Ross ISR Uranium Recovery Project

Public Meeting and
Presentation to the NRC

April 13, 2010

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Meeting Agenda

- Update Regarding Ross Project
  - Agency Consultations
  - Pre-Operational Sampling and Investigation
  - Permitting
- Radiological Baseline Characterization Program
- Conceptual Completion of Stacked Roll Fronts
- Questions from NRC and Strata

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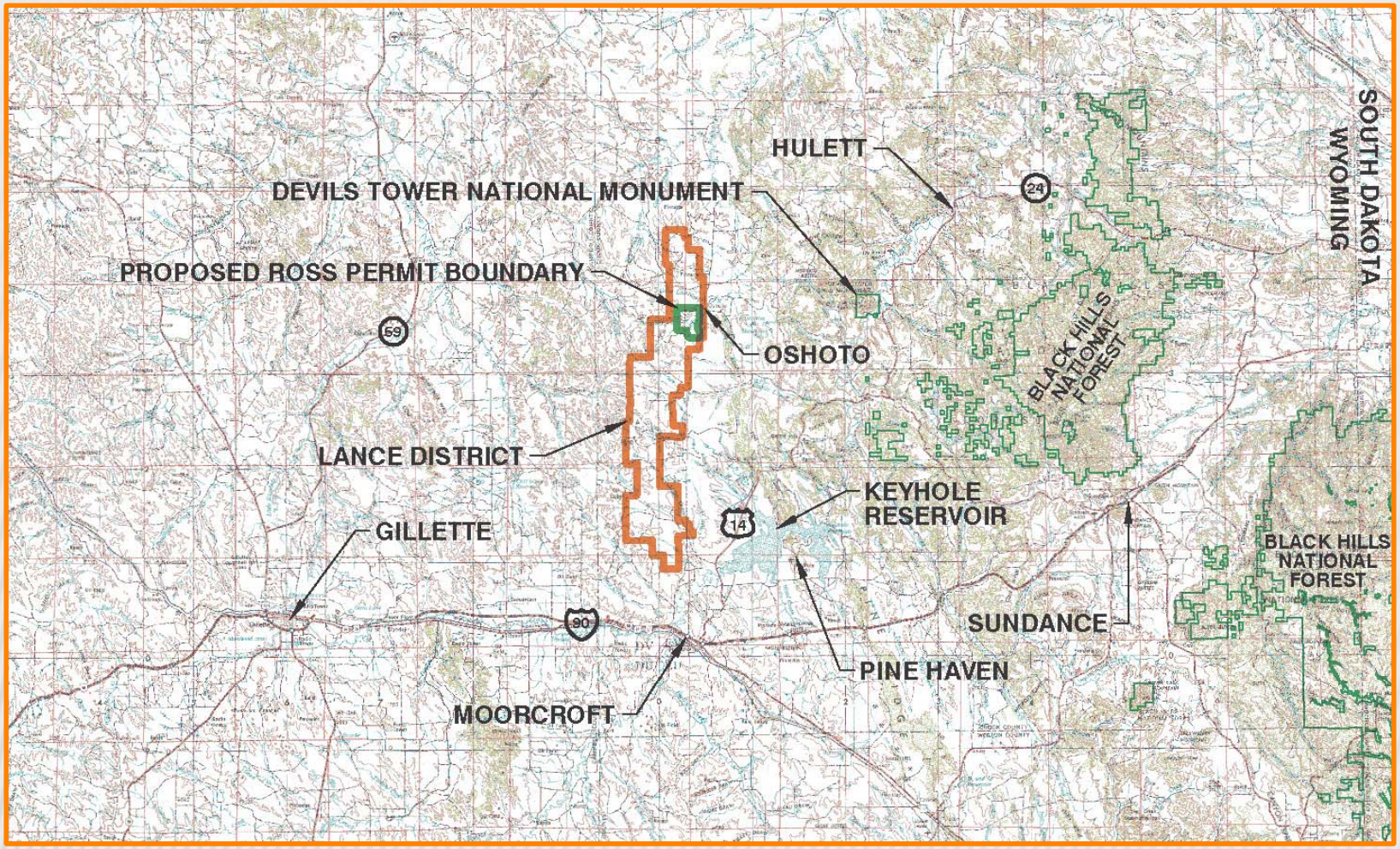
Ross Project/Lance District General Location



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Ross ISR Project Licensing Update

- Agency Consultations:
  - Bureau of Land Management: March 11 meeting with Buffalo Field Office to discuss geology and hydrology
  - Wyoming DEQ: Submitted groundwater model work plan for DEQ review in March
  - Strata attended State of Wyoming ISR Sage Grouse Working Group meeting April 8
- Other Consultations:
  - February 24 PRBRC: regulatory and technical overview

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Ross ISR Project Licensing Update . . .

- Pre-Operational Sampling and Investigations
  - Wildlife surveys: submitted final sampling plans for critical wildlife surveys to WGFD and USFWS
  - Submitted temporary WYPDES NOI for aquifer testing
- Permitting
  - Strata has requested internal drafts of ER and TR
  - Draft ER submitted April
  - Draft TR anticipated May 9

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Ross ISR Licensing Update . . .

- Upcoming Work (April-May)
  - Exploration hole plugging in preparation for multi-well aquifer testing: 47 holes within 522' radius of ore zone baseline well (12-18), full cement to surface
  - Surface water monitoring station installation
  - Cultural surveys with focus on BLM surface
  - Conduct raptor and sage grouse surveys
  - Initiate contact with USACE on wetlands
  - Continue mine planning (IX capacity, production and restoration flow rates) based on testing results (agitation leach, Nubeth, etc.)
  - Initiate mine simulation using groundwater model

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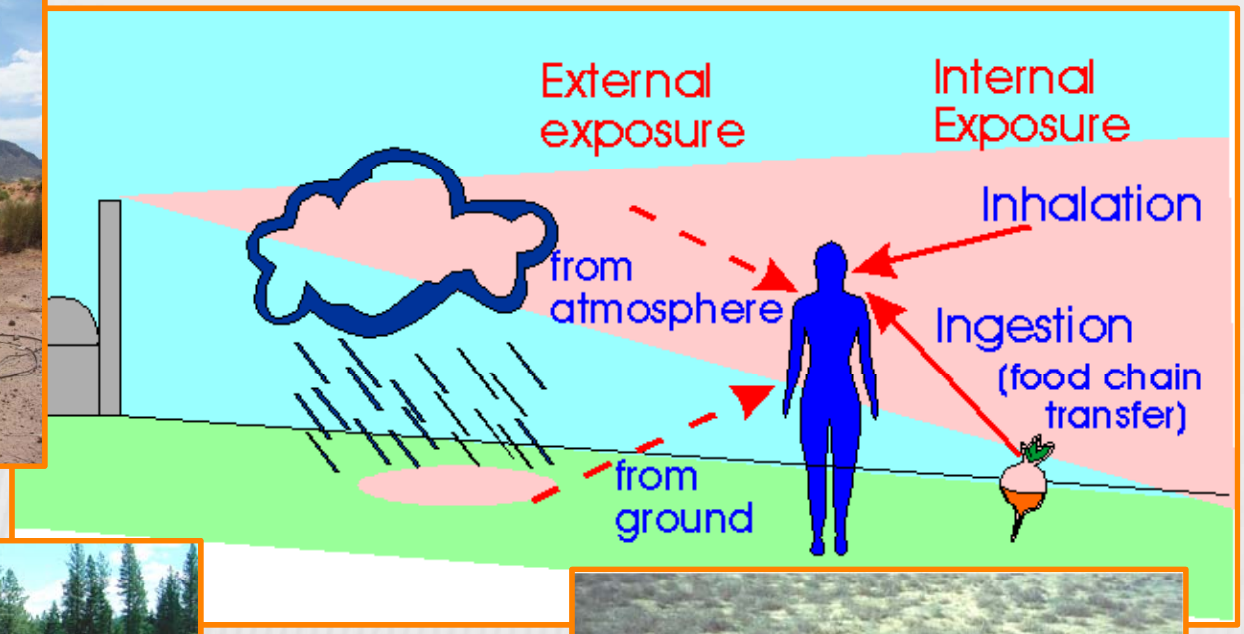
Ross ISR Radiological Baseline Characterization Program



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Basis for Establishing Baseline Characterization for "Any" Site

- What are and where are the effluent sources ?
- Which way does the wind blow and water flow relevant to these sources ?
- What and where are the targets (media) that are potentially impacted by the effluents in consideration of which way wind blows and water flows?
- Where are the people and how are they potentially exposed to the media (air, water, soil, vegetation, critters)

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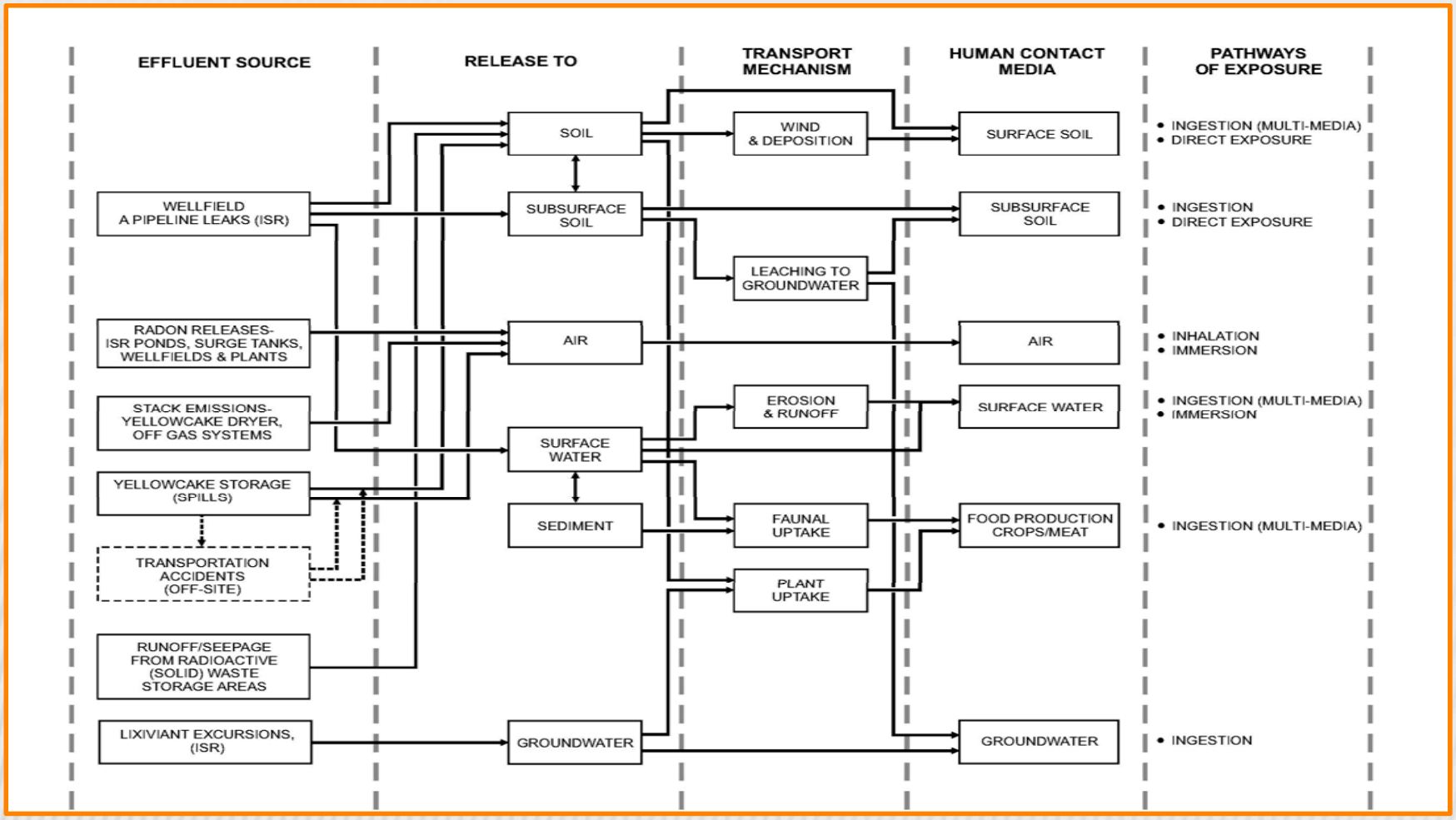
Generic Conceptual Site Model – U ISR



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Generic to Site-Specific CSM – Define Local Characteristics Relevant to Rad Impacts to Humans

- Have Established Two Candidate CPP locations and preliminary layout of well fields – defined sources/ nature/ locations of effluents relative to which way wind blows, which way water flows and where people live
- Have identified transport mechanisms to media potentially impacted (air, soil, vegetation, surface and groundwater water, etc)
- Have identified locations of nearest residences to site and the general characteristics of local demographics (where does their food/water come from) are being established
- Have identified how humans can contact impacted media (local exposure pathway) including food chains to humans
- Twelve month program of measurement, collecting and characterizing media in completed pathways per RG 4.14 underway

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Regulatory Guidance

- Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*
- Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment
- Regulatory Guide 3.46, *Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining*
- NUREG 1569, *Standard Review Plan for In Situ Leach Uranium Recovery License Applications, 2003.*
- NUREG 1748, *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs, 2003.*
- NUREG 1910, *Generic Environmental Impact Statement for In-Situ Uranium Milling Facilities, 2009.*

RG 4.14 Radiological Characterization Program Elements

- Long lived alpha emitting air particulates via continuous filter collection
- Radon gas via passive detectors (continuous)
- Ground water (quarterly as available)
- Surface water (seasonal) and ephemeral
- Vegetation
- Food products relevant to local human food chain
- Soil – surface and profiles (once)
- Sediment (seasonal)
- Direct radiation measurements via both real time gamma surveys (once) and integrating dosimeters (continuous)

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Example "ISR Modifications" to Meet Intent of RG 4.14

Program Element	Reg. 4.14 Conventional Uranium Mill Requirement	Ross ISR Modification
Surface Soil and Soil Profiles	Polar coordinate grid centered at "mill" out to 1500 meters (40+ locations, 5 profiles)	Areas of Interest: Residences, Future CPP and evaporation pond locations, over ore bodies (38 locations, 17 profiles)
Radon Flux	Polar coordinate grid, centered at "mill" out to 1500 meters	No conventional tailings, not necessary
Direct Radiation	Integrating dosimeters (TLDs) in polar coordinate grid centered at mill out to 1500 meters, about 80 locations	Integrating dosimeters at areas of interest (17) and real time direct gamma scan of permit area, mapped with GPS locations - many thousands of data points
Groundwater Sampling	Quarterly sampling of all domestic wells located within 2 km of the permit area	Many wells are no longer functioning or are not operated in the winter time
Surface Water Sampling	Required monthly sampling of all bodies of water crossing the site.	Streams are ephemeral, will be sampled when possible via passive storm water collectors

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Support Documentation for Radiological Baseline Program

- Sampling and Analysis Plan (SAP) – defines sampling / measurement protocols, frequencies, locations and analytical requirements for each program element (media)
- Standard Operating Procedures (12 SOPs) – defines detailed field methods for each program element (media) and includes SOPs for overall sample and data management
- Health and Safety Plan (HASP) – defines H & S requirements for field work

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Formal "Product" of the Radiological Baseline Field Program

- Summary of rational, methods and results = Section 2.9, *Radiological Background Characteristics* of Technical Report
- NUREG 1569 defines acceptance criteria:
  - Monitoring programs are established per pre-operational monitoring guidance provided in Regulatory Guide 4.14
  - Field programs conducted per NUREG–5849 , *Manual for Conducting Radiological Surveys in Support of License Termination* or NUREG–1575, Revision 1, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM)
  - Background radiologic characteristics are described including radionuclides monitored, sampling frequency, methods, location and density
  - Preoperational monitoring that allows for 12 consecutive months of sampling

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Radiological Baseline Characterization Program

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Radionuclides of Interest

- Air: U-nat, ^{226}Ra, ^{230}Th, ^{210}Pb (Reg Guide 4.14)
- Soil: U-nat, ^{226}Ra, ^{230}Th, ^{210}Pb (Reg Guide 4.14)
- Radon Gas (Reg Guide 4.14)
- Water: U-nat, ^{226}Ra, ^{230}Th, ^{210}Pb, ^{210}Po (Reg Guide 4.14) OR Omission of ^{230}Th sampling as suggested in NUREG 1569 section 2.7.3, subpart (4)
- Vegetation and Animal Tissue: U-nat, ^{226}Ra, ^{230}Th, ^{210}Pb (Reg Guide 4.14)

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Air Particulate Sampling

- Requirements: 5 air sampling stations with continuous air monitoring for 4 quarters (continued use during operation):
  - Offsite Met Station
  - Two Nearest Residences
  - Two Other Monitors at Boundaries

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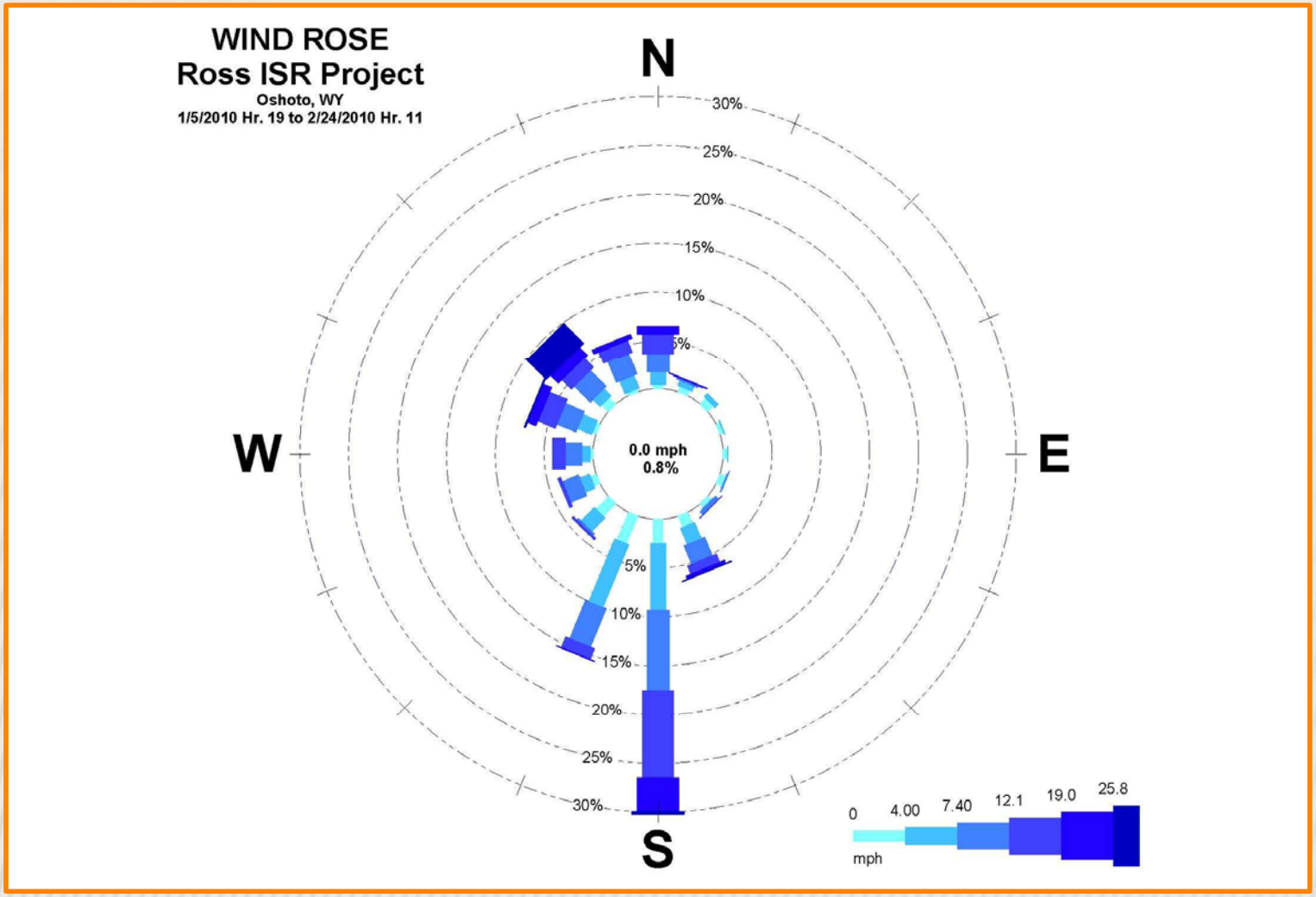
Wind Rose – Ross ISR Project



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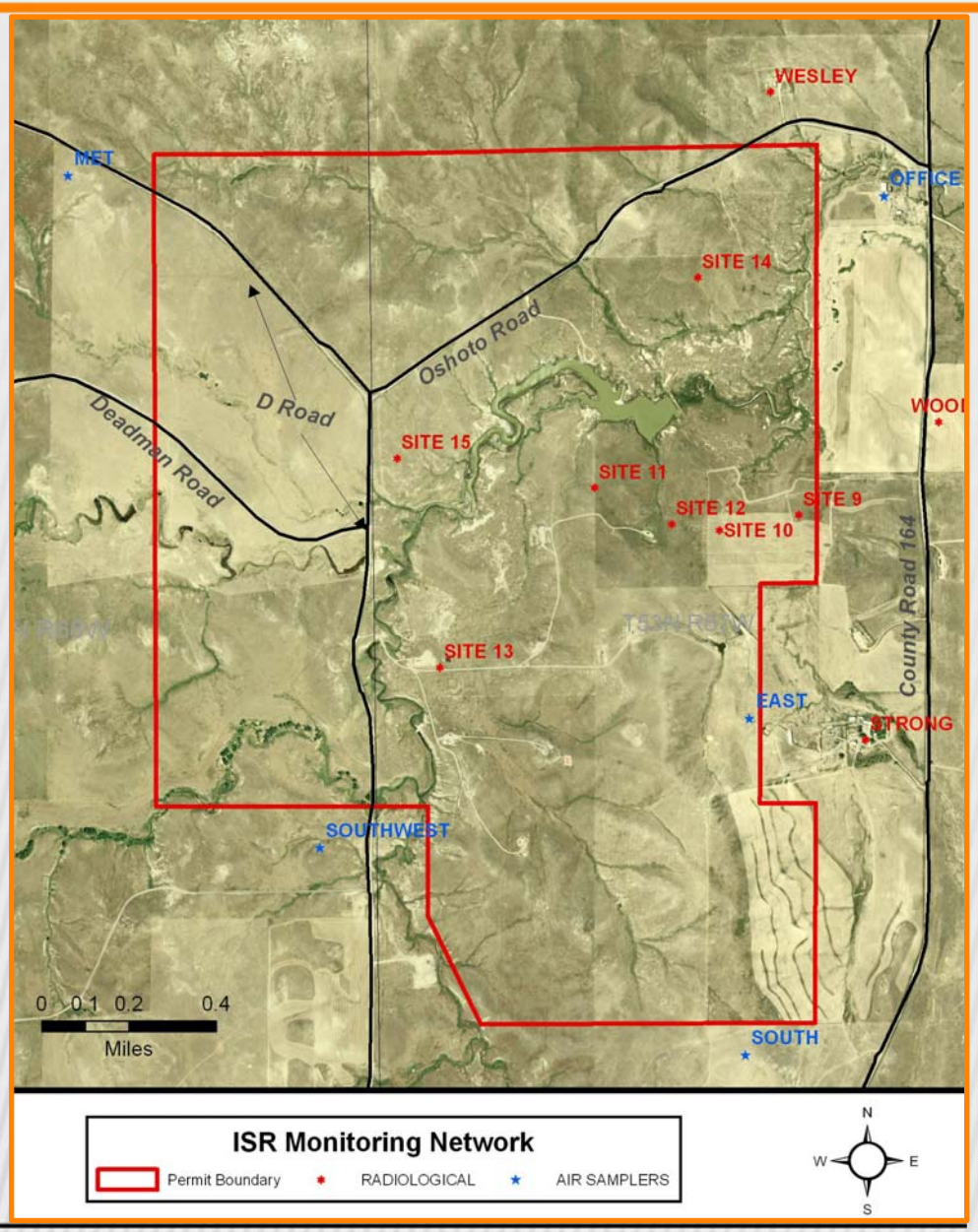
Ross ISR Air and Radiological Monitoring Sites



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Soil Profiles

- Soil Profiles: Traditional in Reg Guide 4.14 based on a polar coordinate grid, 5 total profiles.
- Not meaningful as baseline for this site
- Establish “Areas of Interest” for this site:
  - Particulate monitoring stations
  - Residences close to permit area
  - Potential locations for central processing plant and evaporation ponds
  - Former R&D Site

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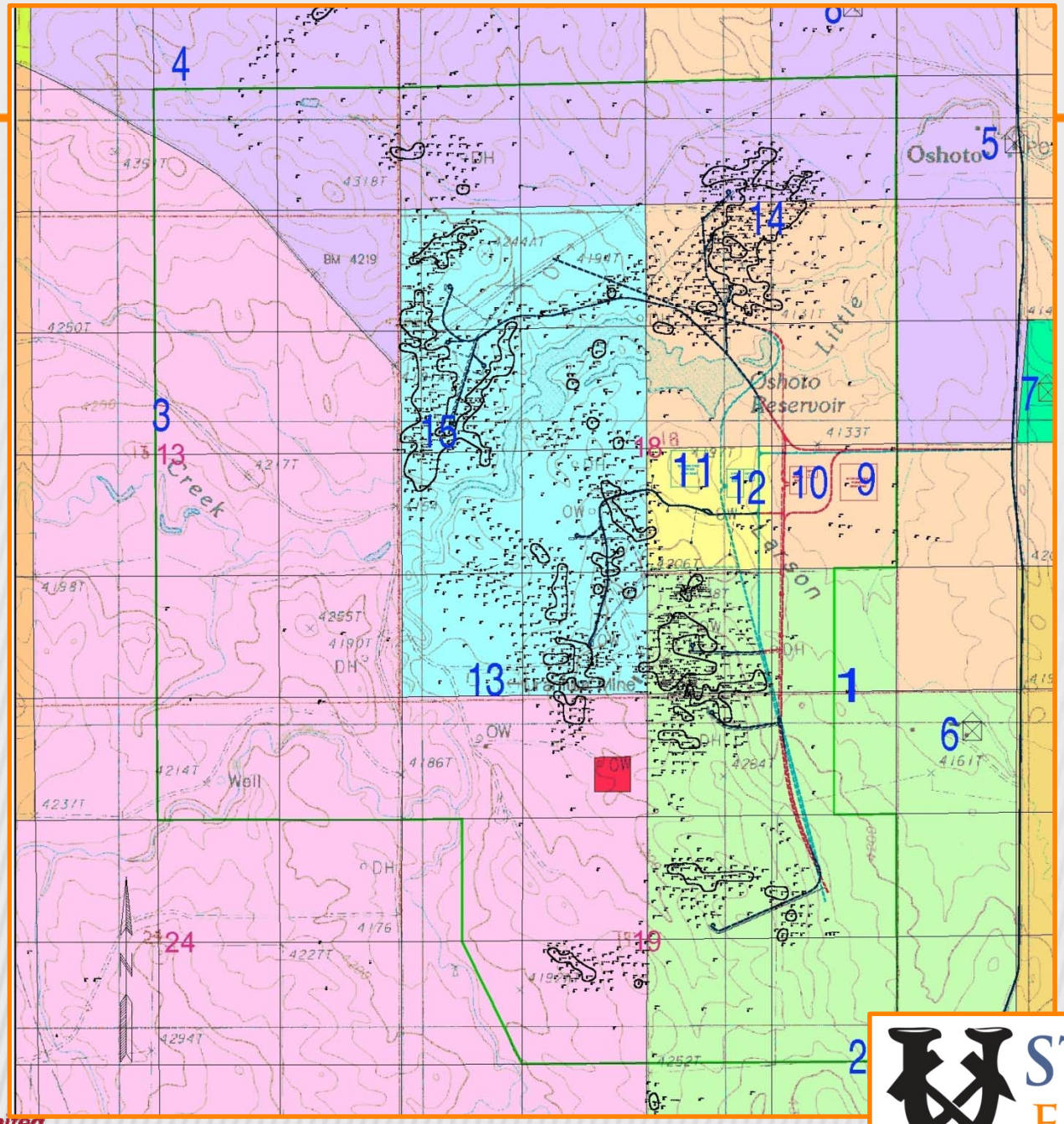

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Surface Soil Sampling

- Reg Guide 4.14 defines the same polar coordinate scheme with higher density of sampling than for profiles (every 300 meters)
- All profile locations will also include a surface sample
- In addition, sampling along mineable ore bodies, every 300 m as represented of well fields
- Surface soil samples will be taken from 0-15 cm as this depth is more practical and better aligned with future compliance with decommissioning standards

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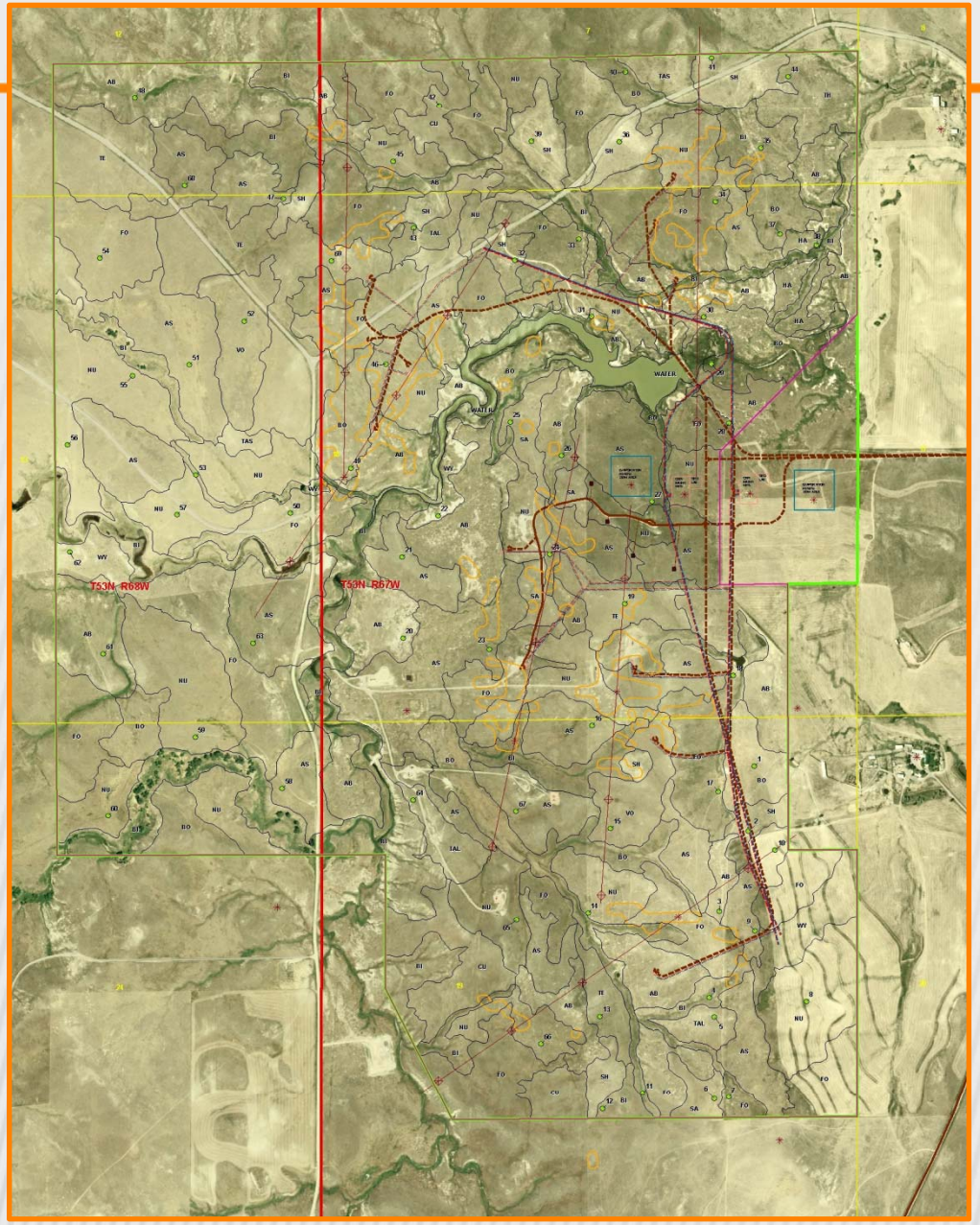

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Radon

- Reg Guide 4.14 - 5 locations
- Ongoing sampling for radon in air with Landauer track-etch style detectors at Areas of Interest (15). Quarterly exchanges of monitors to account for seasonal variation.

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Direct Radiation

- Reg Guide 4.14 guidance uses the polar coordinate grid system with about 80 integrating dosimeters or a pressurized ion chamber
- More detailed information will be/is being obtained:
  - Landauer Environmental TLD monitors placed in the field at "Areas of Interest" and exchanged quarterly- provides long term information
  - In late spring/early summer (dry weather), a one time comprehensive scan of direct gamma radiation will be conducted. (thousands of data points)
  - Will give a more complete data set than is recommended by 4.14 and will enhance compliance with decommissioning standards

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Groundwater

- 4.14 requires ground water samples up and down gradient of the site, hydrologically connected to the tailings impoundment; quarterly sampling, using regional baseline wells drilled (interpretation of tailings pile to be central processing plant location)
- Also requires the sampling of ALL water supply wells within a 2km radius
- Many water supply wells are not functioning or seasonally operated

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Surface Water

- 4.14 mandates sampling of all water impoundments on the site quarterly and all water bodies passing through the site monthly
- Many water impoundments are frozen in the winter
- Streams crossing the site are all ephemeral and will be sampled with storm water samplers when storm events occur.

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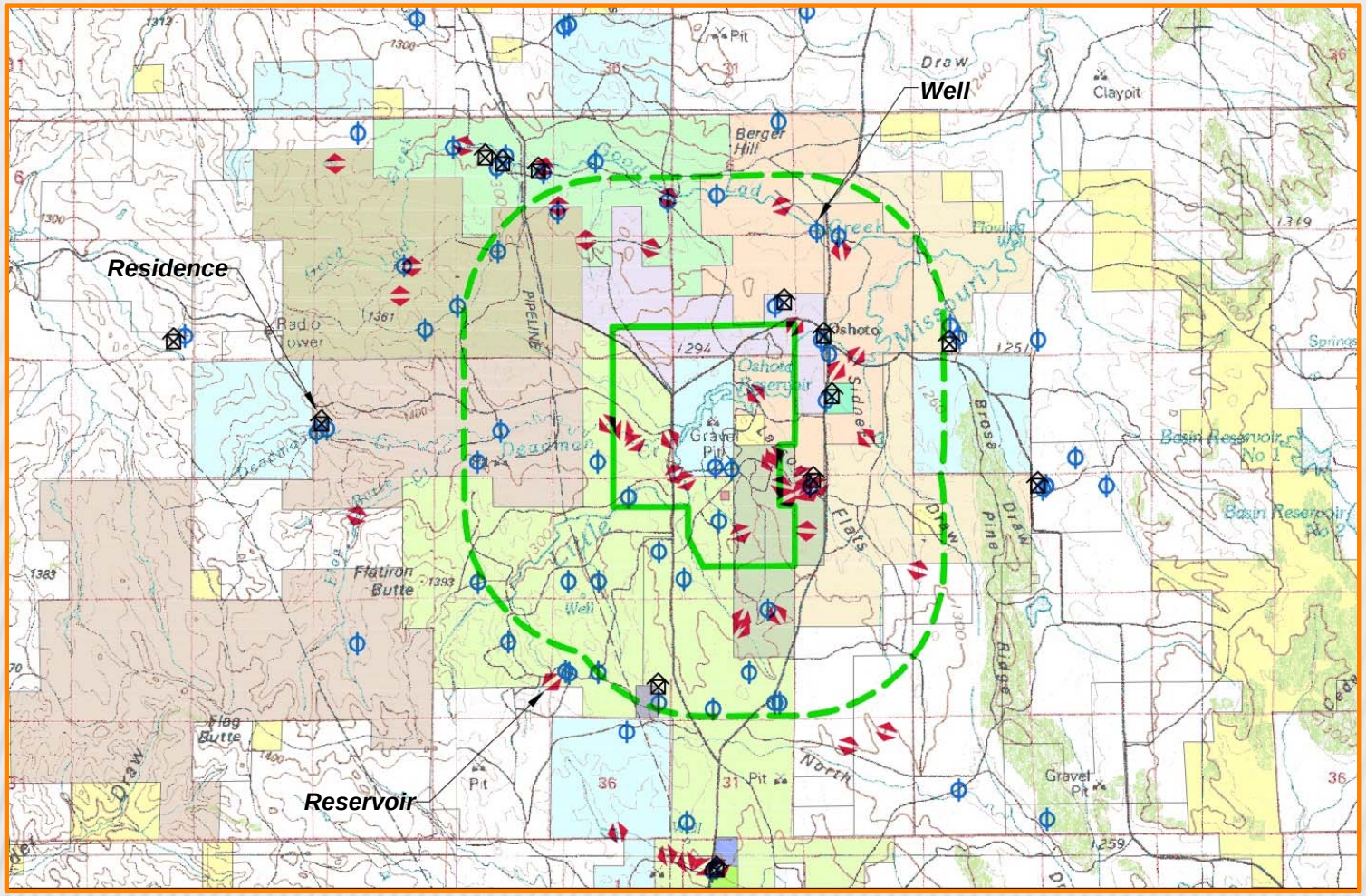
Water Supply Wells and Surface Water Impoundments



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Vegetation Sampling

- Reg Guide 4.14: samples from grazing areas that have the highest predicted air particulate concentrations 3 times during the growing season and / or 3 food product samples at harvest
- Characterization and sampling of site vegetation is soon to be initiated and will be on going.
- Grazing animals feed on grasses and shrubs. Samples of 5-6 dominant grass species and 3-4 dominant shrub species should account for majority of grazing animal diets
- Some hay crops are grown within the permit area and will be sampled

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Vegetation Sampling Continued…

Vegetation Type	Month(s) for Samples
Cool Season Grasses	May, June, July
Warm Season Grasses	June, July, August
Shrubs	July, August, September
Crops	September/October

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Animal Tissue Sampling

- Reg Guide 4.14: Livestock raised within 3km of the site are to be sampled, edible portions of fish living in water subject to runoff from the site
- Fish: Only one water impoundment is large enough to potentially support edible fish, Oshoto Reservoir will be sampled if applicable
- Wild Game: On going interviews with local hunters
- Livestock: Horses and Cows
  - Horses are not part of the human food chain and will not be sampled
  - Cattle raised near the permit area will be evaluated. Cattle that spend the most of their lives near the permit area will be sampled by purchase of meat samples at time of slaughter

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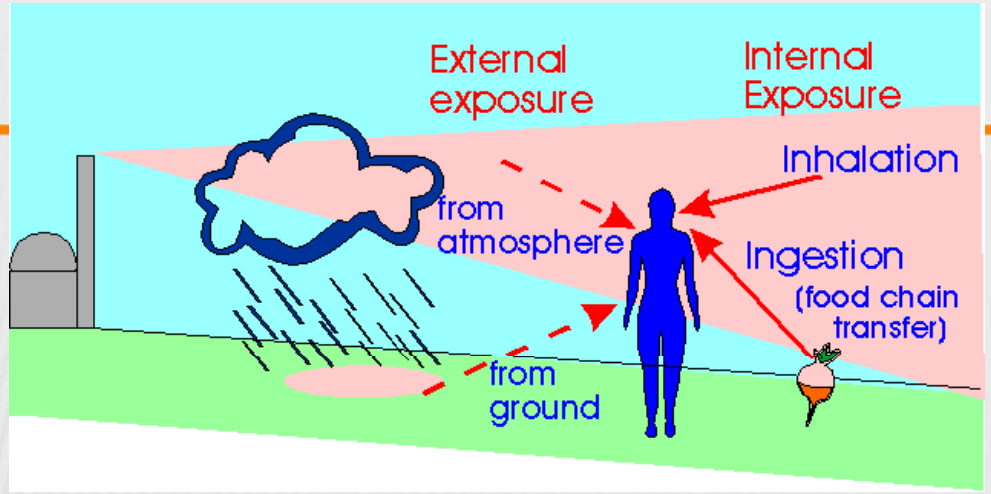

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MILDOS – AREA Summary

- MILDOS AREA (ANL – 1989, ANL/ES – 161) developed from original MILDOS of 1981
- Revised for large area sources (e.g., U tailing impoundments) and to incorporate updated dosimetry (ICRP 30)
- 1997 update of MILDOS – AREA: (1) incorporated revised 10 CFR 20 MPCs and (2) application to ISRs
- Gaussian Plume Dispersion Model
- Source terms defined by user for particulates (U 238, Th 230, Ra 226, Pb 210 in equilibrium with progeny) and Rn 222 gas and progeny
- Exposure pathways considered are inhalation (including resuspension), external exposure (ground shine and cloud immersion), ingestion of vegetables, milk and meat
- Summary of 1997 update for ISRs presented in App D of NUREG 1569 (includes sample problem)

Ross ISR – Preliminary MILDOS Analysis

- Objective: Validate no “fatal flaws” with candidate locations of CPP (<< 100 mrem /yr)
- Used latest version of MILDOS – AREA (v3.07, ANL 2008)
- Meteorological data from Gillette Campbell County airport used to generate joint frequency distribution (STAR file)
- Two CPP locations modeled:
  - On the private property located east of the BLM property (Alternative 2)
  - On BLM property located south-east of the Oshoto Reservoir (Alternative 1)

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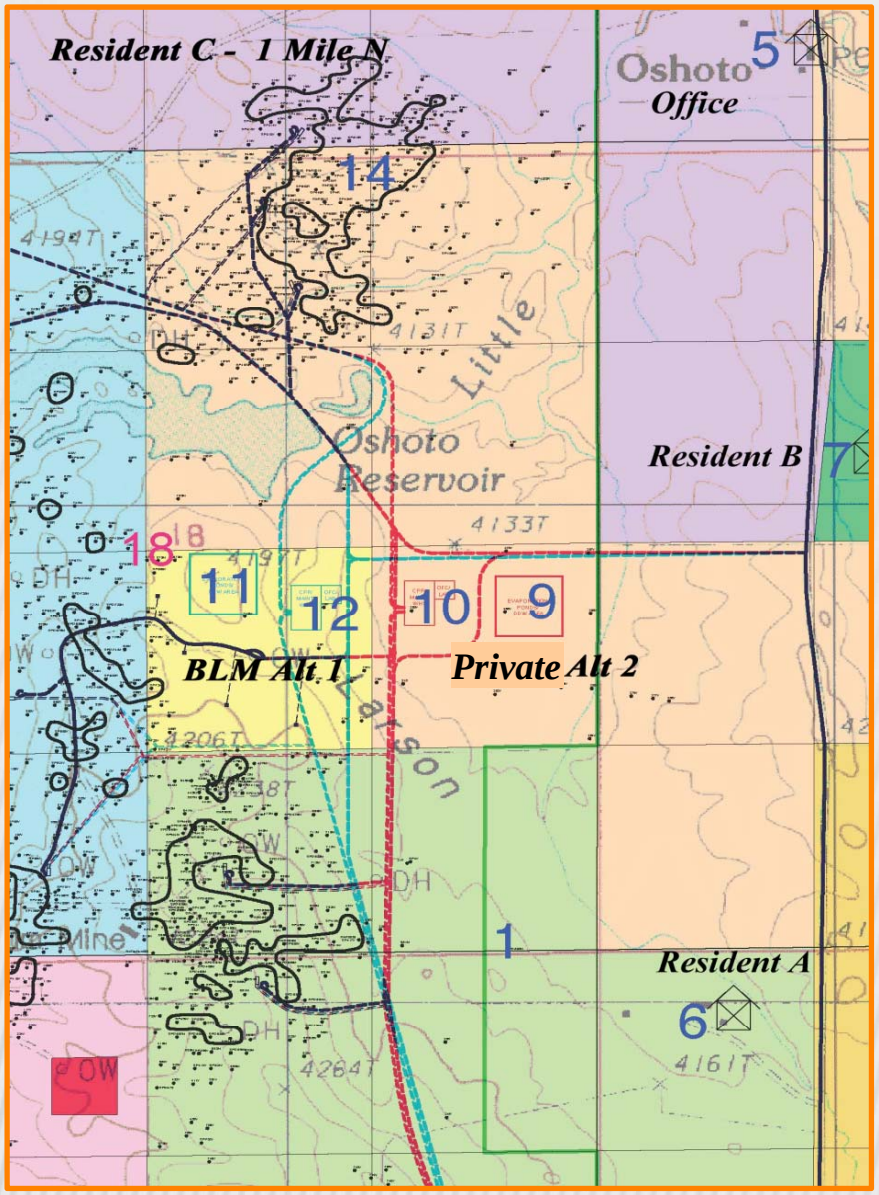
Relationship of CPP Locations and Nearest Residences



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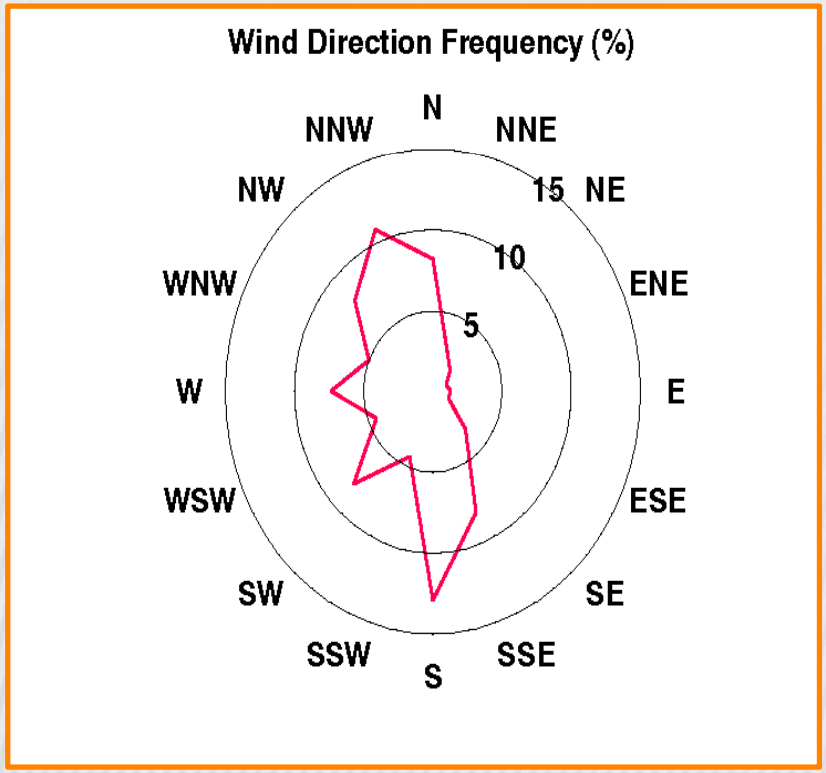
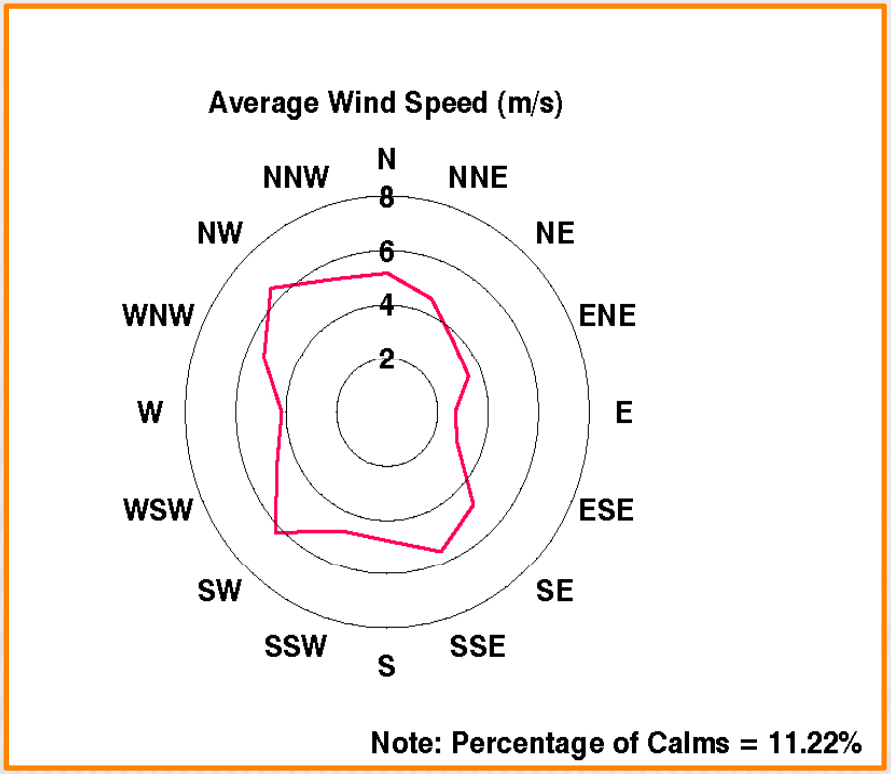
Wind Roses – Gillette 2009





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Assumptions For MILDOS Set UP

- Only radionuclide source is Rn 222 since vacuum dryer(s) will be used (NUREG 1910 – 2.4.2.3 and NUREG / CR-6733) – therefore dose almost exclusively from Rn progeny
- Allowed MILDOS to use its standard defaults for inhalation and multiple ingestion pathways
- All releases (well fields and IX) placed at CPP and modeled as area source from total mined area
- Maximizes release (dose) since well fields in fact spread out over large area and would “dilute” source term (concentration) at receptors
- Releases placed at ground level – also “overestimating” dose

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A Few Selected Inputs

Input Parameter	Units	Value
Mined area	m^2	3.08E+05 (upper bound of suggested value)
Ore grade	$\%U_3O_8$	0.07% (conservative)
Radium-226 concentration in ore zone	pCi/g	197 (equilibrium with U; RG 3.59)
Formation porosity	-	0.25 (other applicant TRs)
Rock density	g/cm^3	2.1 (Strata)
Lixiviant flow rate	gallons per minute	10,000 (upper- bound of suggested value)
Emanating power	-	0.25 (NUREG 1569, App D)
Production days per year	days	365
Radon source term	Ci/yr	RG 3.59 – see next 2 slides

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Radon Releases and Source Term - Reg Guide 3.59

Equation 1: Release to production fluid

$$G = R\rho E(1-p)/p \times 10^{-6}$$

Where:

G = radon release (at equilibrium) from rock to lixiviant (Ci/m^3)

R = radium content (pCi/g)

ρ = rock density (g/cm^3)

E = emanating power

p = formation porosity

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Radon Releases and Source Term - Reg Guide 3.59

Equation 2: Release to atmosphere - annual source term

$$Y = GM\varepsilon D \times 1.44 = GM(1-e^{-\lambda t})D \times 1.44$$

Where:

Y = annual release to atmosphere (Ci/yr)

G = radon release (at equilibrium) from rock to lixiviant (Ci/m^3)

M = lixiviant production rate (L/min)

ε = equilibrium factor which equals $(1-e^{-\lambda t})$

λ = radon decay constant (1/d)

t = residence time (d)

D = production days per year

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Results

RADON SOURCE TERM = 900 Ci/yr (including from both lixiviant in well field and loss at IX/shaker screens but credit taken for “closed, pressurized system” per other applicant TRs)

DOSE (EDE – MREM /YR)

SCENARIO 1	
RECEPTOR	EDE
A	3.0
B	3.9
C	4.9
OFFICE	3.6

SCENARIO 2	
RECEPTOR	EDE
A	3.5
B	4.8
C	6.0
OFFICE	4.5

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Components of Dose Per Pathway
Example: Scenario 2, Resident C (Max Dose)

PATHWAY	EDE	% OF TOTAL
Inhalation	5.75E+00	96.64%
Ground	1.02E-02	0.17%
Cloud	1.87E-01	3.14%
Ingestion - Vegetation	9.65E-04	0.02%
Ingestion - Meat	1.91E-04	0.003%
Ingestion - Milk	5.35E-05	0.001%
TOTAL	5.95	100 %

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When We Run MILDOS for TR Section 7.3: Radiological Effects

- Meteorological data from on – site station (12 months) will be used
- CPP location and well field layouts finalized
- Revisit/ revise standard input parameters with updated info (ore grade, mined area size, flow rates, etc)
- Revisit/ revise calculation of Rn source term per RG 3.59 parameters as appropriate
- Determine dose distribution and population dose within 80 km radius of CPP
- Apply local demographic data if practical (food chain parameters, e.g.)

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Preparation of Technical Report Section 5.7: Radiation Safety Controls and Monitoring

Drivers – staying focused on:

- NUREG 1569 Acceptance Criteria
- Applicable RAIs / "Open Health Physics Issues"
  Identified by NRC to other applicants
- Review of other TRs submitted in last 2 years
- NRC U Workshop, Nov 2009

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5.7.1 Effluent Control Techniques

5.7.1.1 Gaseous and Airborne Particulate Radiological Effluents
(linked to Section 4.1 Gaseous and Airborne Particulates)
- Gaseous Effluents- Radon
- Particulate Effluents- Yellowcake

5.7.1.2 Liquid Effluents
- Liquid Process Waste
- Fluids Associated with Aquifer Restoration

5.7.1.3 Spill Contingency Plans (and/or Section, 7.5, Effects of Accidents)

- Failure of Process Tanks
- Surface Releases Between the Well field and Central Plant
- Impacts and Response To Spills in the Well Fields
- Spills Associated With Transportation (Section 7.5 Effects of Accidents)
- Sub-surface Releases - Well Excursions

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Section 5.7.2 External Radiation Exposure Monitoring Program

5.7.2.1 General Area Gamma Surveys

- Instrumentation and specifications
- Locations/ diagrams, postings (10 CFR 20.1902)
- Use of area TLDs

5.7.2.2 Beta Surveys in Yellowcake Areas

- Instrumentation and specifications
- Locations / diagrams
- RG 8.30 Figs 1 & 2

5.7.2.3 Personnel Dosimetry

- Justification for who is badged , RG 8.34
- Dosimeter types. vendor and credentials, exchange frequency, etc

Section 5.7.3 Airborne Radiological Monitoring

5.7.3.1 Airborne Uranium Particulate Monitoring

- Conduct of surveys per 10 CFR 20.1501 & .1502
- Locations / diagrams, frequency, etc per RG 8.25
- Air sampling equipment (High Vol and BZ) specs, calibration
- LLDs and computation of concentrations per RG 8.25 / 8.30
- Justification of DAC (issue of “mixtures in air” and solubility class)
- Considerations of mixtures in air (sum of fractions), exclusion per 10 CFR 20.1204(g)

5.7.3.2 Airborne Radon 222 and Progeny Monitoring

- Locations / diagrams, frequency, etc per RG 8.30
- Kusnetz method, LLDs, calculation of WL, etc per RG 8.30
- Rn 222 via area Track - etch detectors

5.7.3.3 Respiratory Protection Criteria – 10 CFR Subpart H; RG 8.31

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Section 5.7.4 Exposure Calculations

General: Methods per RG 8.30 and 8.34 using exposure data from programs described in 5.7.2 (external), 5.7.3 (airborne) and 5.7.6 (bioassay); 10CFR 20.1202 and .1204

5.7.4.1 Calculations of Intake of Uranium

- Methods of RG 8.30
- Justification of solubility class
- Estimate of DAC-hrs and % ALI

5.7.4.2 Calculation of Intake of Radon Progeny

- Methods of RG 8.30
- Estimate of WLM using time studies

5.7.4.3 Radiation Dose Calculations

- U Intakes (+ other airborne nuclides if mixture applicable)
- Rn Progeny
- Bioassay data as applicable
- External exposure
- Summation of doses

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Section 5.7.4 Exposure Calculations - continued

5.7.4.4 Limits and Control of Intake of Soluble Uranium (10 mg/wk limit)

5.7.4.5 Notification of Overexposures –RG 8.30, Section 4

5.7.4.6 Prenatal Exposure Calculation – 10 CFR 20.1208, RG 8.13 & RG 8.36

5.7.4.7 Action Levels Tied to Worker Exposure Calculations – RG 8.30, 8.34, 8.22, etc

5.7.4.8 Recording / Reporting Occ. Exposure Data – RG 8.7

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Section 5.7.5 Bioassay Program

5.7.5.1 Regulatory and Technical Basis of Bioassay Program

- Based on NUREG 0874 as implemented via RG 8.22; RG 8.9 and 8.31 and requirements of 10 CFR 20.1204
- Justification of solubility class and molecular composition of "yellowcake" product(s)
- Justification of bioassay methods, frequency, action levels and actions

5.7.5.2 Program Elements

- Samples prior to work in yellowcake areas and at termination
- Instructions to employees, sampling and collection protocols
- Routine and special ad – hoc sampling
- QA/QC requirements and protocols

5.7.5.3 Action Levels and Corrective Actions Based on Urinalysis Results - RG 8.22, Tables 1 and 2, Fig 1; HPS N13.22-1995

5.7.5.4 Dose Assessment and Record Keeping - RG 8.7, 8.34

Section 5.7.6 Contamination Control Program

General: Based on recommendations in RG 8.30

5.7.6.1 Surveys for Surface Contamination in Plant Areas

- ID of routine survey locations in process areas, general plant and in unrestricted areas
- Special surveys during maintenance activities
- Instrumentation: types and specs
- Qualifications of individuals performing surveys per RG 8.31

5.7.6.2 Surveying Skin and Personal Clothing

- Instrumentation: types and specs
- Response to identification of personnel contamination in excess of background

Section 5.7.6 Contamination Control Program – continued

5.7.6.3 Surveys for Release of Equipment to Unrestricted Areas

- Methods and procedures
- Contamination limits for release of equipment and materials from restricted areas (RG 8.30, RG 1.86 and FC 83-23 Enclosure 2)

5.7.6.4 Survey Methods and Instrumentation

- NUREG–5849 (Rad Surveys for License Term.), NUREG–1575 (MARSSIM)

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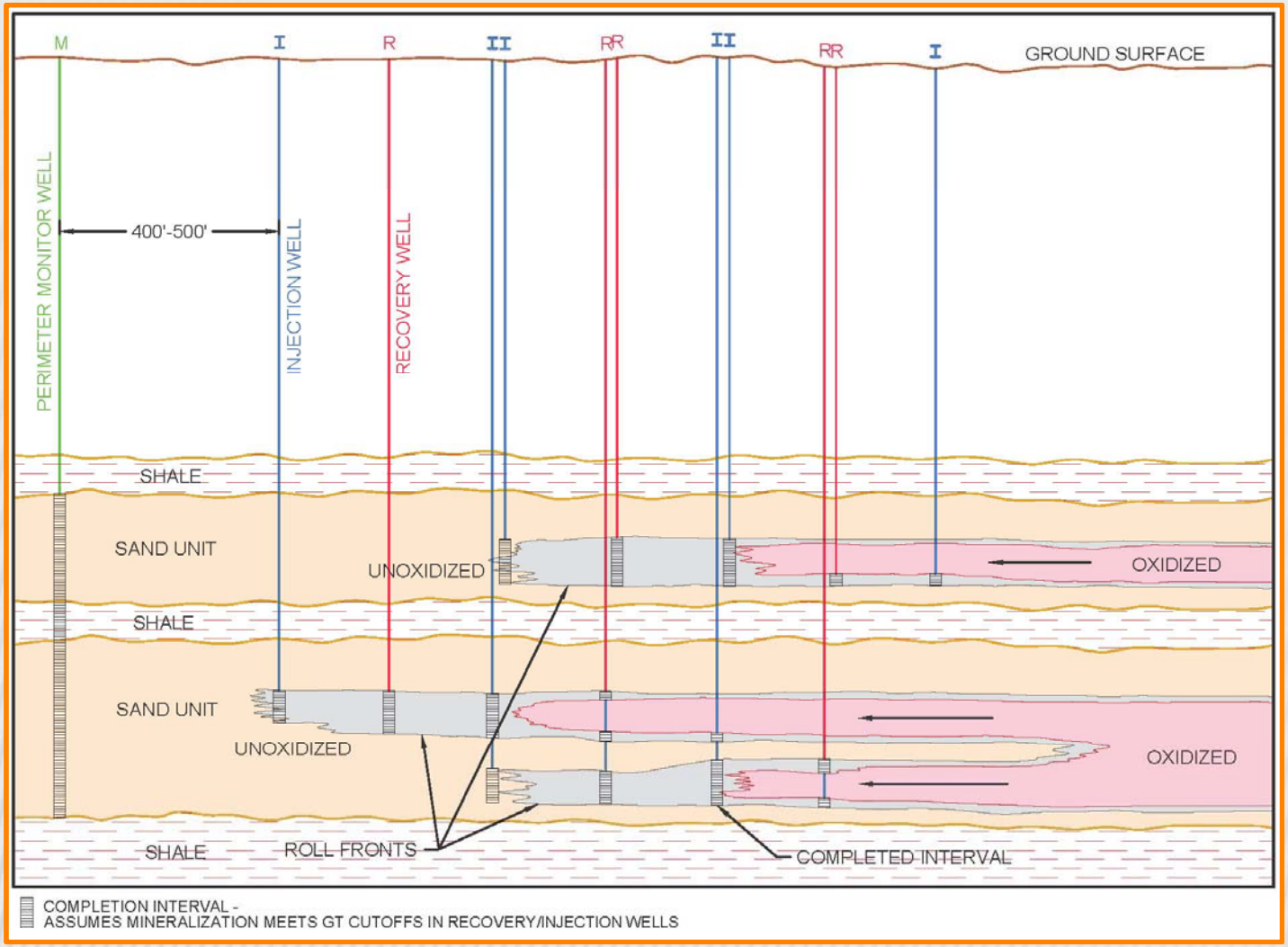
Conceptual Completion of Stacked Roll Fronts



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Questions?

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