A Multidisciplinary Approach to Site Remediation and Management in a Bedrock Environment

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RemTech 2006, Banff, AB

What this presentation is NOT really about:

- Site remediation
- Risk Management
- Bedrock

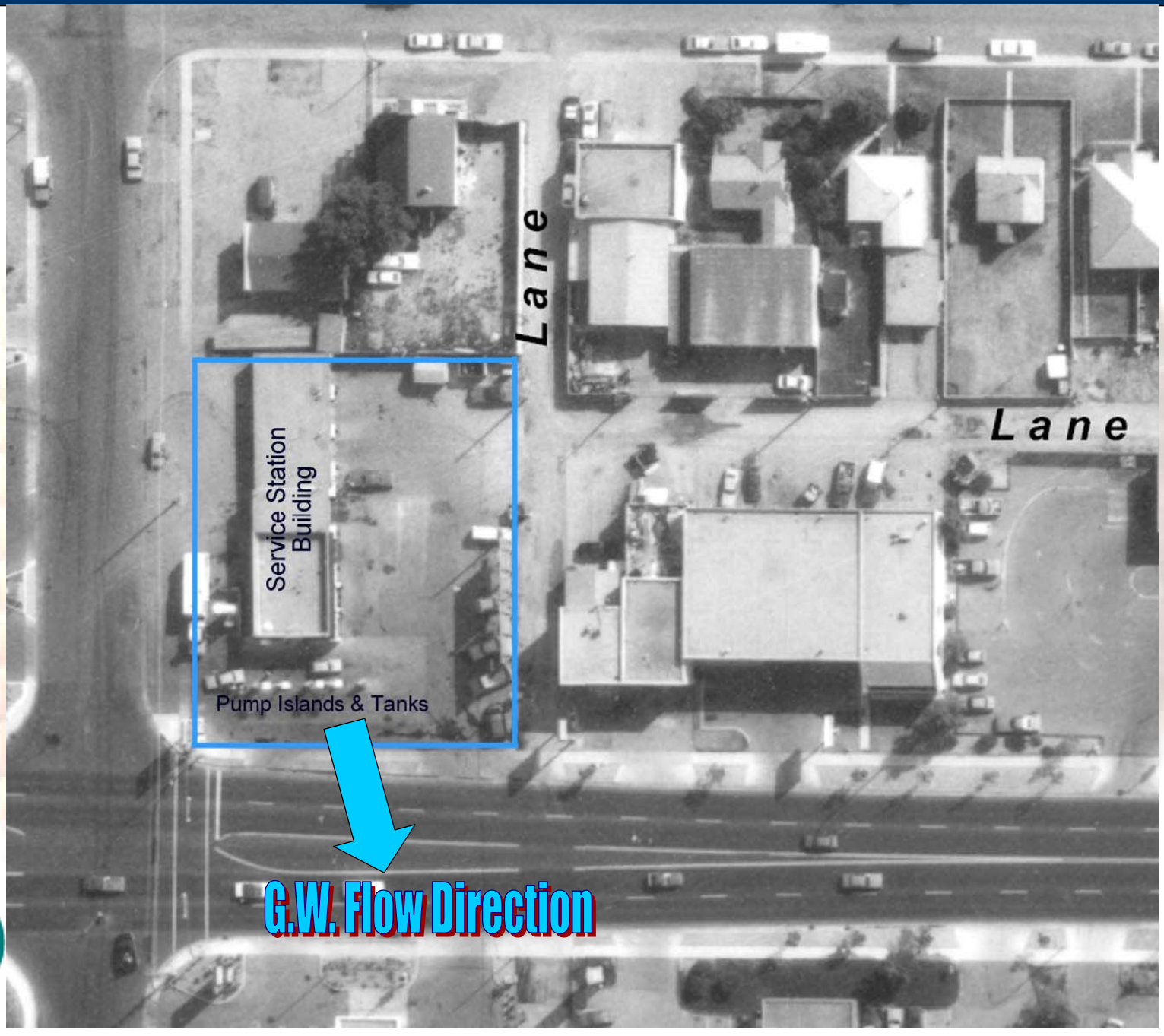
What this presentation is about:

- A multidisciplinary approach, and…
- Presenting a case history that underscores the need to understand and accommodate the multiple objectives and drivers at a site.

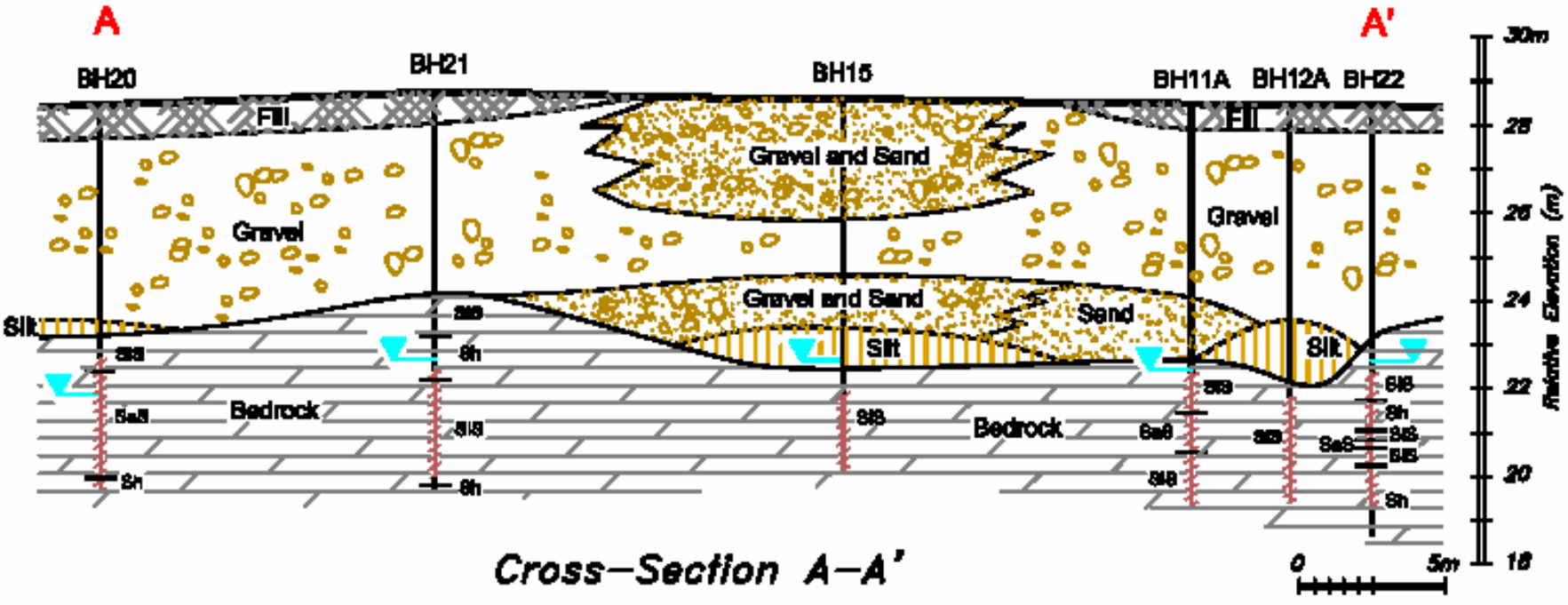
Site Description

- Former service station (1985 to 2003) in Calgary
- Commercial zoning, adjacent to residential
- Gravel to approx. 5 m depth, underlain by fractured siltstone & sandstone bedrock
- Groundwater table generally at or below surface of bedrock

Subject Site



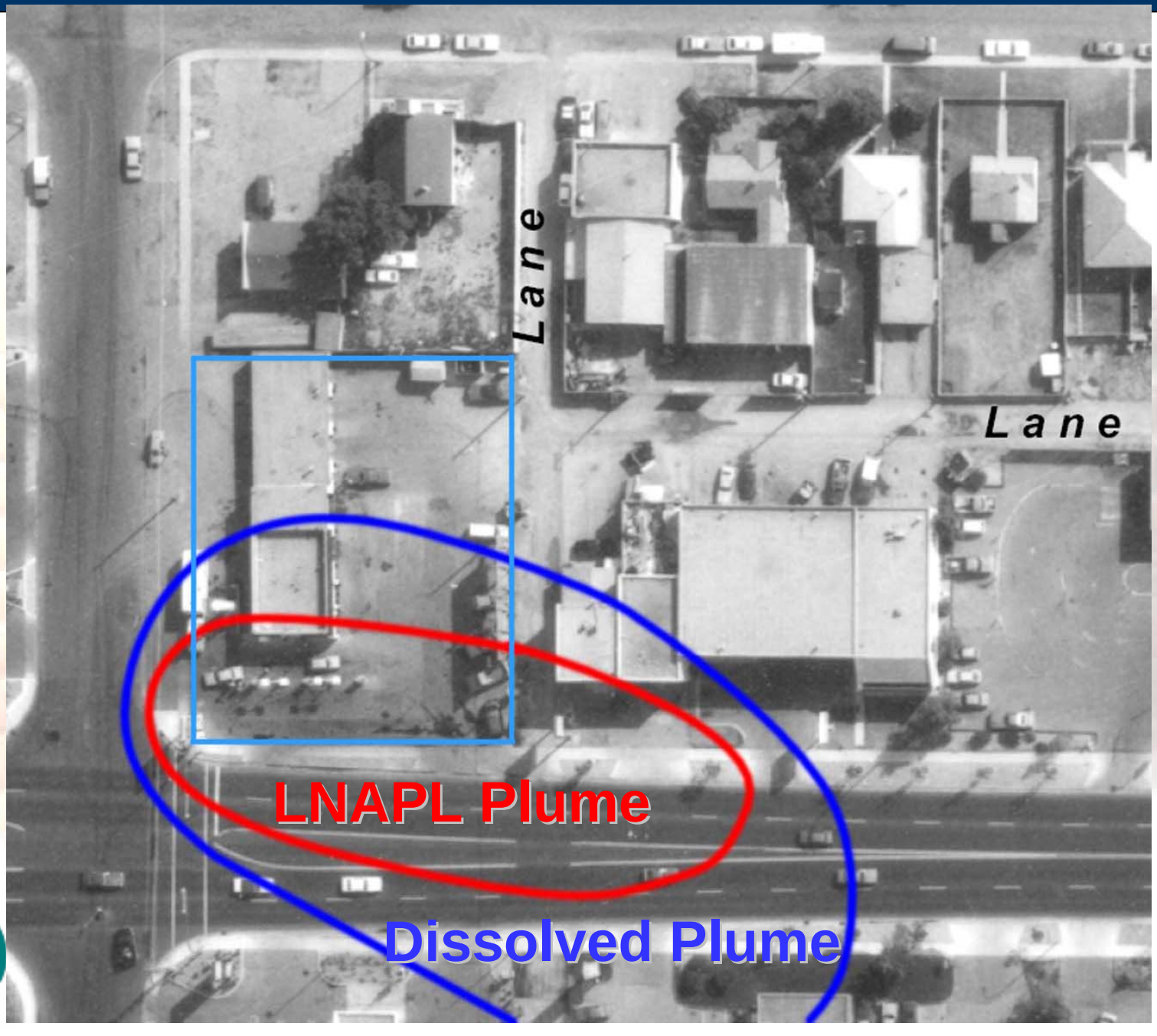
Stratigraphic Section



Initial Environmental Conditions

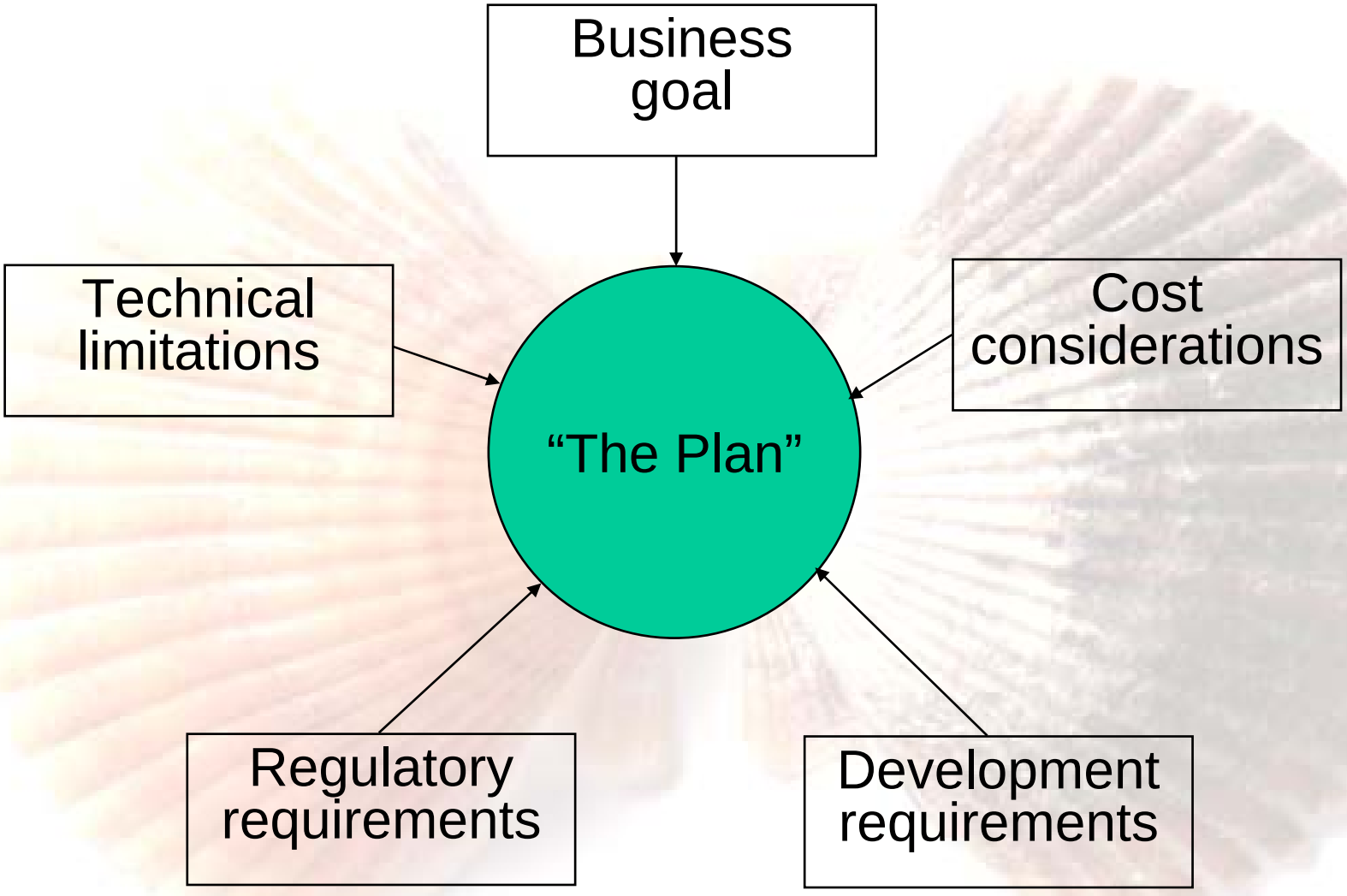
- Following closure, a maximum apparent thickness of 0.53 m of LNAPL measured onsite
- Potentiometric surface was relatively flat, hydraulic conductivity was very high
- LNAPL and dissolved impacts extended offsite, across roadway

Initial Conditions



Project Objectives

- Business Objectives & Considerations:
  - Manage site so that a tenant could re-develop and occupy site
  - Minimize management costs until long-term remediation can be achieved
- Regulatory Objectives:
  - Develop and implement a plan to assess, mitigate, and manage the risk in a manner accepted by AENV and the City of Calgary


Business goal
Technical limitations
Cost considerations
“The Plan”
Regulatory requirements
Development requirements

How do we know if we're done?

- If you don't know where you are going, you'll have a hard time knowing if you've got there.
- A thorough exit strategy was an integral part of the plan.
  - Included numerical and conceptual targets

The Plan

Assess risk to tenants (inhalation)

1. Vapour sampling prior to HVE operation
2. Site-specific vapour criteria

Remove LNAPL

1. Design & install HVE
2. Monitor & refine operation of HVE
3. Shut down HVE when target met

Confirm conditions will improve in the future

1. Absence of detectable LNAPL (source reduction)
2. Numerical model of vapour equilibration

Monitor to track remediation progress and confirm risk assessment

Risk Assessment

- Site-specific criteria for subsurface vapour concentrations were developed, using the Johnson & Ettinger model.
- Vapour samples were collected in an assumed “worst-case” condition (with LNAPL present beneath the vapour wells).

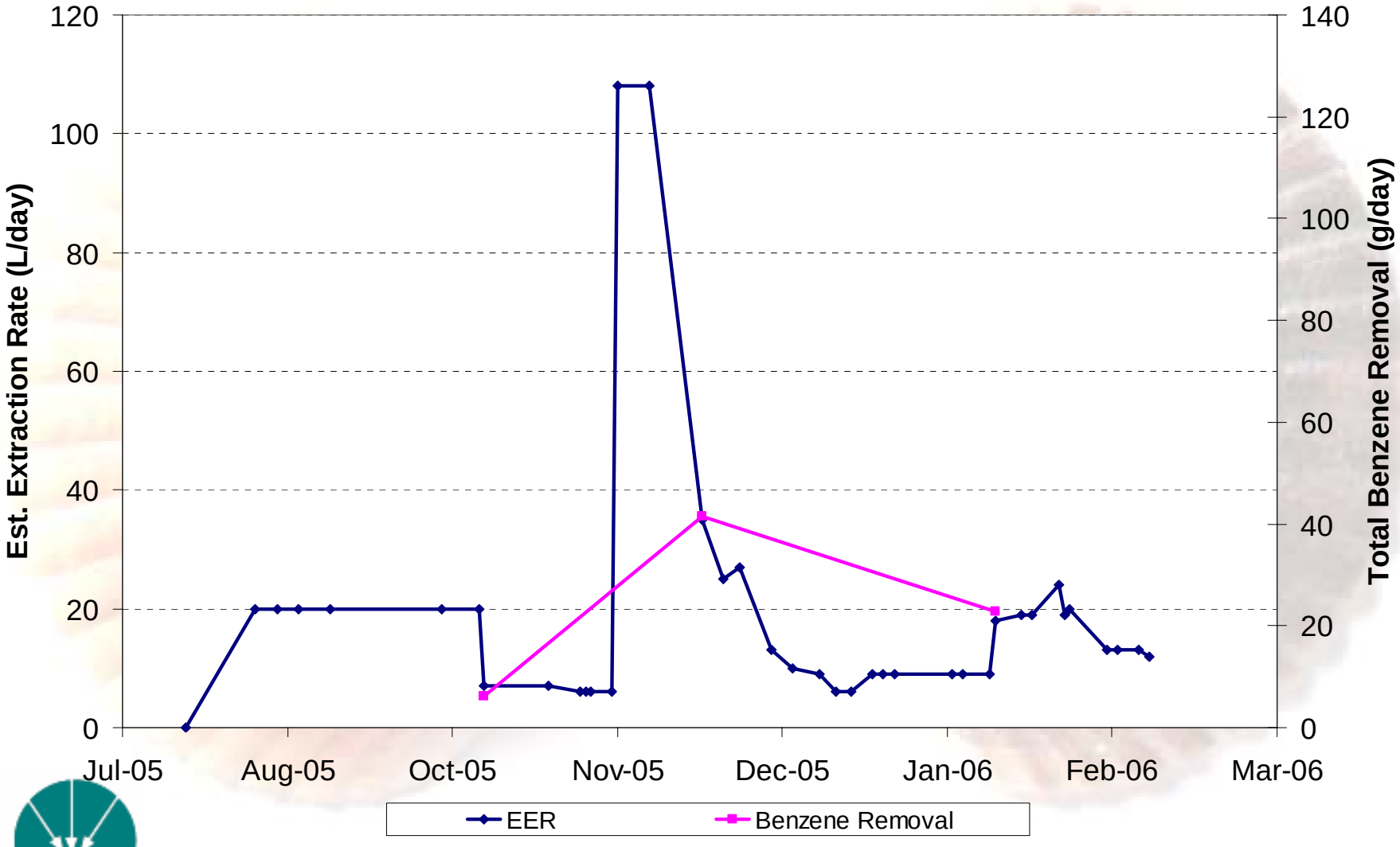
High Vacuum Extraction System

- Rotary claw pump connected to headers and extraction wells with drop tubes
- Designed to allow for monitoring and sampling of key parameters:
  - Vapour discharge (concentration and rate)
  - Liquid phase intake (LNAPL and dissolved)
  - Monitoring wells not connected to HVE header system

Refining HVE Operation

- Periodic chemical analysis of samples of vapours and water being removed by system were correlated to field monitoring parameters.
- Based on field monitoring results, the system was modified (selected headers turned on or off) to maximize the hydrocarbon extraction rate.

HVE Performance Trends



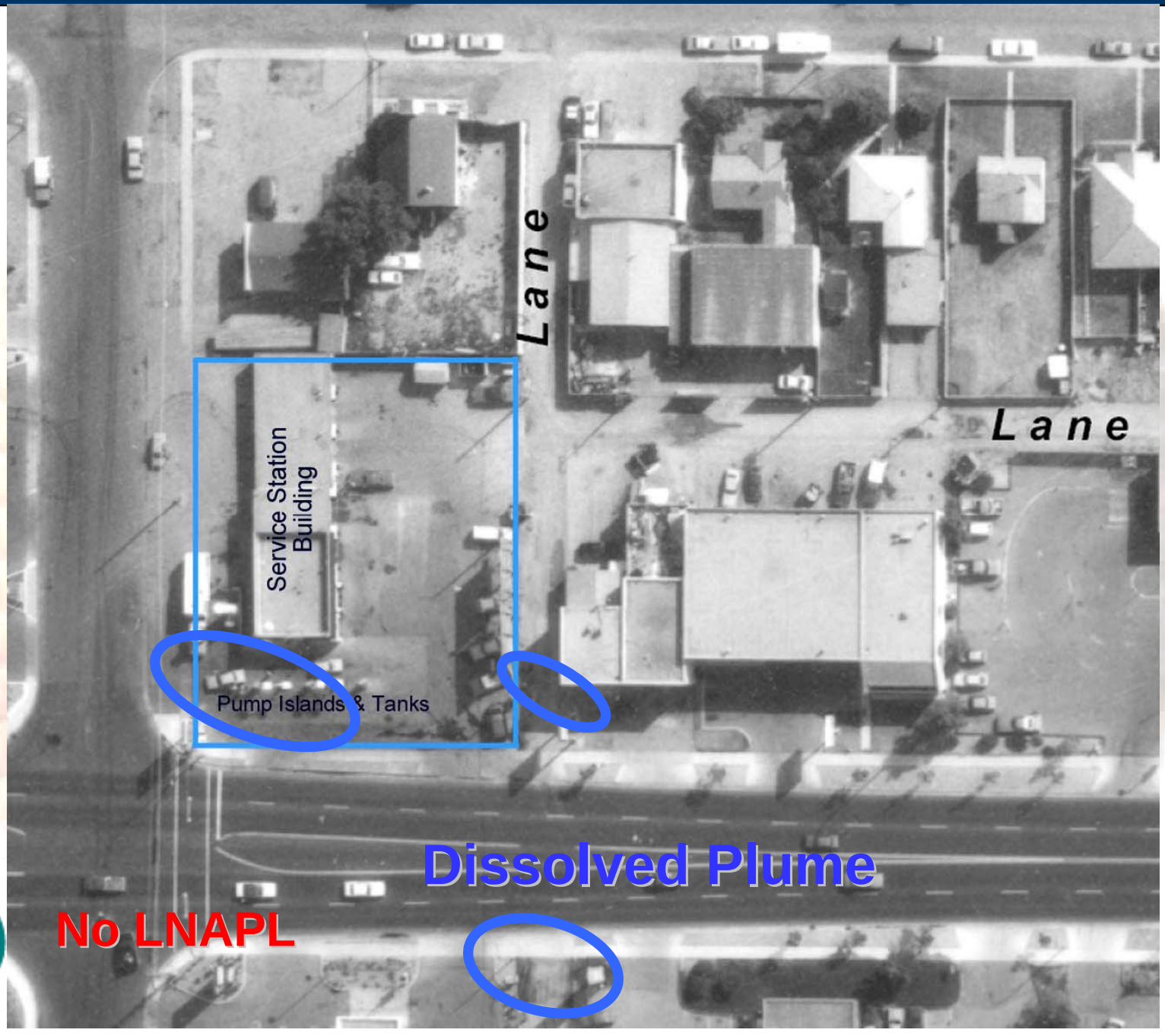
Confirmation of Improving Trend

1. Vapour samples collected in “worst-case” conditions
2. Numerical modelling of vapour equilibration rate in site-soil profile
3. Operation of HVE resulting in improved subsurface conditions

Technical Outcome

- Shallow soil vapour analytical results were several orders of magnitude less than the derived criteria.
- Numerical modelling supported the conclusion that the vapour profile was in equilibrium at time of sampling.
- LNAPL not detected in monitoring network after 6 months of HVE operation.

Current Conditions



Regulatory Outcome

- AENV and the City of Calgary were satisfied with the risk assessment and with progress made in LNAPL removal.
- A development permit was issued to allow the re-development of site to proceed.

Business Outcome

- Tenant leased the site, generating revenue while long-term monitoring tracks improvement in dissolved impacts.
- Liability exposure limited by confirming absence of unacceptable risk, and by moving toward remedial objectives.
- High return on project cost maintained through use of risk assessment and maximized efficiency of HVE.

Ancillary Outcomes

- Site image changed from aging, vacant building to attractive, active business.
- Operating business onsite improves City tax base.
- Reduced ongoing site management costs by allowing work to focus on identified, specific project tasks.

How these results were achieved

- Understanding and accommodating multiple objectives and drivers at the site
- Having a good, explicit view of the desired end points (conceptual and technical), both short-term and long-term
- Modifying the work dynamically to keep the work moving toward the identified objectives (including anticipating complications)

How these results were achieved

- A goal-specific, integrated risk assessment and remediation approach was developed, based on the explicitly identified objectives
- Early and frequent involvement of the stakeholders

Acknowledgements

- Mr. Barry Nevokshonoff, Sequoia Environmental Remediation
- Ms. Kim Kirillo, AENV
- Ms. Anne Breckenridge & Mr. Kevan Van Velzen, City of Calgary
- The Calgary Health Region
- The very patient and capable field staff at O'Connor Associates