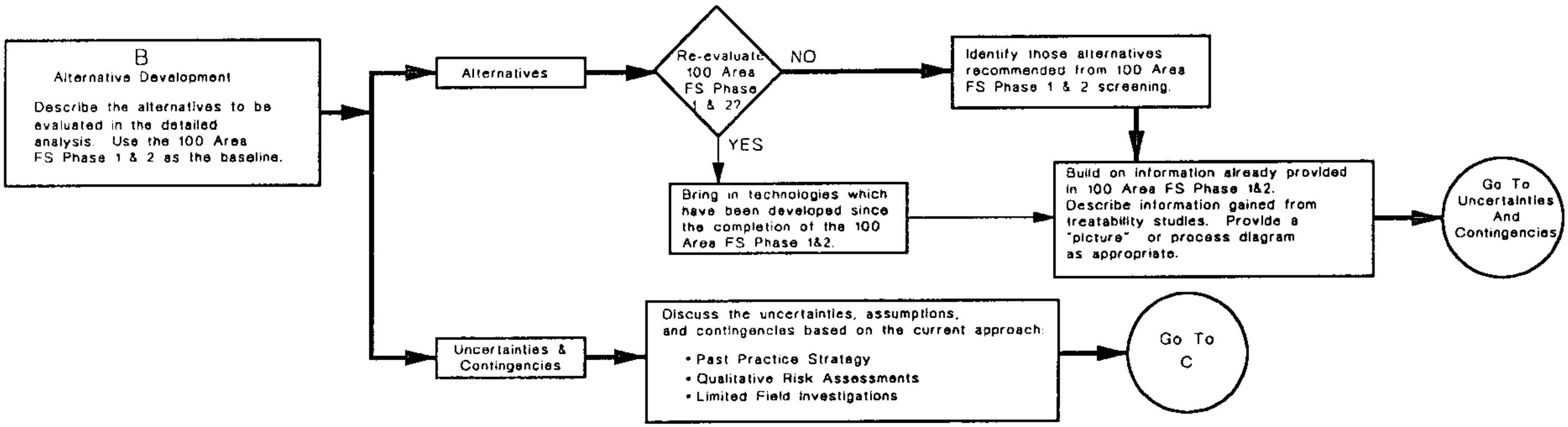

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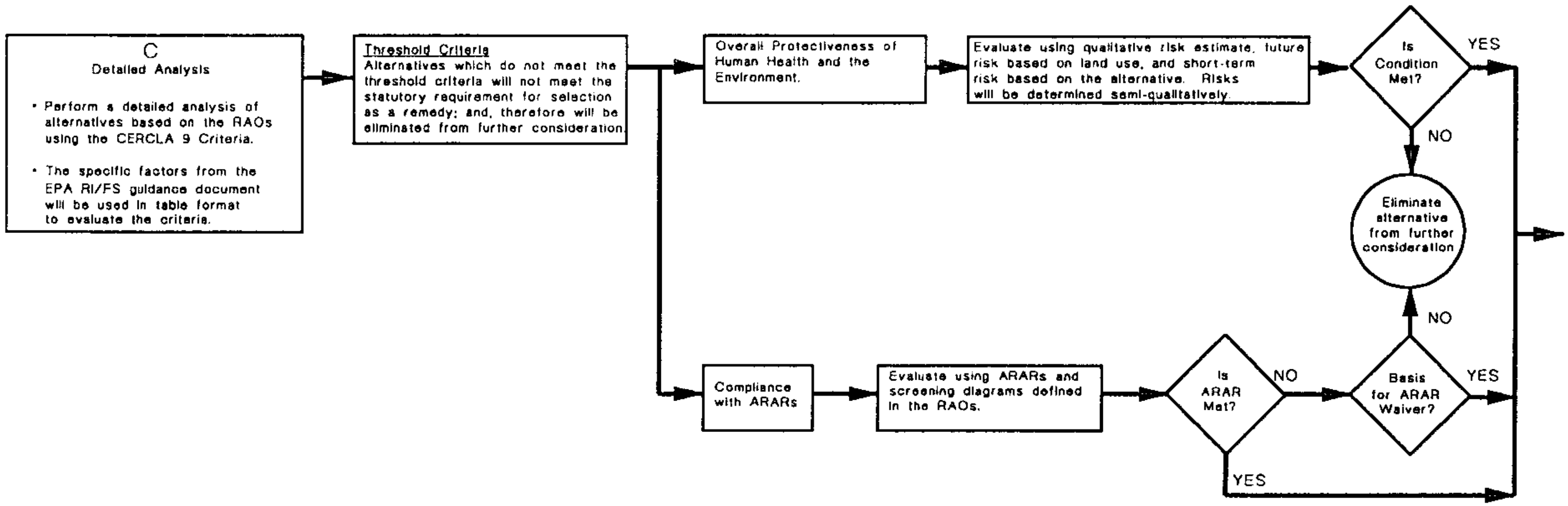

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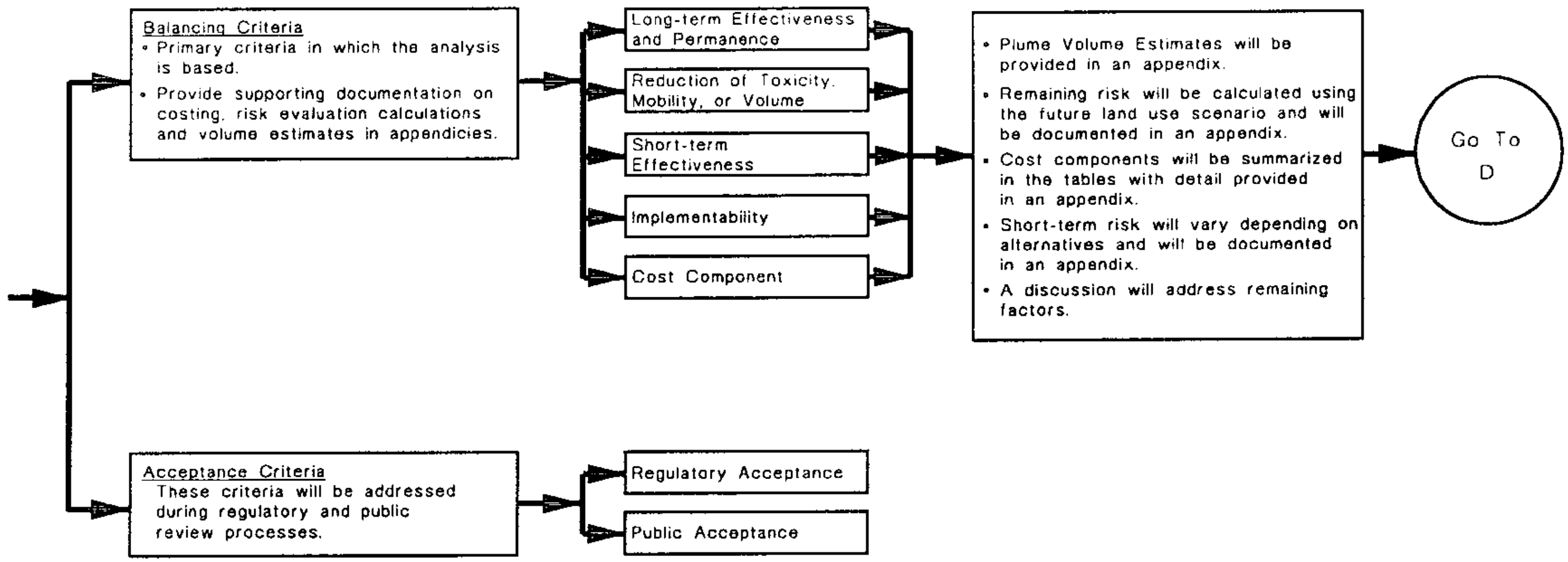
INTERNATIONAL TECHNOLOGY CORPORATION



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INTERNATIONAL TECHNOLOGY CORPORATION

100 AREA GROUNDWATER FOCUSED FEASIBILITY STUDY METHODOLOGY DOCUMENT

1.0 INTRODUCTION

A description of the regulatory framework of the RI/FS program including CERCLA, RCRA, Tri-Party Agreement, and the Hanford Past-Practice Strategy

1.1 PURPOSE AND SCOPE

The definition of an FFS as presented in the Hanford Past-Practice Strategy; a discussion of FFS objectives, scope, and organization

1.2 REPORT ORGANIZATION

A summary of the report organization.

1.3 SUMMARY OF THE HANFORD PAST-PRACTICE STRATEGY

A brief discussion of the past-practice strategy describing the steps of the process. This section will summarize and refer to Section 6.0 of the Phase 1 and 2 FS; Figure 6-1 will be included.

1.4 SUMMARY OF 100 AREA FEASIBILITY STUDY PHASES 1 AND 2

A brief summary of the Phase I/II FS purpose and results.

1.5 100 AREA WIDE AND AGGREGATE AREA STUDIES

Summaries of 100 Area studies which provide supporting information to the FFS.

1.5.1 Hanford Site Background
1.5.2 Ecological Analysis

1.6 SUMMARY OF 100 AREA GROUNDWATER TREATABILITY STUDIES

Summaries of treatability studies conducted in support of the FFS.

1.6.1 Biodenitrification
1.6.2 Precipitation/Reduction
1.6.3 Ion Exchange

2.0 REMEDIAL ACTION OBJECTIVES

Discussions of the elements of remedial action objectives and their application to the 100 Area groundwater operable units

2.1 LAND-USE

Land-use is recreational for the 100 Area groundwater operable units.

2.2 CONTAMINANTS OF POTENTIAL CONCERN

Contaminants of potential concern are identified in the limited field investigation reports for the occasional-use scenario

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs from the 100 Area Phase 1 and 2 FS are refined.

2.4 EXPOSURE PATHWAYS

A discussion of exposure pathways as presented in the QRA

2.5 REMEDIATION GOALS

A discussion and quantification of remediation goals for the 100 Area groundwater operable units based on the land use, ARARs, and objectives of the FFS.

3.0 GROUNDWATER REMEDIAL ALTERNATIVE DESCRIPTIONS

Descriptions from the Phase I/II FS would be expanded to incorporate information from limited field investigations, qualitative risk assessments, treatability testing, and more detailed technical information on the process options which make up the alternatives.

3.1 ALTERNATIVE GW-1

3.1.1 Description

A description of the no action alternative.

3.2 ALTERNATIVE GW-2

3.2.1 Description

A description of the institutional control alternative.

3.3 ALTERNATIVE GW-3

3.3.1 Objective

A discussion of the purpose of the alternative, i.e., containment of a groundwater plume(s).

3.3.2 System Configuration

A description of the system elements and process flow.

3.3.3 Description

A description of the containment alternative.

3.3.4 Equipment

A discussion of the equipment specified for the remedial system.

3.3.5 Disposal Distances and Location

A discussion of the disposal process for the alternative.

3.4 ALTERNATIVE GW-4

3.4.1 Objective

3.4.2 System Configuration

3.4.3 Unit Operations

A discussion of each element of the process.

3.4.4 Disposal Distances and Location

3.5 ALTERNATIVE GW-5

3.5.1 Objective

3.5.2 Size and Configuration

3.5.3 Unit Operations

3.5.4 Disposal Distances and Location

3.6 ALTERNATIVE GW-6

3.6.1 Objective

3.6.2 Size and Configuration

3.6.3 Unit Operations

3.6.4 Disposal Distances and Location

3.6.5 Groundwater Monitoring

4.0 DESCRIPTION OF CERCLA EVALUATION CRITERIA

A discussion of the detailed analysis methodology to be applied in the FFS and a description of the CERCLA 9 criteria.

4.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
4.2 COMPLIANCE WITH ARAR
4.3 LONG-TERM EFFECTIVENESS AND PERMANENCE
4.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT
4.5 SHORT-TERM EFFECTIVENESS
4.6 IMPLEMENTABILITY
4.7 COST
4.7.1 Direct Capital Costs
4.7.2 Indirect Capital Costs
4.7.3 Annual O&M Costs
4.7.4 Accuracy of Cost Estimates
4.7.5 Present Worth Analysis
4.8 REGULATORY ACCEPTANCE
4.9 COMMUNITY ACCEPTANCE

5.0 COMPARATIVE ANALYSIS

A discussion of the methodology for comparing the alternatives in the FFS.

6.0 REFERENCES

FIGURES:

TABLES:

100-??-? OPERABLE UNIT FOCUSED FEASIBILITY STUDY REPORT

1.0 OPERABLE UNIT BACKGROUND

Summaries of operable unit-specific characterization and study efforts

1.1 LIMITED FIELD INVESTIGATION

Brief summary of LFI results.

1.2 QUALITATIVE RISK ASSESSMENT

Brief summary of QRA results including summary tables.

1.3 CULTURAL INVESTIGATIONS

Summary of results of cultural investigations.

2.0 REMEDIAL ACTION OBJECTIVES

A discussion of all the elements of remedial action objectives specific to the operable unit.

2.1 CONTAMINANTS OF POTENTIAL CONCERN

A review and refinement of contaminants of concern to focus the remediation.

2.2 REMEDIATION GOALS

A discussion and quantification of remediation goals specific to the operable unit (included only if different than for the entire 100 Area).

3.1 DESCRIPTION MODIFICATIONS

A discussion of changes to the alternative descriptions in the methodology document based on OU-specifics. For example, one of the alternatives deals with in situ nitrate remediation. Because nitrate is not a contaminant of concern for most of the operable units, this alternative drops out.

A discussion of the site-specific implementation of the alternative considering site conditions.

3.1.1 Alternative GW-1 - No Action
3.1.2 Alternative GW-2 - Institutional Controls
3.1.3 Alternative GW-3 - Containment

3.1.4 Alternative GW-4 - In Situ Treatment
3.1.5 Alternative GW-5 - Extraction, Treatment, Disposal with Ion Exchange
3.1.6 Alternative GW-6 - Extraction, Treatment, Disposal with Reverse Osmosis

3.2 UNCERTAINTY ISSUES

A discussion of uncertainties associated with each alternative and contingencies to deal with the uncertainties.

3.2.1 Alternative GW-1
3.2.2 Alternative GW-2
3.2.3 Alternative GW-3
3.2.4 Alternative GW-4
3.2.5 Alternative GW-5
3.2.6 Alternative GW-6

4.0 MODELING RESULTS

4.1 GROUNDWATER FLOW MODEL

4.1.1 Model Design
4.1.2 Model Grid
4.1.3 Boundary Conditions
4.1.4 Initial Conditions
4.1.5 Bottom Elevations of Model Grid
4.1.6 Recharge
4.1.7 Aquifer Hydraulic Conductivity
4.1.8 Storage Coefficient and Porosity
4.1.9 River Nodes
4.1.10Model Calibration

4.2 SOLUTE TRANSPORT MODEL

4.2.1 Model Design
4.2.2 Technical Approach

4.3 MODELING RESULTS

4.3.1 No Action Alternative
4.3.2 Vertical Barrier Alternative
4.3.3 Groundwater Extraction and Treatment Alternative

5.0 DETAILED ANALYSIS OF ALTERNATIVES

A tabulation of the detailed analysis of alternatives using questions as described in guidance.

6.0 COMPARATIVE ANALYSIS

A qualitative comparative analysis of the alternatives against the CERCLA 9 criteria.

6.1 OVERALL PROTECTIVENESS OF HUMAN HEALTH AND THE ENVIRONMENT
6.2 COMPLIANCE WITH ARAR
6.3 LONG-TERM EFFECTIVENESS
6.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME
6.5 SHORT-TERM EFFECTIVENESS
6.6 IMPLEMENTABILITY
6.7 COST

7.0 REFERENCES

APPENDIX:
A - COST MODELS

FIGURES:

TABLES:

DON'T SAY IT --- *Write It!*

DATE: May 26, 1994

TO: Dennis Faulk, EPA
Phil Staats, Ecology

FROM: Glenn I. Goldberg, DOE-RL

Telephone: 376-9552

cc: Eric Goller, DOE-RL
Joan Woolard, WHC

SUBJECT: XRF PAPER

Attached please find the white paper that was requested to compare XRF and SW-846 and give recommendation on their future use for the 100-DR~~-1 soil~~ washing test. The paper recommends that a screening approach using both XRF and SW-846 be used. This approach would increase the speed of obtaining analytical information during testing and reduce analytical costs of the test signicantly.

For the 100-DR-1 test chromium is the only metal of concern that for which the XRF and the SW-846 techniques would be used. The paper emphasizes that XRF provides a conservative analyses compared with SW-846 and therefore is a good screening tool. However, SW-846 analyses are recommended for final decision making. This is consistent with current EPA protocol and the SW-846 method gives a better assesment of metals that may leach or be a potential risk to the public.

USE OF X-RAY FLUORESCENCE (XRF) TO GENERATE SCREENING DATA FOR METALS IN SOILS

SUMMARY

This white paper recommends an analytical screening approach using both XRF and SW-846 analyses for the 100-DR-1 soil washing test at Hanford. This approach would increase the speed of obtaining analytical information during testing and reduce analytical costs of the test significantly.

For the 100-DR-1 test chromium is the only metal of concern for which XRF and SW-846 methods would be used. The paper emphasizes that XRF provides a conservative analyses compared with SW-846 and therefore is a good screening tool. However, SW-846 analyses are recommended for final decision making. This is consistent with current EPA protocol and the SW-846 method gives a better assessment of metals that may leach or be a potential risk to the public.

USE OF X-RAY FLUORESCENCE (XRF) TO GENERATE SCREENING DATA FOR METALS IN SOILS

R.G. McCain
March 26, 1994

INTRODUCTION

Analysis of soil samples for metals to support regulatory decision making is generally carried out in accordance with approved laboratory methods as published in Test Methods for Evaluating Solid Waste EPA(1988)[1], or in the Inorganics scope of work for the EPA Contract Laboratory Program[2]. For convenience, these methods will be referred to herein as SW-846 and CLP, respectively.

These methods require chemical digestion and analysis using sophisticated instrumentation in an off-site laboratory. As a result, data are not available for several weeks after sample collection. Depending on the level of validation required, the turnaround time from sample collection to data reporting may vary from two to six weeks, or longer. This delay is clearly unacceptable when the results are needed to monitor the progress of a remediation effort. In a pilot-scale treatability test, data regarding contaminant concentrations in the incoming soil, the end product, and any effluent streams are required to assess the effectiveness of the remediation effort. If these data can be made available in a short time frame, then the overall remediation process can be modified to achieve optimum contaminant removal. Moreover, the process can be modified as necessary to accommodate changes in contaminant levels in the incoming soil. Clearly, the flexibility and effectiveness of any remediation process can be greatly enhanced if contaminant levels can be determined in real time. Furthermore, the risk of discharging material in which one or more contaminants are present at unacceptable levels is greatly reduced when detection of contaminants in the output can be reported in time to modify or stop the remediation process.

As a general rule, all sites exhibit some degree of uncertainty with regard to important parameters relevant to each remediation process under consideration. This is because site characterization invariably follows the law of diminishing returns: more and more time, money and effort are expended in gaining smaller and smaller incremental reductions in the level of uncertainty. Therefore at some point, it becomes reasonable to proceed with remediation. Any remaining uncertainty in site parameters can be dealt with by application of the Observational Method, which provides flexibility to accommodate variations in site conditions or contaminant levels.

DESCRIPTION OF THE OBSERVATIONAL METHOD

The observational method has been applied in geotechnical engineering for more than three decades. This approach was first discussed in detail by

Peck (1969)[3]. It has been shown to be very effective in reducing the costs and time associated with geotechnical engineering projects.

The basic premise of the observational method is that uncertainty can be dealt with by determining what parameters are likely to have the greatest effect on the outcome and instituting a program to measure and/or monitor those parameters as the work progresses. Any deviations from anticipated conditions will be quickly recognized and contingency plans can be implemented, or the design or process parameters can be modified to deal with the actual conditions. For a treatability test, the observational method is particularly important because of uncertainties associated with process performance, in addition to site and contaminant characteristics. The observational method can be summarized as follows:

1 Collect existing information and conduct site exploration sufficient to establish at least the general nature, pattern and properties of subsurface deposits and contaminant distribution, although not necessarily in detail.

2 Determine the most probable conditions and the most unfavorable credible deviations from those conditions.

3 Establish a design based on a working hypothesis of behavior anticipated under the most probable conditions.

4 Select quantities or parameters to be observed and calculate or estimate anticipated values on the basis of the working hypothesis.

5 Calculate or estimate values of the same quantities under the most unfavorable conditions.

6 Select in advance a course of action or design modification for every likely significant deviation of the observational data from values predicted based on the working hypothesis.

7 Measure the quantities to be observed and evaluate actual conditions.

8 On the basis of actual conditions, modify the design as necessary or select an alternative course of action.

If it is to be successful, the Observational Method requires that important parameters be monitored and reported in a timely fashion. Because most likely deviations should have been anticipated, pre-determined alternatives may be implemented based on the field screening results.

CATEGORIES OF ANALYSIS

Three general categories of analysis can be defined primarily on the basis of turnaround time. These are described below:

Field Screening is carried out on site, with results available within approximately 1 hour. Field screening data may be either qualitative or quantitative. The basic purpose of field screening is to provide real time data necessary for on-site decision making.

Quick Turnaround Analyses are carried out on-site in a mobile laboratory or at a nearby off-site lab. Results are typically available within 12 to 48 hours. Quick turnaround analyses may follow accepted procedures, with modifications and abbreviated QA/QC requirements to shorten analytical time.

Conventional Laboratory Analyses are carried out at an off-site laboratory in accordance with accepted, published procedures, and well-defined QA/QC protocols (eg SW-846, CLP SOW). The data are validated in accordance with defined criteria. Results are generally available within two to six weeks.

In guidance regarding development of data quality objectives (DQOs), (EPA, 1987)[4], EPA has defined five levels of analysis. These are shown in Table 1. The first four are widely accepted and have come to represent specific levels of overall data quality. However, these levels have been generally misinterpreted as defining the data quality objectives instead of simply defining the data quality level. Hence, more recent guidance has placed less emphasis on specific analytical levels. To assist in the interpretation of data, the EPA Superfund program has proposed the use of two descriptive data categories (EPA, 1993, p 42-43)[5]:

"Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. ... Screening data provide analyte identification and quantification, although quantification may be relatively imprecise. At least ten percent of the screening data must be confirmed using analytical methods and QA/QC procedures and criteria associated with definitive data. Screening data without associated confirmation data are not considered to be data of known quality."

"Definitive data are generated using rigorous analytical methods, such as approved EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. ... Data may be generated on-site or at an offside location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined."

Generally, screening data are generated by field screening and quick turnaround methods, while conventional laboratory analysis is required to generate definitive data. These data categories are consistent with those defined in a data quality strategy developed to support site characterization activities at Hanford[6]. EPA guidance specifically indicates that the Data Categories are to replace references to analytical levels, quality assurance objectives and data use categories in previous documents (EPA, 1993, p 44)[5]. Figure 1 illustrates how analytical levels, analytical categories, and data categories are related.

The basic problem is that screening data are required for process evaluation and control, primarily because of the long turnaround time required to generate definitive data, whereas definitive data are required to support regulatory decision making. This issue can be resolved by establishing a correlation between screening data and definitive data for specific analytes, such that a number of screening data points are confirmed by direct comparison to definitive data for the same samples. EPA guidance (EPA, 1993, p43)[5] provides specific criteria for definitive confirmation of screening data:

> "Definitive confirmation: at least ten percent (10%) of the screening data must be confirmed with definitive data as described below. As a minimum, at least three (3) screening samples reported above the action level (if any) and three (3) screening samples reported below the action level (or as non-detects, ND) should be randomly selected from the appropriate group and confirmed."

Confirmation should take place at two levels. The first is between the quick turnaround laboratory and the conventional lab. The second is between field screening and the quick turnaround lab. A third correlation, between field screening and the conventional lab is also established, since confirmation samples sent to the conventional lab from the quick turnaround lab have also been subjected to field screening measurements. Under this approach, the screening data provided by the quick turnaround lab is confirmed in accordance with the criteria established above, while the data provided by field screening measurements is confirmed to a lesser degree. The rationale for this is that field screening measurements are used to provide indications of the overall process performance, and that a large number of such measurements may be made.

It is neither practical nor cost effective to confirm ten percent of these measurements with definitive data. However, samples which exceed test performance limits or other specified levels will be analyzed by quick turnaround methods, with at least ten percent subject to confirmation by definitive data, so that a secondary correlation is established. If no samples exceed specified levels, a minimum of ten percent of field screening samples showing the highest concentrations would be submitted to the quick turnaround laboratory. Ten percent of those samples will be submitted to a conventional laboratory.

COMPARISON OF SW-846/CLP and LABORATORY/FIELD XRF METHODS FOR METALS IN SOILS

Both SW-846 and CLP methods for metals in soils are based on either atomic absorption (AA) spectroscopy for individual elements or inductively coupled plasma (ICP) emission spectroscopy for multiple elements. AA is a spectrophotometric technique based on absorption of radiant energy at a specific wavelength by analyte atoms suspended in the light path. The most common means of suspension is an acetylene flame, but other methods such as the graphite furnace or cold vapor technique are also used. AA methods are generally limited to measurement of a single element. In ICP, the sample is introduced into an inductively heated argon plasma, and the light emitted by excited ions within the plasma is measured. The wavelength is an indication of the element involved, and intensity is an indication of concentration. By measuring intensity at multiple wavelengths, it is possible to make multi-element measurements with ICP.

Both ICP and AA require a liquid for analysis, typically a dilute solution. In the case of soils, the solution is prepared by subjecting the soil to an acid digestion. In theory, this should remove material adsorbed to the grain surfaces and will likely dissolve much of the granular material as well. However, some of the material will remain behind as a residue. From an environmental contamination perspective, this is a reasonable approach, since the soil grains themselves are seldom hazardous, and the acid digestion is somewhat more aggressive in mobilizing potential contaminants than conditions likely to be encountered in the natural environment. Results obtained by conventional laboratory methods based on acid digestion therefore reflect the probable maximum amount of relatively mobile elements within the soil and not necessarily the true elemental content of the mineral matrix.

In X-Ray fluorescence (XRF), the sample is subjected to X-Rays which interact with the inner electron shells of the various atoms present. If the energy level of the X-ray is sufficient, an electron may be ejected from an inner orbital. When this occurs, an electron from an outer orbital will move in to fill the gap, giving off a discrete quantity of energy in the form of an X-ray. The emitted energy is a function of both atomic number and the electron transition involved. Each element has characteristic energy lines which can be used for identification. The energy level or wavelength of the fluoresced X-rays is an indication of the element involved and the intensity is an indication of the concentration.

Two basic types of XRF instruments are available, wavelength-dispersive (WDXRF) and energy dispersive (EDXRF). In WDXRF, fluoresced X-rays are directed onto a diffracting crystal. The angle of diffraction is determined by the lattice spacing of the crystal and the energy level of the incident X-rays. A detector is used to measure X-ray intensity as a function of angle. WDXRF instruments are better suited to analysis of a small number of specific elements. In EDXRF, the fluoresced X-rays are directed into a detector which produces an energy pulse whose height (voltage) is proportional to the energy level of the X-Ray. By using a pulse-height analyzer and multichannel analyzer, it is possible to create a spectra of pulse counts or intensity as a function of energy level. EDXRF can thus provide simultaneous multi-element determination.

With a laboratory XRF instrument, X-ray tube current, secondary targets, and filters can be used to selectively enhance fluorescence of specific elements and reduce or eliminate interelement effects. "Fundamental parameters" programs are available to determine individual element concentrations from energy spectra by accounting for excitation efficiency, absorption, scattering, secondary enhancement, and other factors.

In XRF, the soil is analyzed directly. Drying, grinding to uniform grain size, and pressing or fluxing into a solid pellet are frequently performed to eliminate many sources of error. The entire mineral matrix, as well as any adsorbed contaminants is analyzed. XRF is thus a "whole rock" elemental analysis technique, in which no distinction is made between elements in substances adsorbed to the surface of grains, and those contained within the mineral grain matrix. With XRF, the material which would normally remain behind in the residue during acid digestion is also analyzed. In most cases, therefore, one would expect that elemental concentrations determined by XRF would be somewhat higher than those determined by AA or ICP analysis of a solution prepared by acid digestion.

One disadvantage of XRF is that available electron transitions and energy levels of the resulting characteristic energy lines decrease with decreasing atomic number. As a routine analytical method, XRF is not suitable for elements with atomic number less that about sodium (Z=11) or aluminum (Z=13) in the periodic table. Hence, XRF cannot be used for elements such as beryllium, boron, or fluorine.

Field XRF instruments utilize radioisotope sources to provide low-energy gamma rays. This results in relatively less excitation energy and less flexibility in selective excitation. Field instruments are therefore generally less sensitive, and sensitivity may vary from element to element, depending on the radioisotope used for excitation. In general, field instruments are not able to measure elements with atomic numbers less than 22 (Ti) on the periodic table.

It is difficult to compare detection limits for XRF directly with ICP and AA because of the different way in which the samples are analyzed. However, detection limits are not the primary concern with many metals. Many common elements are present in ppm levels in a typical soil. This is well within the detection limits for ICP or AA or laboratory XRF. In some cases, such as mercury, the detection limits for field XRF may be too high.

PROGRAM TO DEMONSTRATE COMPARABILITY OF XRF RESULTS IN HANFORD SOILS

In order to demonstrate comparability between XRF results and SW-846, it will be necessary to conduct parallel analyses on typical Hanford soils. This will be accomplished by setting up the analytical program associated with the treatability test so that sufficient sample material is collected for both laboratory XRF and SW-846 methods for all samples submitted for laboratory XRF. A sample size of 10 to 20 grams will provide sufficient material for both analyses. The laboratory will hold the sample until XRF results are available. After review, any samples exceeding test performance limits, or ten percent of all samples will be forwarded to an offsite laboratory for SW-846 analysis.

In the case of the 100-DR-1 Soil Washing Treatability Test, the primary elemental analyte of concern is chromium (Cr). Other contaminants of concern are radionuclides, which will be quantified by radiometric and radiochemical methods. Cr is difficult to detect using field XRF instruments because Cr is poorly excited by available radioisotope sources, and because Cr is subject to interference and peak overlap effects resulting from relatively high iron (Fe) concentrations in Hanford soils. Hence, field XRF screening will not be used for the 100-DR-1 Soil Washing Treatability Test. Analysis for Cr will be done by laboratory XRF to overcome the limitations of field XRF in this situation.

The general sampling program to support the soil washing treatability test with laboratory XRF will be as follows:

- Laboratory XRF measurements will be made of soil samples collected during tests. Enough soil will be collected in each sample to send a portion of that sample for off-site SW-846 analyses, if needed.
- If samples exceed test performance levels for Cr as determined by laboratory XRF, they will be submitted to an off-site lab for SW-846 analysis.
- In any case, a minimum of ten percent of the samples will be submitted for SW-846 analysis. These will include the samples with the highest concentrations of Cr.

The preceding approach of sending a minimum of 10% of the samples measured in quick turnaround labs for off-site confirmatory analyses is recommended for radionuclides as well. Radionuclides analyses in both sets of labs will be performed using gamma spectrometetry for cesium, europium and cobalt isotopes. Alpha/beta analyses will also be conducted for plutonium and strontium isotopes in samples sent off-site.

TABLE 1

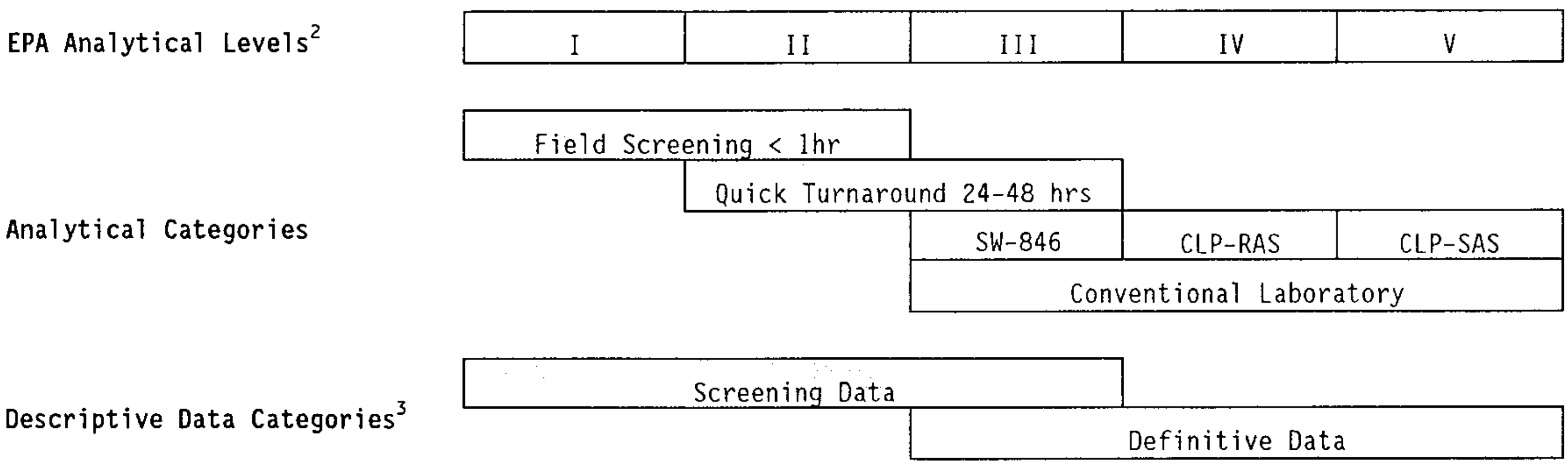
EPA ANALYTICAL SUPPORT LEVELS[1]

Level	Description
I	Field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative, but results are available in real-time. It is the least costly of the analytical options
II	Field analysis using more sophisticated portable analytical instruments. In some cases the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. It depends on the use of suitable calibration standards, reference materials, and sample preparation equipment; and the training of the operator. Results are available in real-time or several hours.
III	All analyses performed in an analytical laboratory. Level III analyses may or may not use CLP procedures, but do not usually utilize the validation or documentation procedures required of CLP level IV analyses. The laboratory may or may not be a CLP laboratory.
IV	CLP routine analytical services (RAS). All analyses are performed in an offsite CLP analytical laboratory following CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.
V	Analysis by non-standard methods. All analyses are performed in an off-site analytical laboratory which may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits. CLP special analytical services (SAS) are level V.

1 EPA (1987); **Data Quality Objectives for Remedial Response Activities: Development Process**; EPA 540/G-87/003; US EPA, Washington, DC

FIGURE 1

COMPARISON OF ANALYTICAL LEVELS, ANALYTICAL CATEGORIES, AND DESCRIPTIVE DATA CATEGORIES



[2] EPA (1987); **Data Quality Objectives for Remedial Response Activities: Development Process**; EPA 540/G-87/003; US EPA, Washington, DC

[3] EPA (1993); **Data Quality Objectives Process for Superfund: Interim Final Guidance**; EPA/540/G-93/071, US EPA, Washington DC

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4. EPA (1987); **Data Quality Objectives for Remedial Response Activities: Development Process**; EPA 540/G-87/003; US EPA, Washington, DC

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ENCLOSURE 1

Summary Table Comparing MDLs for XRF vs SW-846 For Cr (From Enclosures 2 and 3) and Summary Table Comparing XRF Data vs SW-846 Data For Cr (From Enclosure 4).

Table E1-1. Comparison of MDLs for XRF vs SW-846 For Cr (From Enclosures 2 and 3).

Cr	Soils			Water		
	MDL (mg/kg)	Precision	Accuracy	MDL (mg/L)	Precision	Accuracy
SW-846	2	±25	75-125	0.02	±25	75-125
XRF	50	±10	90-110	40	±10	90-110

Table E1-2. Comparison of XRF Data vs SW-846 Data For Cr (From Enclosure 4).

Sample Number	Vadose Zone Samples	
	SW-846 Cr (mg/kg)	XRF Cr (mg/kg)
SB9+1	15.7	53
SB9+2	17.5	56
SB9+3	22.8	63
SB9+4	19.1	54
SB9+4.75	17.8	53
SB9+PAN	18.7	62
SB9<2mm	17.3	53
SB11+0	4.5	26
SB11+1	3.3	28
SB11+2	2.3	30
SB11+3	5.4	35
SB11<2mm	2.8	30
SB12-1	9.2	44
SB12+0	6.5	35
SB12+1	12.6	44
SB12+2	9.4	21
SB12+3	15.7	48
SB12<2mm	7.6	50

ENCLOSURE 2

Table A-1 from DOE/RL-92-21 showing minimum detection levels for metals using SW-846 analyses.

9413293.3386

Table A-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 300-FF-1 Operable Unit EPA System Treatability Test. (Sheet 1 of 2)[a]

Category of Analysis	Analyte of Interest	Analytical Level	Analytical Method[d]	MDC (Soil)[b] (ppb)	Precision (Soil)[b]	Accuracy (Soil)[b]	MDC (Water)[b] (ppb)	Precision (Water)[b]	Accuracy (Water)[b]
Radionuclides	Cesium-137	V	Gamma Spectroscopy	0.1 pCi/g	±25	75-125	20 pCi/L	±25	75-125
	Cobalt-60	V	Gamma Spectroscopy	0.1 pCi/g	±25	75-125	20 pCi/L	±25	75-125
	Uranium-natural	V	Fluorimetry	0.01 pCi/g	±25	75-125	0.5 μg/L	±25	75-125
	Uranium-isotopic	V	Fluorimetry	1 pCi/g	±25	75-125	0.1 pCi/L	±25	75-125
Metals	Aluminum	III	SW-846 6010[c]	20000	±25	75-125	200	±25	75-125
	Antimony	III	SW-846 6010[c]	20000	±25	75-125	200	±25	75-125
	Arsenic	III	SW-846 7060[c]	500	±25	75-125	5	±25	75-125
	Beryllium	III	SW-846 6010[c]	300	±25	75-125	3	±25	75-125
	Cadmium	III	SW-846 6010[c]	1000	±25	75-125	10	±25	75-125
	Chromium	III	SW-846 6010[c]	2000	±25	75-125	20	±25	75-125
	Copper	III	SW-846 6010[c]	2000	±25	75-125	20	±25	75-125
	Iron	III	SW-846 6010[c]	2000	±25	75-125	20	±25	75-125
	Lead	III	SW-846 7421[c]	500	±25	75-125	5	±25	75-125
	Manganese	III	SW-846 6010[c]	1000	±25	75-125	10	±25	75-125
	Mercury	III	SW-846 7470[c]	400	±25	75-125	0.2	±25	75-125
	Nickel	III	SW-846 6010[c]	3000	±25	75-125	30	±25	75-125
	Silver	III	SW-846 6010[c]	2000	±25	75-125	20	±25	75-125
	Zinc	III	SW-846 6010[c]	1000	±25	75-125	10	±25	75-125
Volatile Organics (VOAs)	1,2-Dichloroethene	III	SW-846 8240[c]	N/A	N/A	N/A	1	±25	75-125
	Methylene Chloride	III	SW-846 8240[c]	N/A	N/A	N/A	5	±25	75-125
	Tetrachloroethene	III	SW-846 8240[c]	N/A	N/A	N/A	0.5	±25	75-125
	Trichloroethene	III	SW-846 8240[c]	N/A	N/A	N/A	1	±25	75-125

Table A-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 300-FF-1 Operable Unit EPA System Treatability Test. (Sheet 1 of 2)[a]

Category of Analysis	Analyte of Interest	Analytical Level	Analytical Method[d]	MDC (Soil)[b] (ppb)	Precision (Soil)[b]	Accuracy (Soil)[b]	MDC (Water)[b] (ppb)	Precision (Water)[b]	Accuracy (Water)[b]
Pesticides/PCBs	Aroclor-1016 thru 1260	III	SW-846 8080[c]	100	±25	75-125	1	±25	75-125

[a] This table is compiled from Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities (WHC 1992) and the Statements of Work for the laboratories.

[b] MDC refers to the Minimum Detectable Concentration for radionuclides and CQRL refers to Contractually Required Quantitation Limit for all other constituents. Precision is expressed as Relative Percent Difference (RPD); accuracy is expressed as percent recovery (%R).

[c] Methods specified are from Test Methods for Evaluating Solid Waste (EPA 1990).

[d] All analytical methods shall be Westinghouse Hanford approved methods.

ENCLOSURE 3

XRF Analysis Capabilities at PNL plus discussion of Precision and Accuracy of the XRF method

Project Number

Battelle
Pacific Northwest Laboratories

Internal Distribution

Date April 19, 1987

To Workshop Participants

From R.W. Sanders

Subject X-Ray Fluorescence Analysis Capabilities at PNL

9113293.3389

Introduction

X-ray fluorescence (XRF) is a rapid and sensitive method for analysis of up to 49 elements in a wide variety of samples. Because many of the elements can be determined simultaneously, and because little sample preparation is required, it is often the most cost effective. The lack of required sample preparation (i.e., dissolution) also makes XRF the method of choice for hard-to-dissolve samples and for hard-to-dissolve elements (i.e., Zr, Nb, Y). Finally, although XRF does not always appear to be the most sensitive technique for many elements, the fact that the sample does not have to be diluted several orders of magnitude during dissolution frequently makes XRF's detection limits quite competitive.

PNL Capabilities in X-Ray Fluorescence

We have developed a sophisticated energy dispersive x-ray fluorescence (EDXRF) capability. This system is currently operated as a service center by the Analytical Chemistry Section and is used as a laboratory-wide facility.

The system is computer-controlled and has the ability to provide analytical results for up to 49 elements at a rate of in excess of 100 samples per week. This makes the technique very cost effective as well as giving a very rapid turn-around on reported results. It uses a backscatter fundamental parameter data reduction method developed at PNL and provides analytical flexibility by eliminating the necessity for matrix matching. Essentially all elements in the periodic table between aluminum and cerium are accessible to analysis using K lines, with platinum through uranium analyzed by L excitation. We have recently modified the computer program running the system to perform a fully automatic analysis of all elements of interest without operator intervention to change sources. The technique has been used primarily for a wide variety of types of solid samples including glass, geological, biological, and metallic matrices. It is particularly well suited to the analysis of filter samples. It is also applicable to liquid samples including brines and oils. The laboratory currently has in operation two Kevex secondary source EDXRF systems. We also have a Bausch and Lomb wavelength dispersive system in limited operation. The wavelength dispersive system provides better sensitivity for low atomic weight elements including sodium and magnesium as well as providing better elemental resolution for a number of intermediate

Workshop Participants
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Page 2

mass elements commonly subject to major element interferences. Minimum detection limits (MDL's) for the energy dispersive systems are typically in the low ppm range for most elements in a geological matrix. This can be extended in some cases to much lower levels for less complex matrices (see attached tables). The analytical accuracy of the EDXRF technique has been demonstrated to be excellent in a large number of multi-technique and multi-laboratory intercomparisons and round-robins. The attached bibliography provides more detailed information on some selected past applications.

Tables 1-3 and Figure 1 give minimum detection limits (MDL's) for the full range of elements in several matrix types including geological, biological, water, and air filters. The detection limits quoted are for a fairly typical set of analytical conditions and are, as such, conservative. It should be noted that the MDL's listed in the tables and the figure can be improved considerably if greater sensitivity is required for a specific element or a suite of elements excited by any one of the available sources. This can be accomplished by increased run time, higher tube currents, and use of alternate secondary sources.

The laboratory is located in the 300 Area, 3708 Building. The sample preparation laboratory is adjacent to the x-ray laboratory. Both laboratories will have provisions for handling radioactive samples. We have found in the past that even relatively highly radioactive samples can be handled successfully by the EDXRF technique and similar considerations should apply to the wavelength dispersive system. We currently have one specialist and one technician assigned full-time to this laboratory.

/dlm
Attachments

TABLE 1

Minimum Detection Limits by EDXRF in a Geological Matrix

Element	MDL (ppm)[a]	Element	MDL (ppm)[a]
Al	5400	Sn	5
Si	1900	Sb	6
P	620	Te	6
S	360	I	6
Cl	70	Cs	6
K	60	Ba	7
Ca	50	La	8
Sc	240	Ce	8
Ti	110		
V	60	Pt	5
Cr	50 ☆	Au	5
Mn	25	Hg	5
Fe	20	Tl	4
Co	12	Pb	5
Ni	6	Bi	4
Cu	5	Th	4
Zn	3	U	5
Ga	3		
Ge	2		
As	2		
Se	2		
Br	1		
Rb	2		
Sr	3		
Y	2		
Zr	2		
Nb	2		
Mo	2		
Ru	4		
Pd	3		
Ag	4		
Cd	5		
In	5		

(a) Minimum detection limit based on a total live time count of 3500 sec on 500 mg sample. Limits computed from analysis of pure SiO_2 and $CaCO_3$

☆ Currently XRF has quantified sediments from 300 Area N. Process Ponds to values as low as 5 ppm. See WHC-SD-EN-TI-214, Rev 0. Appendix B. RJ Serne 4-14-94

TABLE 2

Minimum Detection Limits by EDXRF in a Biological Matrix

Element	MDL (ppm)[a]	Element	MDL (ppm)[a]
Al	1400	Sn	5
Si	340	Sb	5
P	120	Te	6
S	50	I	6
Cl	30	Cs	6
K	10	Ba	7
Ca	9	La	8
Sc	35	Ce	8
Ti	13		
V	8	Pt	1.4
Cr	5	Au	1.5
Mn	3	Hg	1.5
Fe	3	Tl	1.3
Co	2	Pb	2.4
Ni	1.7	Bi	1.5
Cu	1.1	Th	2.1
Zn	.9	U	2.7
Ga	.8		
Ge	.7		
As	.8		
Se	.7		
Br	.6		
Rb	1.2		
Sr	1.3		
Y	1.3		
Zr	1.3		
Nb	1.3		
Mo	1.3		
Ru	3		
Pd	3		
Ag	3		
Cd	4		
In	4		

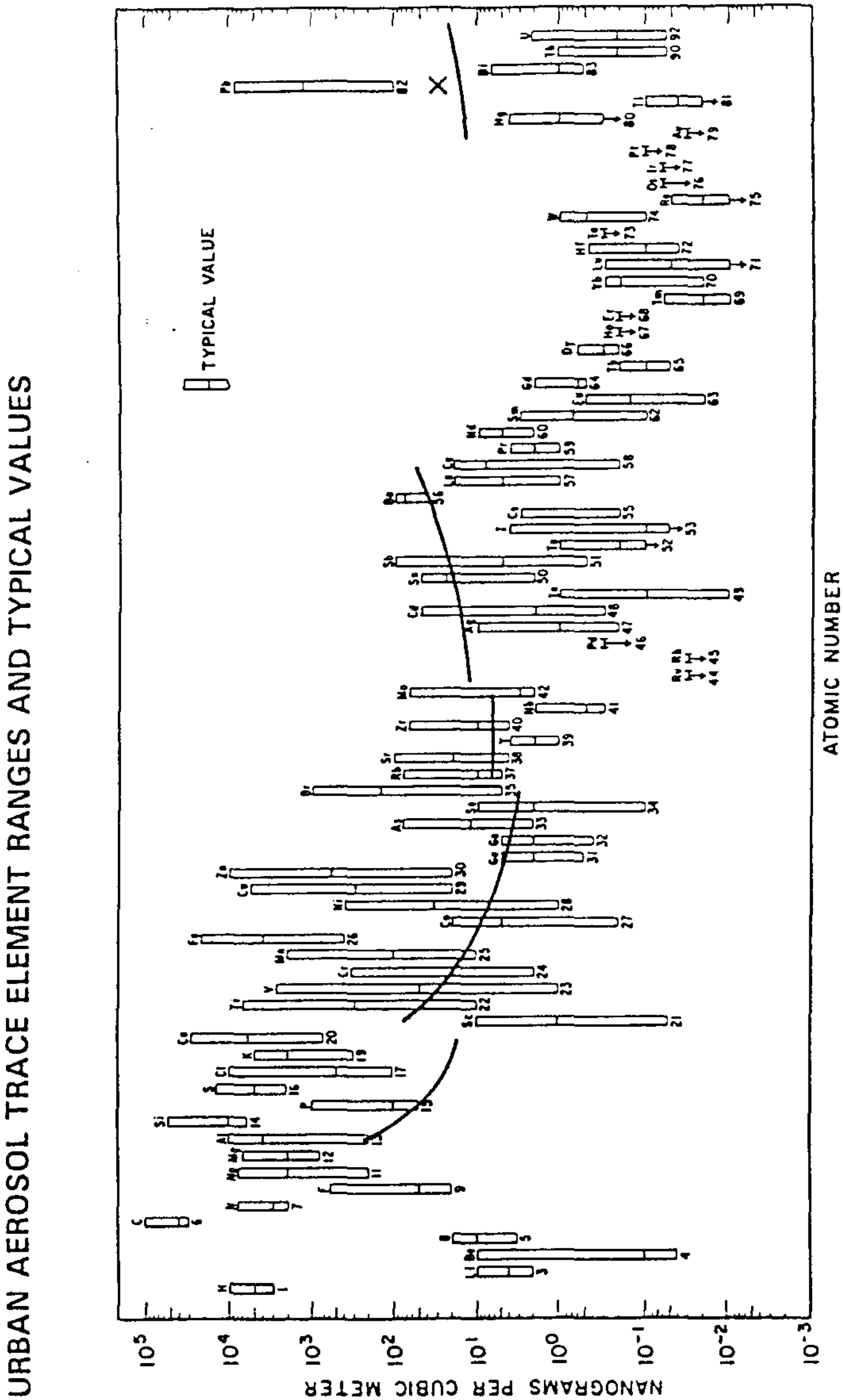
(a) Minimum detection limit based on a total live time count of 3500 sec on a 500 mg sample. Limits computed from analysis of pure cellulose.

TABLE 3

Minimum Detection Limits by EDXRF in a Water Sample

Element	MDL (ppb)[a]	Element	MDL (ppb)[a]
Al	9300	Sn	30
Si	2250	Sb	40
P	810	Te	40
S	360	I	40
Cl	220	Cs	40
K	66	Ba	50
Ca	60	La	50
Sc	230	Ce	50
Ti	90		
V	50	Pt	10
Cr	40	Au	10
Mn	20	Hg	10
Fe	20	Tl	9
Co	10	Pb	16
Ni	7	Bi	10
Cu	7	Th	14
Zn	6	U	18
Ga	6		
Ge	5		
As	5		
Se	5		
Br	4		
Rb	8		
Sr	8		
Y	8		
Zr	8		
Nb	9		
Mo	9		
Ru	20		
Pd	20		
Ag	20		
Cd	30		
In	30		

(a) Minimum detection limit based on a total live time count of 3500 sec. 50 ml of water evaporated at ambient temperature on 500 mg of pure cellulose.



<u>Figure 1</u>. Minimum detection limits for energy dispersive x-ray fluorescence of an air filter. Based on a filter loading of $3m^3/cm^2$ on a Whatman #41 substrate. Solid lines shown on plot are MDL's to be compared with range of typical levels found in urban aerosols.

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PRECISION AND ACCURACY OF LABORATORY XRF

PRECISION

Precision of PNL's energy dispersive XRF can be calculated two ways.

The raw print outs give an estimate of the true analyte concentration and an estimate of the uncertainty based on computer software calculations of possible peak interferences (overlaps) between two elements; Self-absorption, a function of sample thickness and grain size and specific matrix element enhancements. In general, the standard deviations calculated by the SAP3 computer software are + or - 5% of the estimated value when an element is present above the detection limit. In a few cases the standard deviation reaches 10%.

A second measure of precision is obtained because PNL routinely analyzes two aliquots from each sediment sample submitted. Given the inherent heterogeneity in contaminants present in the Hanford soil (contaminants are generally micron sized specks or individual atoms bound non-uniformly to larger rock minerals) the duplicate analyses protocol gives a truer estimate of overall reproducibility.

For example:

In the 300 Area North Process Pond sediment data presented in WHC-SD-EN-TI-214, Rev. 0, Appendix B (22 distinct samples) one can find the following. For each analysis 45 independent observations are made for 43 elements (two measurements for Al and Si are available). The vast majority of the (22 X 45) 990 pairs of numbers fall within 5 to 10% of each other. There are a few instances where reproducibility (precision) exceeds 30%.

ACCURACY

PNL uses "standard rock samples" with known metal concentrations supplied by NIST, USGS, or the Canadian Research Council to check the accuracy of XRF measurements for each batch of samples analyzed. Typically a 16-sample container is filled with 2 standards and 14 unknowns. Analyses of all samples are considered acceptable if the results of the standards are within + or - 10% of the known value.

A second technique used to ensure accuracy is to spike samples using "known amounts" of elements and to quantify recovery. For example, in 300 Area analyses samples were spiked with 200 ppm Uranium. The recoveries were 198, 196 and 215 or 99%, 98%, and 107.5% recovery respectively.

It should be noted that Cliff J. Kirchmer, Quality Assurance Officer for the Department of Ecology, State of Washington has been using "standard samples" such as the Canadian Research Council sediment samples to check the PNL energy dispersive x-ray fluorescence data for several years. On a frequency of two times/year Ecology reviews results of such analyses on certified standard sediment samples. PNL has maintained consistent and acceptable results for all the elements for which sediment standards have been made available. A copy of a recent certification was provided to P. Beaver of EPA and T. Wooley of Ecology on March 22, 1994 at a meeting in Room 1416 at 2440 Stevens Center.

ENCLOSURE 4

Sections from DOE/RL-92-24 comparing XRF and SW-846 analyses of metals.

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4.1.2 Relationships Between Physical and Chemical Composition

The general relationships between the physical and chemical composition of soil samples and also between bulk and digestate/leachate compositions are presented in this section. The Site-specific implications of these relationships for soils that occur naturally in the vadose zone on the Hanford Site are discussed in Section 4.1.2.2.

4.1.2.1 General Relationships. The chemical composition of geologic materials is controlled by the compositions of the components that make up the material, and the relative amounts (mass fraction) of the components. This general relationship can be expressed by considering the concentration of a single analyte A in a sample. The total amount of this analyte (C^A_{total}) can be represented by the following expression

$$C^A_{total} = \sum_{i=1}^{n} (C^A_1 * f^A_1 + C^A_2 * f^A_2 .... + C^A_n * f^A_n) \qquad (1)$$

where

C^A_{total} = total (bulk) concentration of analyte A

$C^A_1 .... C^A_n$ = concentration of analyte A in components 1 to n

$f^A_1 .... f^A_n$ = mass fractions of components 1 to n in the sample, where the sum of the mass fractions of all components in the sample equals 1.0.

i = component.

Thus, the concentration of an analyte in a soil sample depends on the relative amount of the components (e.g., minerals) in the sample, and the amount of the analyte present in each of these components, i.e., the product of the mass fraction and analyte concentration for each component.

As indicated in Equation 1, the only constituents in soil samples that are important in controlling the concentration of an analyte are those that contain the analyte and that either are modally abundant or have such large concentrations that they contribute significantly to the bulk composition even if the mass fractions of the component is small. Components that do not contribute significantly to the bulk composition serve to dilute analyte concentrations, and are otherwise insignificant. Physical characteristics such as grain size do not affect bulk composition, but are expected to have important effects on digestate/leachate compositions.

The chemical composition of digestate/leachate for soils can be expressed in the same manner as bulk composition (Equation 1), but with the addition of a term representing the extent to which the analytes are effectively extracted from the soil components. This term is referred to here as extraction efficiency (EF), and is defined as the ratio of digestate/leachate concentration to the bulk concentration for a given analyte.

The mathematical description for the relationship between digestate/leachate composition, the modal proportion of the constituents, the analyte concentration in the individual constituents, and the bulk concentration of an analyte is given by the expression

$$C_{DL}^{A} = \sum_{i=1}^{n} (C_1^A * f_1^A * EF_1^A + C_2^A * f_2^A * EF_2^A .... + C_n^A * f_n^A * EF_n^A) \qquad (2)$$

where C_{DL}^{A} is digestate/leachate concentration of analyte A determined in accordance with the regulatory protocols, and EF_1^A to EF_n^A are the EF factors of analyte A for the respective components. All other terms are the same as those defined for Equation 1.

The digestate/leachate concentration of an analyte, therefore, differs from the bulk concentration of an analyte, in proportion to the EF ratio. The EF term incorporates all of the parameters that affect the dissolution-reaction process, including solubility, surface area effects, and precipitation.

The relationships between mass fraction (mode) and analyte concentration for each component (e.g., mineral type) in controlling digestate/leachate composition are the same as for bulk composition. The main difference is that digestate/leachate composition also depends on the extent to which an analyte goes into solution resulting from the extraction process (i.e., efficiency of extraction). This difference is important in the soil background conceptual model because it establishes the relationship between digestate/leachate composition and factors such as grain size that also influence EF.

In practice, however, individual EF ratios generally are not known or are even measurable. The effective EF ratio for an entire sample is defined by the following expression

$$EF^{A}_{eff} = C^{A}_{DL} \; / \; C^{A}_{total} \qquad (3)$$

This effective EF ratio (EF^{A}_{eff})is a parameter that can be measured for individual samples (refer to Chapter 6.0, Section 6.2). Thus, the effective EF of an analyte for various sample types is a characteristic that relates all pertinent Site-specific physical characteristics of a sample to its digestate/leachate composition. These expressions are important in the conceptual model because they provide a mathematical basis for the relationship between physical and chemical composition, and also for understanding the implications of factors such as the 'nugget' effect (Section 4.2.3) on soil composition.

6.2.2.2 Grain Size Effects. Evaluations of the effects of grain size on the chemical composition of the soils were based on the comparison of bulk and digestate compositions for different size fractions from three soils and a basalt control sample (Tables 6-6 and 6-7). Comparisons of bulk to leachate compositions (e.g., chloride, nitrate) could not be made because these analytes were not determined in the bulk composition analyses. These soil samples represent a range of modal compositions and grain size distributions. Comparisons between the bulk composition and digestate composition reflect the extent to which the bulk analyte contents in soils are represented in digestate analyses. The ratio of digestate to bulk concentration for an analyte is referred to as EF, as used in Equations 4-2 and 4-3 in Chapter 4.0, Section 4.1.

The results of this evaluation demonstrate that EF increases systematically with decreasing particle size (i.e., surface area) for nearly all analytes. The analyte concentration in basalt digestate alone can be over 10 times larger for grain sizes <0.04 millimeters in diameter than for grain sizes 1 to 2 millimeters in diameter, because of the effect of grain size on EF (Figure 6-7). The effect of grain size variation on the digestate compositions of soil samples is less predictable than on the composition of the basalt control sample. This is because of the variety and proportions of mineral types in the different size fractions in the soils.

The variation in EF for the measured analytes in soil samples is presented in Figure 6-8. The EF values are greatest for lead (up to 95 percent) and smallest for sodium (less than 1 percent). The important trace elements barium and chromium have an EF of less than 30 percent. The high standard deviations associated with virtually all of the analytes are a measure of the inter- and intrasample variability in EF. A quantitative evaluation of the effects of grain size, independent of differences in the proportion of mineral and rock components as expressed in Equation 4-2, is possible only if EF values for each component are known. Thus, the data resulting from these evaluations are only for bulk EF as defined in Equation 4-3. These data provide a quantitative basis for the Site-specific relationships between physical composition, bulk composition, and digestate/leachate composition of the soils described in the conceptual model.

These data also indicate that the concentrations of many of the analytes are affected so strongly by EF and the parameters that influence it (e.g., grain size and material type) that the digestate/leachate concentrations for many analytes could be affected more by Site-specific EF relationships than by bulk composition. These results also represent one of the first assessments of the importance of these effects in the evaluation of environmental data, and the only Hanford Site-specific measurements of effective EF values for soils.

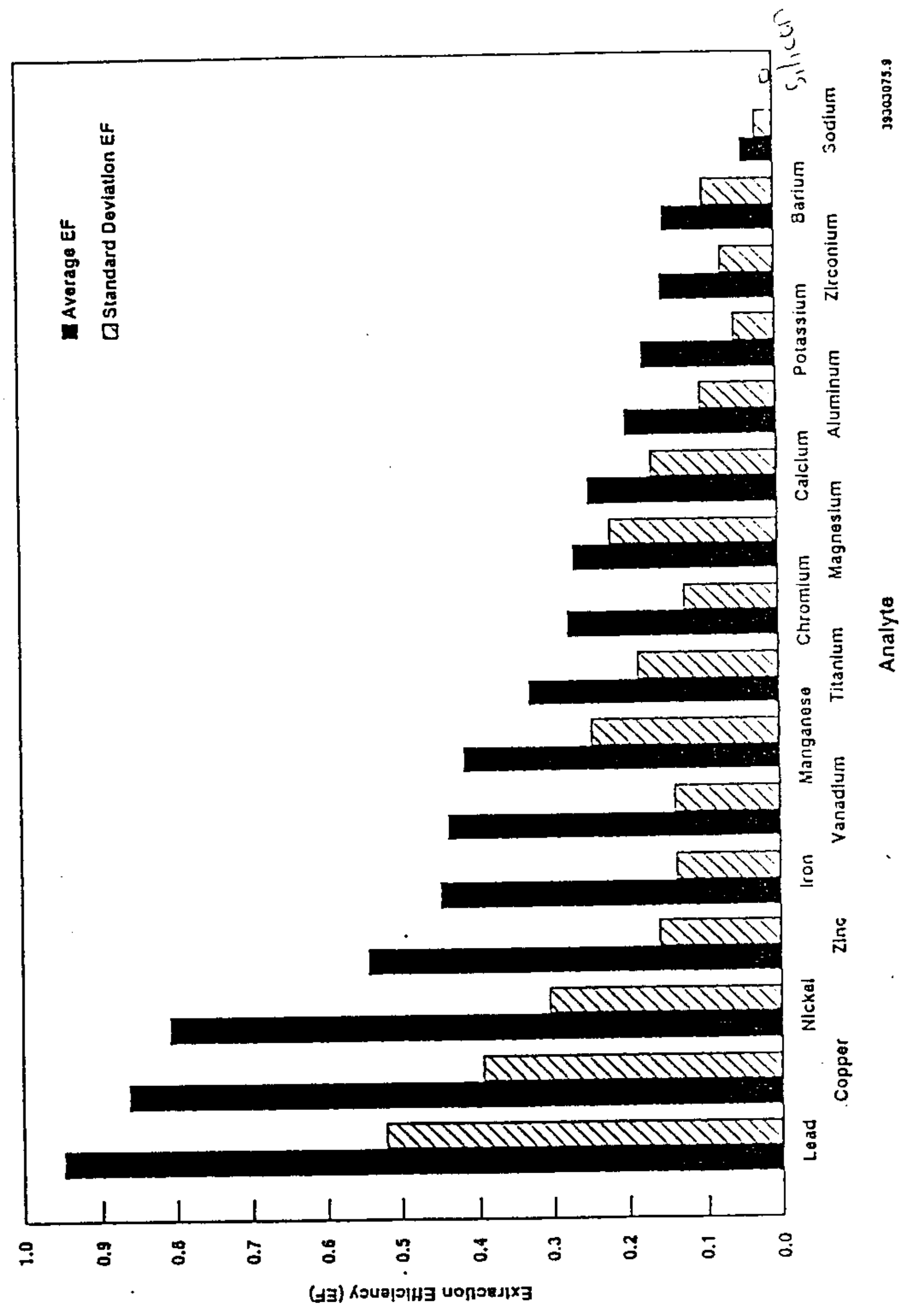


Figure 6-8. Average Vadose Zone Soil Extraction Efficiency Values for Various Analytes. Extraction efficiency is the ratio of the digestate concentration to the total (bulk) concentration. Standard deviations also are plotted.

Table 6-6. Bulk, Digestate, and Leachate Compositions for Seven Size Fractions of a Reference Basalt (Umtanum Basalt). Major elements are in wt%, others are in mg/kg.

		Sample number						
Analysis type	Analyte	BAS+0	BAS+1	BAS+2	BAS+3	BAS+4	B+4.75	BAS+PAN
Bulk rock	Silicon	25.74	25.68	25.61	25.66	25.73	25.27	24.90
	Titanium	1.33	1.33	1.31	1.26	1.23	1.34	1.42
	Aluminum	3.51	3.50	3.52	3.56	3.62	3.46	3.23
	Iron	10.05	10.04	10.00	9.65	9.63	10.31	11.08
	Manganese	0.16	0.16	0.16	0.16	0.16	0.16	0.18
	Magnesium	2.07	2.05	2.09	2.00	1.95	1.95	2.21
	Calcium	5.10	5.08	5.09	5.10	5.04	4.95	5.00
	Sodium	1.22	1.17	1.18	1.18	1.20	1.13	1.05
	Potassium	0.77	0.77	0.76	0.76	0.77	0.77	0.76
	Phosphate	0.09	0.09	0.09	0.09	0.09	0.10	0.11
Digestion	Silicon	0.00	0.00	0.00	0.00	0.01	0.01	0.02
	Titanium	0.34	0.70	0.55	0.68	0.75	0.99	0.96
	Aluminum	0.16	0.22	0.25	0.31	0.44	0.51	0.62
	Iron	1.74	3.35	2.58	3.20	3.54	4.44	4.33
	Manganese	0.01	0.03	0.02	0.03	0.03	0.04	0.04
	Magnesium	0.04	0.05	0.05	0.06	0.08	0.10	0.12
	Calcium	0.39	0.44	0.45	0.48	0.55	0.57	0.67
	Sodium	0.01	0.02	0.03	0.04	0.07	0.08	0.12
	Potassium	0.07	0.10	0.12	0.14	0.16	0.18	0.20
Bulk rock	Nickel	0	0	0	0	0	0	0
	Chromium	17	14	17	18	14	22	22
	Scandium	41	38	38	38	36	37	42
	Vanadium	314	313	304	305	300	319	346
	Barium	599	583	598	577	584	600	578
	Rubidium	46	47	47	43	49	48	47
	Strontium	310	309	310	316	325	311	283
	Zirconium	182	181	181	180	182	185	183
	Yttrium	37	37	39	37	36	37	38
	Niobium	13.8	14	14.2	13.7	14	15.1	14.4
	Gadolinium	23	24	24	24	22	20	21
	Zinc	130	135	136	135	133	166	232
	Lead	9	11	7	10	13	48	36
	Lanthanum	32	19	37	21	27	26	13
	Cerium	46	37	55	40	43	39	43
	Thorium	5	6	7	5	6	6	5
Digestion	Nickel	3.2	3.2	3.2	3.2	3.2	3.2	3.2
	Chromium	1.7	3	2.5	3.8	6.1	9.5	11.2
	Arsenic	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Vanadium	78.1	161	124	166	177	244	237
	Barium	18.4	33.7	37	40.5	53.5	58.2	71.7
	Beryllium	0.6	1.1	0.9	1	1.2	1.5	1.5
	Zirconium	20.6	34.4	30.8	36.8	40.2	48.1	48
	Cobalt	10.4	19.2	14.7	19.2	21.1	27.6	30.3
	Zinc	27.8	53.8	43.5	55.7	63.9	106	140
	Lead	10.6	6.4	8.6	27.1	14.9	29.4	30.7
Leachate	Ammonia	nd	nd	nd	nd	nd	nd	nd
	Alkalinity	452	402	626	453	564	404	1,280
	Fluoride	2.87	0.75	0.5	0.53	0.66	2.27	3.48
	Chloride	57.1	6.73	13.4	12.6	13.3	17.4	27.7
	Nitrite	0.85		0.23	0.25	0.36		
	Nitrate	298	46.9	106	98.2	87.6	116	123
	O-Phosphate		2.8	2.94	5	8.44	149	128
	Sulfate		64.3	116	163	190	260	407

mg/kg = milligrams per kilogram.
nd = not determined.
wt% = weight percent.
Bulk compositions were determined by x-ray fluorescence spectroscopy. Digestate and leachate compositions were determined by EPA protocols.

Table 6-7.a. Bulk, Digestate, and Leachate Compositions of Various Size Fractions of the Vadose Zone Soils Described in Table 6-3. Major elements are in wt%, others are in mg/kg. (sheet 1 of 3)

Analysis type	Analyte	Sample number						
		SB9+1	SB9+2	SB9+3	SB9+4	SB9+4.75	SB9+PAN	SB9<2mm
Bulk rock	Silicon	30.72	31.00	30.98	32.00	32.84	30.88	31.94
	Titanium	0.42	0.44	0.47	0.41	0.44	0.56	0.46
	Aluminum	4.00	3.99	3.83	3.62	3.45	3.70	3.64
	Iron	3.82	3.57	4.00	3.48	3.30	3.98	3.65
	Manganese	0.07	0.08	0.08	0.07	0.06	0.07	0.07
	Magnesium	1.27	1.33	1.30	1.21	1.13	1.28	1.25
	Calcium	2.27	2.32	2.35	2.26	2.38	2.67	2.42
	Sodium	0.95	0.91	0.82	0.86	0.90	0.84	0.88
	Potassium	1.22	1.23	1.20	1.11	1.00	1.03	1.07
	Phosphate	0.03	0.03	0.03	0.03	0.04	0.05	0.04
Digestion	Silicon	0.00	0.02	0.03	0.01	0.02	0.06	0.03
	Titanium	0.10	0.09	0.12	0.09	0.08	0.09	0.08
	Aluminum	0.80	1.02	1.41	1.18	1.12	1.27	1.09
	Iron	1.82	1.88	2.71	2.30	2.06	2.40	2.14
	Manganese	0.04	0.04	0.06	0.05	0.04	0.04	0.04
	Magnesium	0.63	0.58	0.79	0.70	0.59	0.66	0.64
	Calcium	0.81	0.91	1.20	1.14	1.12	1.47	1.17
	Sodium	0.02	0.03	0.04	0.03	0.03	0.04	0.03
	Potassium	0.24	0.23	0.34	0.27	0.20	0.20	0.22
Bulk rock	• Nickel	29	30	32	26	25	26	26
	• Chromium	53	56	63	54	53	62	53
	Scandium	16	17	13	15	17	18	18
	• Vanadium	94	90	102	70	78	88	97
	• Barium	834	821	842	770	659	638	703
	Rubidium	113	116	115	102	89	94	100
	Strontium	327	297	302	291	285	264	292
	• Zirconium	154	187	200	183	312	498	298
	Yttrium	25	27	30	27	29	43	32
	Niobium	13.7	17.8	17	18.6	14.6	19.9	15.9
	Gadolinium	21	18	21	15	17	15	18
	• Zinc	95	84	88	76	71	85	71
	• Lead	19	25	23	23	23	41	20
	Lanthanum	19	19	48	30	26	55	38
	Cerium	47	78	74	73	93	134	102
	Thorium	11	12	12	12	13	18	14
Digestion	Nickel	17.3	15.7	20.9	19.6	15.9	17.8	17.1
	Chromium	15.7	17.5	22.8	19.1	17.8	18.7	17.3
	Arsenic		5.5	7.9	7.2	6.6	9.9	7.5
	Vanadium	33.6	34	47.3	38.3	35.6	41.6	35.1
	Barium	92.2	113	193	159	97.5	94.4	119
	Beryllium	0.78	0.9	1.4	1.2	1.1	1.2	1.1
	Zirconium	13	10	14.3	12.5	13.6	17.2	11.9
	Cobalt	8.3	8.2	12.8	11	9.1	10.3	9.9
	Zinc	46.4	48.4	68.9	60.9	50.9	64.9	52.9
	Lead	10.6	13.6	22.2	21.5	19.4	34.2	15
Leachate	Ammonia	nd	nd	nd	nd	nd	nd	nd
	Alkalinity	56	1,810	1,380	1,570	3,590	2,470	2,160
	Fluoride	2.75	1.59	3.44	3.24	30.4	4.08	6.1
	Chloride	58.5	31.9	49.4	84.2	142	99	94.9
	Nitrite						0.35	
	Nitrate	308	69.1		532	822	498	499
	O-Phosphate						1.78	
	Sulfate		59.4	63.2	107	144	92.1	61.5

Table 6-7.b. Bulk, Digestate, and Leachate Compositions of Various Size Fractions of the Vadose Zone Soils Described in Table 6-3. Major elements are in wt%, others are in mg/kg. (sheet 2 of 3)

Analysis type	Analyte	Sample number				
		SB11+0	SB11+1	SB11+2	SB11+3	SB11<2mm
Bulk rock	Silicon	27.85	27.48	27.55	27.66	27.52
	Titanium	1.00	1.06	1.09	1.11	1.07
	Aluminum	3.64	3.52	3.43	3.36	3.46
	Iron	7.10	7.67	8.07	8.25	7.86
	Manganese	0.11	0.12	0.13	0.14	0.13
	Magnesium	1.80	1.97	2.06	2.03	2.02
	Calcium	4.63	4.86	4.87	4.45	4.80
	Sodium	1.25	1.13	1.08	0.95	1.10
	Potassium	0.63	0.62	0.64	0.69	0.64
	Phosphate	0.07	0.07	0.07	0.06	0.07
Digestion	Silicon	0.00	0.00	0.00	0.00	0.00
	Titanium	0.20	0.31	0.32	0.36	0.32
	Aluminum	0.42	0.53	0.41	0.60	0.44
	Iron	2.40	3.28	2.83	3.49	3.04
	Manganese	0.03	0.04	0.04	0.05	0.04
	Magnesium	0.28	0.36	0.27	0.36	0.29
	Calcium	0.57	0.77	0.63	0.71	0.72
	Sodium	0.02	0.04	0.02	0.03	0.03
	Potassium	0.08	0.07	0.06	0.09	0.06
Bulk rock	Nickel	8	4	8	8	4
	Chromium	26	28	30	35	30
	Scandium	27	29	33	31	37
	Vanadium	241	283	280	285	278
	Barium	665	607	624	646	627
	Rubidium	41	41	43	49	43
	Strontium	403	360	327	315	346
	Zirconium	160	160	158	169	162
	Yttrium	31	30	31	32	31
	Niobium	15	12.1	15.3	16	12.7
	Gadolinium	20	20	20	19	17
	Zinc	97	104	105	105	101
	Lead	14	5	7	13	6
	Lanthanum	17	27	15	20	15
	Cerium	32	40	63	40	43
	Thorium	4	6	5	5	6
Digestion	Nickel	6.8	7	6.2	8.7	5.6
	Chromium	4.5	3.3	2.3	5.4	2.8
	Arsenic	0.9	1.3	1.8	1.1	0.9
	Vanadium	61.3	97.6	91.8	122	95.7
	Barium	59.8	60.7	57	118	67
	Beryllium	0.9	1.2	1	1.4	1.1
	Zirconium	25.7	36.5	32.5	34.4	32.1
	Cobalt	9.3	14.8	13.5	17.8	13.8
	Zinc	39.5	53.7	43.2	52.8	47.7
	Lead	3.5	8.2	5	7.3	7.4
Leachate	Ammonia	nd	1.32	nd	nd	nd
	Alkalinity	1,210	565	259	1,280	706
	Fluoride	3.13	2.37	5.9	6.72	3.78
	Chloride	3.74		3.23	3.13	3.98
	Nitrite					
	Nitrate	19.5		19.2	19.2	19.6
	O-Phosphate					
	Sulfate	14.7	10.1	13.4	14.7	13.9

Table 6-7.c. Bulk, Digestate, and Leachate Compositions of Various Size Fractions of the Vadose Zone Soils Described in Table 6-3. Major elements are in wt%, others are in mg/kg. (sheet 3 of 3)

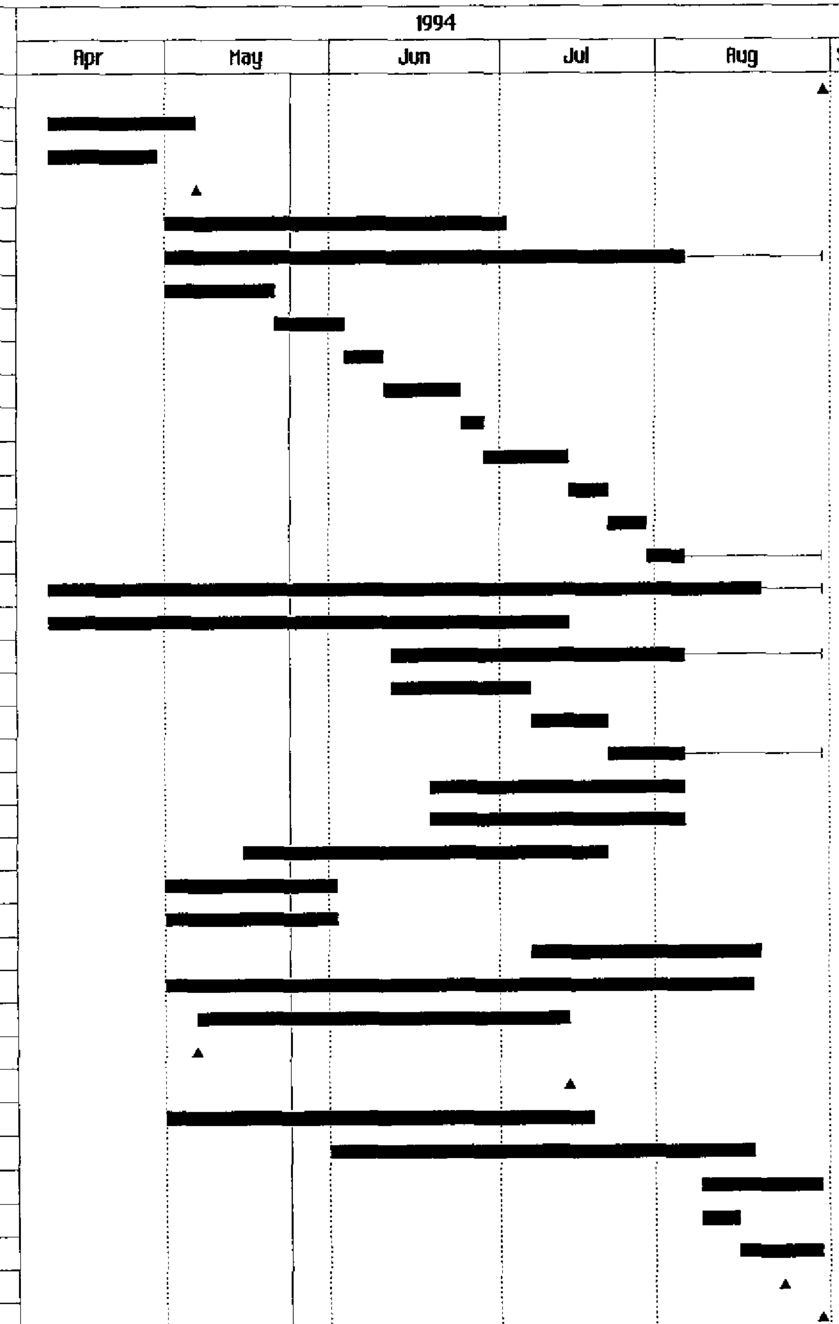
Analysis type	Analyte	Sample number					
		SB12-1	SB12+0	SB12+1	SB12+2	SB12+3	SB12<2mm
Bulk rock	Silicon	26.73	26.47	27.35	35.15	30.56	27.57
	Titanium	1.07	1.20	1.04	0.32	0.59	1.04
	Aluminum	3.69	3.70	3.63	2.92	3.65	3.61
	Iron	7.31	7.98	6.86	2.53	4.21	7.13
	Manganese	0.13	0.13	0.13	0.05	0.08	0.13
	Magnesium	1.90	2.00	1.75	0.66	1.21	1.83
	Calcium	4.99	4.85	3.90	1.45	2.55	4.22
	Sodium	1.03	1.02	0.83	0.80	0.90	0.94
	Potassium	0.73	0.70	0.83	1.14	1.12	0.79
	Phosphate	0.08	0.08	0.07	0.02	0.04	0.07
Digestion	Silicon	0.00	0.00	0.01	0.01	0.00	0.01
	Titanium	0.10	0.18	0.16	0.08	0.10	0.14
	Aluminum	1.10	0.71	1.14	0.66	1.03	0.66
	Iron	3.24	2.83	3.39	1.48	2.32	2.28
	Manganese	0.03	0.13	0.07	0.03	0.04	0.04
	Magnesium	0.61	0.44	0.59	0.33	0.58	0.40
	Calcium	2.11	0.77	1.00	0.45	1.00	1.02
	Sodium	0.07	0.06	0.08	0.04	0.05	0.05
	Potassium	0.13	0.09	0.18	0.13	0.21	0.12
Bulk rock	Nickel	13	12	16	13	19	13
	Chromium	44	35	44	21	48	50
	Scandium	30	34	30	9	16	24
	Vanadium	250	277	243	78	119	247
	Barium	633	635	699	882	925	722
	Rubidium	57	53	72	91	103	64
	Strontium	317	315	275	274	337	309
	Zirconium	171	178	175	120	186	172
	Yttrium	34	36	32	16	28	33
	Niobium	18.7	16.9	20.9	9.2	19.3	16.6
	Gadolinium	19	19	21	14	17	21
	Zinc	108	117	109	49	81	108
	Lead	8	10	12	14	16	10
	Lanthanum	23	26	11	22	35	17
	Cerium	39	35	53	37	61	55
	Thorium	7	6	10	6	11	7
Digestion	Nickel	12.9	8.9	13.5	8.5	14.3	8.8
	Chromium	9.2	6.5	12.6	9.4	15.7	7.6
	Arsenic	2.2	2.5	6.9	4.2	0.9	3.5
	Vanadium	51.5	67.1	76.2	32.5	47.5	51.1
	Barium	95.8	294	146	119	256	127
	Beryllium	1.8	1.1	1.7	0.8	1.2	1.1
	Zirconium	29.5	30.2	31.9	14.6	22.7	25.2
	Cobalt	12.2	15.4	13.6	7.5	11	9.8
	Zinc	60.2	52.4	62.3	33.3	52.4	45
	Lead	12.5	11	15.7	6.9	13.6	6.9
Leachate	Ammonia	nd	nd	nd	nd	nd	0.62
	Alkalinity	958	551	967	697	36	284
	Fluoride	2.92	2.39	1.99	2.37	2.3	2.99
	Chloride	875	840	891	525	590	700
	Nitrite						
	Nitrate	56	37.9	56	35.2	43	45.4
	O-Phosphate						
	Sulfate	86.5	103	268	545	1,060	1,304

mg/kg = milligrams per kilogram.
nd = not determined.
wt% = weight percent.
Bulk compositions were determined by x-ray fluorescence spectroscopy. Digestate and leachate compositions were determined by EPA protocols.

Attachment #11

100-HR-3 Pump and Treat Treatability Test

Task Name	Start Date	End Date	Duratn (Days)
TPA Milestone	31-Aug-94	31-Aug-94	0
Develop Strategy	11-Apr-94	6-May-94	19
Develop Strategy	11-Apr-94	29-Apr-94	14
Regulator Approval	6-May-94	6-May-94	0
Well Pump Tests	2-May-94	5-Jul-94	44
Prepare Test Plan	2-May-94	5-Aug-94	67
Draft Test Plan	2-May-94	20-May-94	14
WHC/DOE Review	20-May-94	3-Jun-94	9
Comment Resolution	3-Jun-94	10-Jun-94	5
Revise Document	10-Jun-94	24-Jun-94	10
Transmittal	24-Jun-94	29-Jun-94	3
Regulator Review	29-Jun-94	15-Jul-94	11
Comment resolution	15-Jul-94	22-Jul-94	5
Revise Document	22-Jul-94	29-Jul-94	5
Issue Document	29-Jul-94	5-Aug-94	5
Supporting Documents	11-Apr-94	19-Aug-94	92
NEPA	11-Apr-94	15-Jul-94	67
Operating Procedures	13-Jun-94	5-Aug-94	38
Draft Procedures	13-Jun-94	8-Jul-94	18
WHC Review	8-Jul-94	22-Jul-94	10
Revise and Issue	22-Jul-94	5-Aug-94	10
HWOP	20-Jun-94	5-Aug-94	33
RWP	20-Jun-94	5-Aug-94	33
Safety Assessment	16-May-94	22-Jul-94	47
Plant Forces Work Review	2-May-94	2-Jun-94	22
POC Checklist	2-May-94	2-Jun-94	22
Readiness Review	8-Jul-94	19-Aug-94	30
Equipment	2-May-94	18-Aug-94	76
Ion Exchanger Unit	6-May-94	15-Jul-94	48
Award Contract	6-May-94	6-May-94	0
Take Delivery	15-Jul-94	15-Jul-94	0
Ancillary Equipment	2-May-94	20-Jul-94	55
Construct and inspect	1-Jun-94	18-Aug-94	55
Operational Testing	9-Aug-94	31-Aug-94	16
Train Operators	9-Aug-94	16-Aug-94	5
Functional Test	16-Aug-94	31-Aug-94	11
5 Day Notification	24-Aug-94	24-Aug-94	0
Start System	31-Aug-94	31-Aug-94	0



Location of Test is 100-D

100-HR-3 PILOT SCALE TREATABILITY TEST
INTERNAL DRAFT TECHNICAL PROPOSAL

May 18, 1994

9413293.3409

Regulatory Requirement

TPA Milestone M-15-06E -- Begin pilot-scale pump and treat operations for 100-HR-3 by August 31, 1994.

Pilot Test, Phase I and II

Ion exchange was selected as the treatment method of choice as described in document WHC-SD-EN-TC-003, Rev 1, 100-HR-3 Area Groundwater Treatment tests for Ex Situ Removal of Chromate, aNitrate and Uranium (VI) by Precipitation/Reduction and/or Ion Exchange, dated August 5, 1993. As a result, ion exchange (IX) will be demonstrated to meet the M-15-06 milestone.

The IX system will be operated in two phases. During Phase I of the treatability test the IX system will be operated nominally 8 hours per day, 5 days per week with no provisions for winter operations. Individual well capacities will be determined and the operational parameters of the IX system will be verified. In Phase II, the IX system and extraction and injection well systems will be modified as required for 24 hour/day, 7 day/week four season operation. The target date for Phase II operational capability is March, 1995.

Spill protection for extracted water prior to treatment will consist of drip trays installed at all areas of line fittings, valves, flanges, etc. between the well head and the IX treatment column.

Site Considerations

Reactor area --The 100-D area was selected due to higher levels of chromium (2000 Vs 350 ppb) in groundwater than in the 100-H area. The relatively narrow configuration of the chromium plume in proximity to well D5-15 also was a consideration.

Preferred extraction wells --Well 199-D5-15 has the highest measured values of chromium (VI) in 100-HR-3. D5-15 is an existing monitoring well with an estimated 12 to 17 gpm extraction rate. Other possibilities for extraction wells are D5-16 and D5-14, in order of preference. Limited existing data indicate that these wells may have limited production capacity. Actual extraction rates will be determined by conducting pumping tests following redevelopment of these wells.

Influent- Phase I -- Well D5-15 will be pumped at its nominal sustainable rate to the IX system. The IX system will be operated on a nominal 8 hour/day basis 5 days/week. If sustained flow from well D5-15 is less than the minimum flow requirements of the IX system an inventory will be built up to allow a nominal 8 hour/ day system operation. Following an extended period of pumping from well D5-15 (to observe potential drawdown in wells D5-14 and D5-16) these wells will be manifolded to the IX system to provide additional influent capacity and chromium plume capture and treatment. Sustained flow capacities for each individual well will also be measured.

Effluent -Phase I -- Effluent from the IX system will flow through a polishing filter, a biocide injector, and then via flex hose to injection wells located 500 to 600 meters to the south (D5-18 and D5-19).

Influent- Phase II--It appears that the three well network may be extraction limited, therefore all three wells will be manifolded for continous (24 hour/day) pumping to an influent storage tank. This will facilitate handling the various flow rates and pressures from the three individual wells and also provide an adequate inventory to run the IX system at or near capacity during a single (day) shift.

Effluent- Phase II--Effluent from the IX system will flow into an effluent storage tank. This tank will provide several functions: 1) sufficient capacity to allow continuous (24 hour) flow to the injection well system (to inhibit potential "sanding" problems); 2) act as a "blending" tank for the biocide addition; and 3) provide storage capacity (prior to injection) that can be routed back to the influent tank for reprocessing should the need arise. A booster pump, if needed, will be installed to pump fluid from the effluent tank through the polishing filter to the injection well network.

Winterization-- Prior to initiating Phase II, the entire pilot test system will be modified to allow four season operational capability.

Treatment System

Ion Exchange Unit -- The IX unit will consist of four columns with three in operation in a lead-lag-lag (series) alignment and the fourth in standby (resin change out). The columns will be manifolded to allow all possible variations of alignment. The unit will be skid-mounted, expandable, and operated via programmable logic controllers (PLC's) with air-operated control valves. All piping is schedule 80 PVC and the unit is being fabricated by Resource Technologies Group, Inc. in Lakewood, Colorado.

Resin -- Selected resin is DOWEX 21K, manufactured by Dow Chemical Company. DOWEX 21K is a strong-base anion exchange resin and will very effectively remove chromate (target contaminant), and uranium, with limited nitrate capability.

Sampling -- The IX unit will have sampling valves on the system influent line and effluent line of each column for grab samples. Samples will initially be field tested for Cr(VI) with a HACH DR-100 colorimeter using an Acc-u-vac ampule with a Cr(VI) detection limit of <50 ppb. QA samples will be collected and laboratory analyzed for Cr(VI) (water) and gross alpha and beta (resin).

Hydrogeologic Considerations

Adjacent wells -- Surrounding wells are currently monitored monthly for water level and every six months for chemical analyses and this schedule will remain unchanged. This information will be used to assess general changes in localized groundwater flow and chromium plume concentration. Wells D5-14, D5-16 and D5-12 will initially be instrumented with pressure transducers and data loggers to monitor potential water level response to pumpage from well D5-15.

Test Performance Goals

Effluent Chromium (VI) Concentration-- The treatability goal for the IX system shall be to maintain injected effluent below 50 ppb which is consistent with WAC 173-200 for disposal to the ground, and more conservative than the Model Toxics Control Act (MTCA) guidelines stated in the Test Plan.

Pilot-scale -- By measuring chromium concentrations changes over time and taking into account the total flow through the IX unit, the mass of chromium (VI) removed from the aquifer will be calculated. The mass removed compared to the estimated total mass of chromium in the plume will be the measure of system performance. The chromium capture zone will be calculated theoretically or empirically to determine the zone of influence of the pump and treat system and estimates will be made of the dependence on the zone of influence to changes in groundwater extraction rates. Other Phase I goals are: 1) determine maximum sustainable individual well extraction rates; 2) individual extraction well chromium concentration Vs time; and 3) verify IX column resin life Vs flow rate/concentration of influent.

Continuous operation -- After continuous operation commences in phase II, the mass of chromium removed will continue to be measured to assess the long-term performance of the system for chromium (VI) removal. The continuous operation of the IX system may be interrupted for valid technical reasons such as: 1) to modify and upgrade the components or controls of the system; 2) to evaluate the operational mode of "pulsing" the extraction system by switching the system off for sufficient time to "rewet" the sediments in the cone of depression; 3) to conduct various tests/remediation of the extraction, injection or treatment systems; 4) to move the entire system to another area of interest; or 5) the influent concentration approaches the treatment concentration goal of 50 ppb and it is no longer economically nor technically feasible to continue system operation at that well network.

100-HR-3 Groundwater Treatability Pilot Test
Summmary of Items of Aggreement
Among WHC/DOE/WSDOE/EPA

Considerable discussion concerning the 100 HR-3 Groundwater Treatability Pilot Test has taken place over the last six months or so. The summary below is an attempt to list those items in which WHC believes we have general, although not necessarily formal, agreement between the parties. Please review these items and provide any comments back to me prior to next weeks Unit Managers Meeting.

- The Groundwater Treatability Pilot Test (Pilot Test) will utilize only **existing wells** in the 100 HR-3 groundwater operable unit.
- **Chromium (VI)** is the **contaminant of concern** for treatment, and required sampling and analysis in the Pilot Test is limited to this constituent.
- **Biodentrification** was agreed to be **deleted** from the current 100HR-3 Pilot Test.
- The Bench Scale studies recommend **ion exchange** as the method of choice for the Pilot Test.
- Well **D5-15 in D Reactor** area is the existing well of choice for initiation of the Pilot Test.
- Treated **effluent** to be disposed by **re-injection** via existing wells.
- The Pilot Test system will **continue to be operated** for chromium (VI) removal after initial Pilot Test goals have been achieved.

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Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
May 26, 1994

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