Closure of a Mall Site Contaminated by Off-site Sources Using a Phased Remediation Approach

presented by

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Outline

- Background
- The Phased Remediation Plan
- Phase 1 - Engineered Remediation
- MNA Assessment and Risk Assessment
- Phase 2 - Passive Remediation
- Conclusions

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Background

- Preliminary site investigations characterized free product and dissolved phase plumes migrating from 2 off-site retail sites
- Gasoline releases occurred before 1981 or 1985
- Product plume covered 700 m^2
- Dissolved plume extended 70 m across site

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Site Boundary

Gas Station Boundary

Borehole

Monitoring Well

Piezometric Contour (m)

Extent of Free Phase Hydrocarbon

Extent of Dissolved Hydrocarbon (<Special Waste)

N

W E

S

0 7.5 15 22.5 30 37.5 m

ESTIMATED AREAL EXTENT OF FREE PHASE AND DISSOLVED HYDROCARBON CONTAMINATION (1994)

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The Phased Remediation Plan

- Removal of free product using engineered solution – Phase 1
- Risk management of residual soil and dissolved phase contamination – Phase 2
- BC Ministry of Environment “Approval in Principle” obtained in 2002

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Phase 1 – Engineered Remediation

- Pilot trials conducted in 2002
- DPE system and oxidizer commissioned in 2002
- 3 QED 4” AP-4 pumps in a network at site P/L
- System extension to adjacent site constructed in 2005
- 3 major modes of operation between 2002 and 2006

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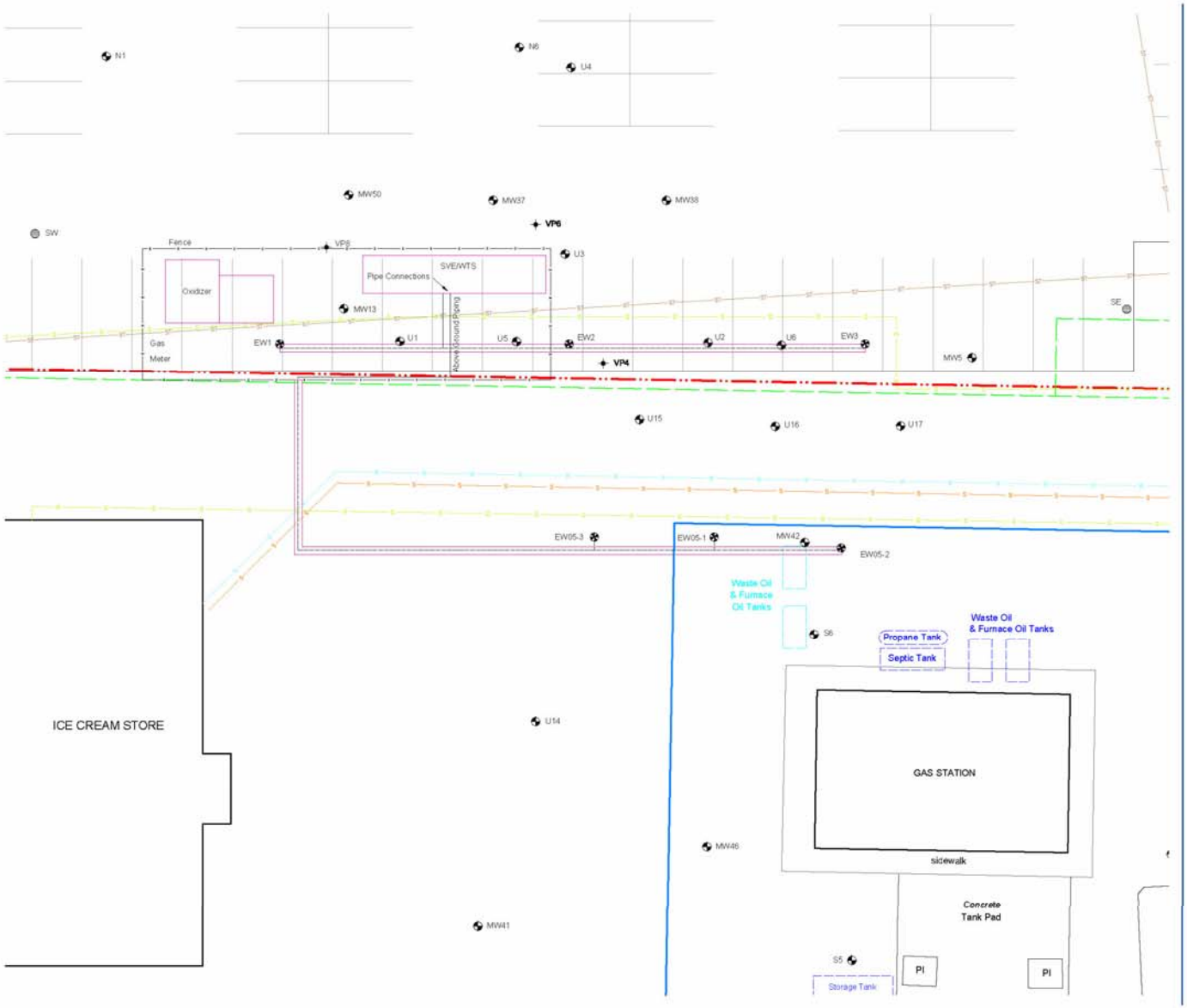

Site Boundary

Gas Station Boundary

Extraction Well

Monitoring Well

Vapour Point

SVE/WTS Trench & Underground Piping

N

W E

S

0 2 4 6 8 10 m

SYSTEM LAYOUT

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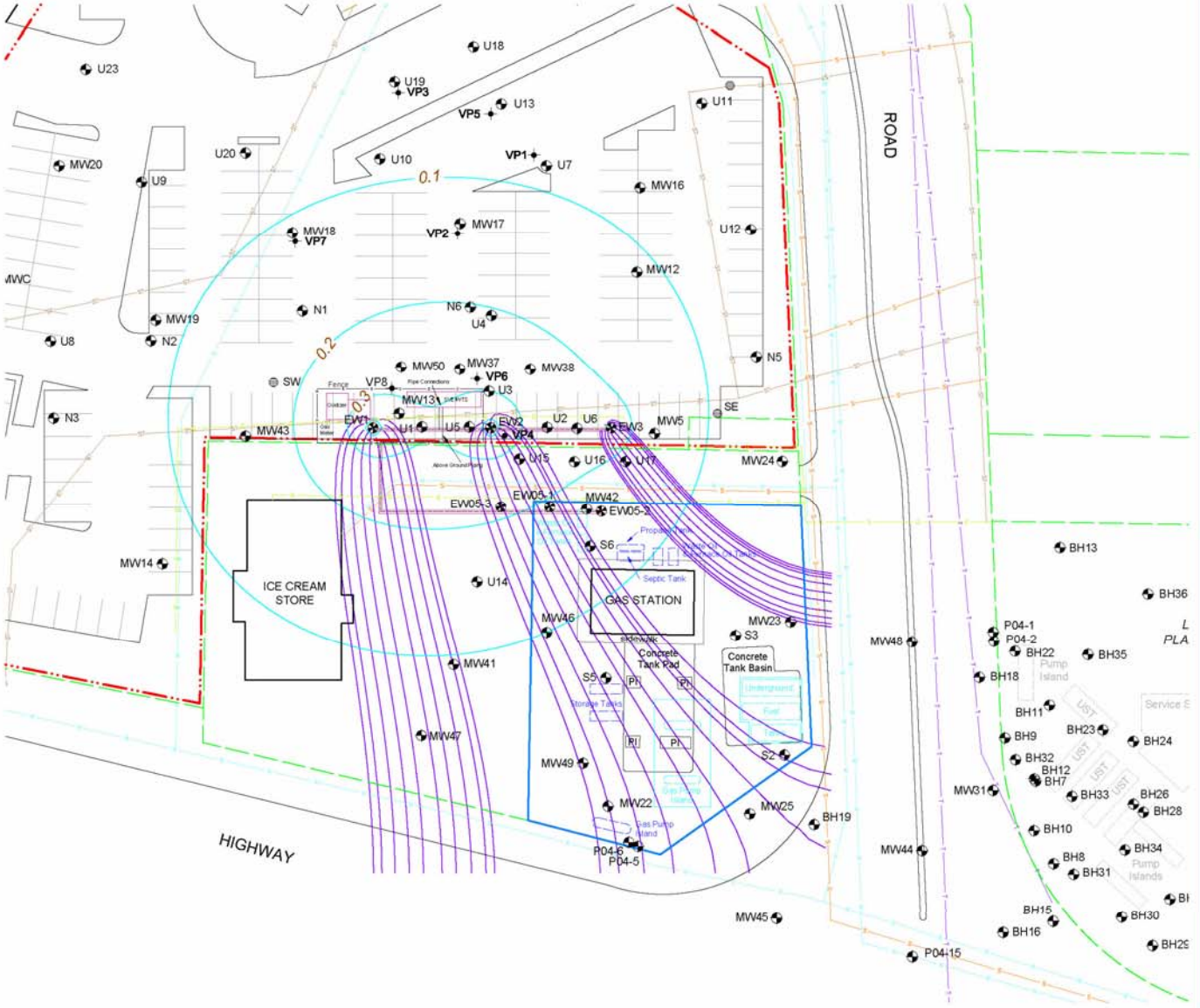

SYSTEM OPERATION
2002 - JULY 2005
(Average Recovery Rate = 10 LPM)

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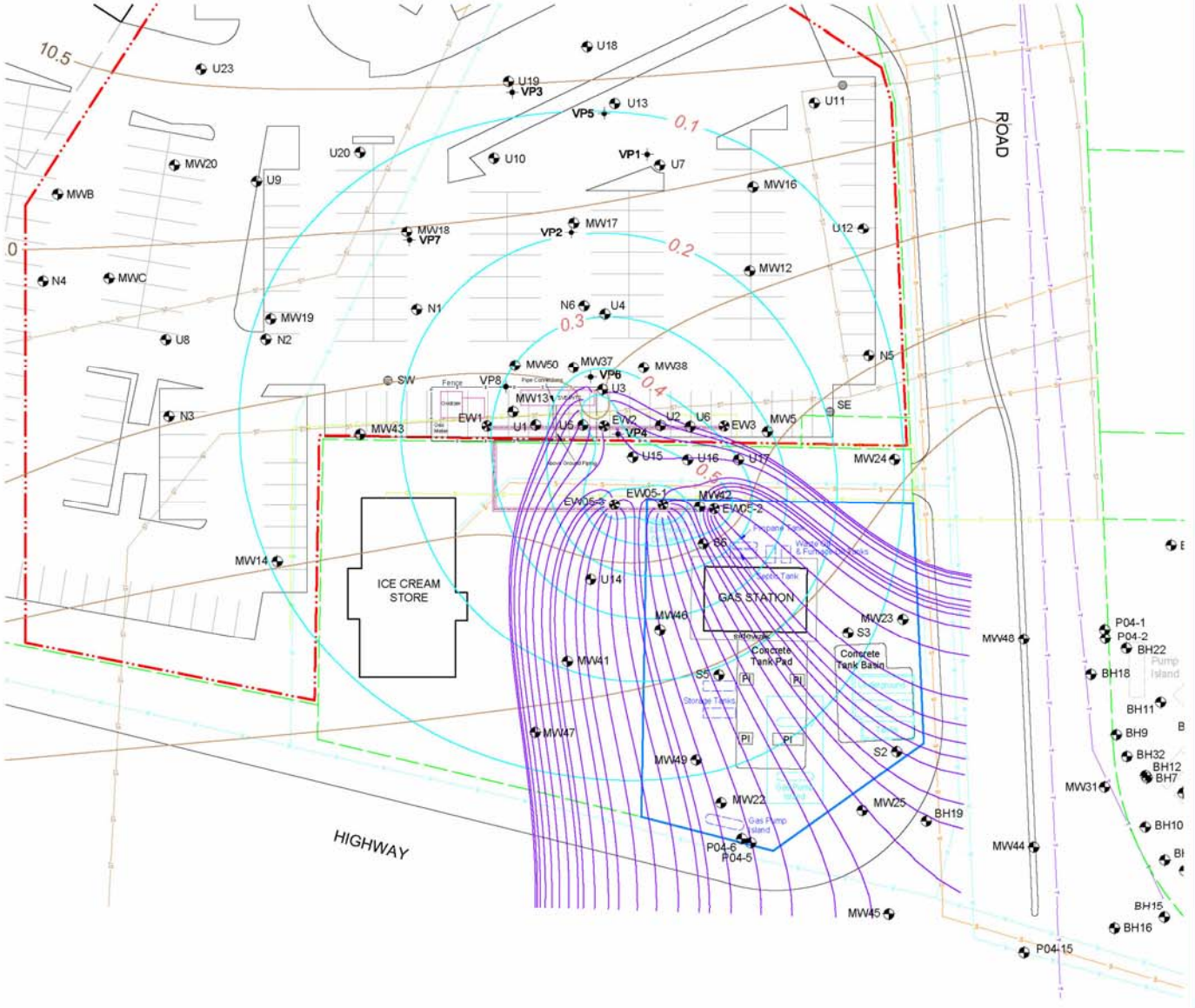

SYSTEM OPERATION
JULY 2005 - NOVEMBER 2005
(with EW2 Operating)

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Phase 1 End Point

- End point of Phase 1 had TBD
- Operations on mall site ceased in November 2005
- No free product since December 2005
- Operations on adjacent site continued through July 2006
- No free product recovered in system in final 18 months of operation
- Estimated 100,000L (liquid equivalent) of product recovered during Phase 1

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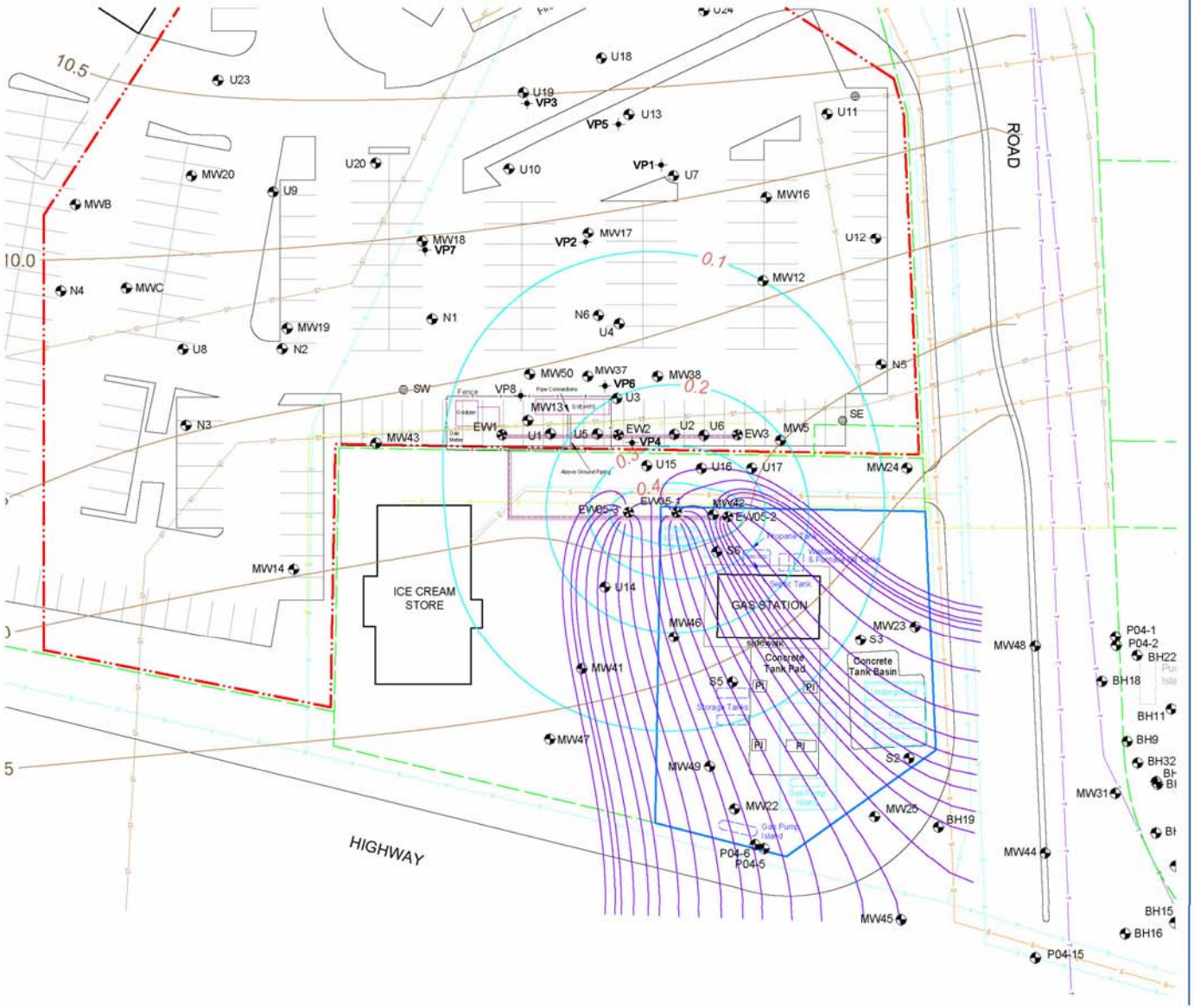
Site Boundary
Gas Station Boundary
Extraction Well
Monitoring Well
Vapour Point
Estimated Drawdown Contour
0.1
Capture Zone Pathlines
Model Groundwater Heads
ROAD
HIGHWAY
ICE CREAM STORE
GAS STATION
MW20
MWB
MWC
MW19
MW18
MW17
MW16
MW12
MW43
MW24
MW14
MW41
MW47
MW49
MW22
MW25
MW45
MW46
MW23
MW48
MW31
MW44
BH18
BH11
BH9
BH32
BH19
BH15
BH16
P04-1
P04-2
BH22
P04-6
P04-5
P04-15
N
W
E
S
0 5 10 15 20 25 m
SYSTEM OPERATION
(Average Recovery Rate = 16.6 LPM)

MNA and Risk Assessments

- Assessments conducted to support site closure using a Passive approach – Phase 2
- Assessments conducted under ambient conditions
- Risk Assessment characterized health risk from exposure via the soil vapour inhalation pathway
- Soil vapour and ambient air data evaluated for current and future land use scenarios
- MNA assessment supported exposure pathway analysis and feasibility of Phase 2

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MNA Assessment

- Assessment of NA processes and plume stability
  - Contaminant max flux calculations – deterministic and probabilistic or Crystal Ball methods
  - Quantitative evaluation of plume stability – review of groundwater quality trends and contaminant distributions
  - Analysis of geochemical indicators – physical and chemical testing, assessment of redox zone distribution using “redox indicator tapes”

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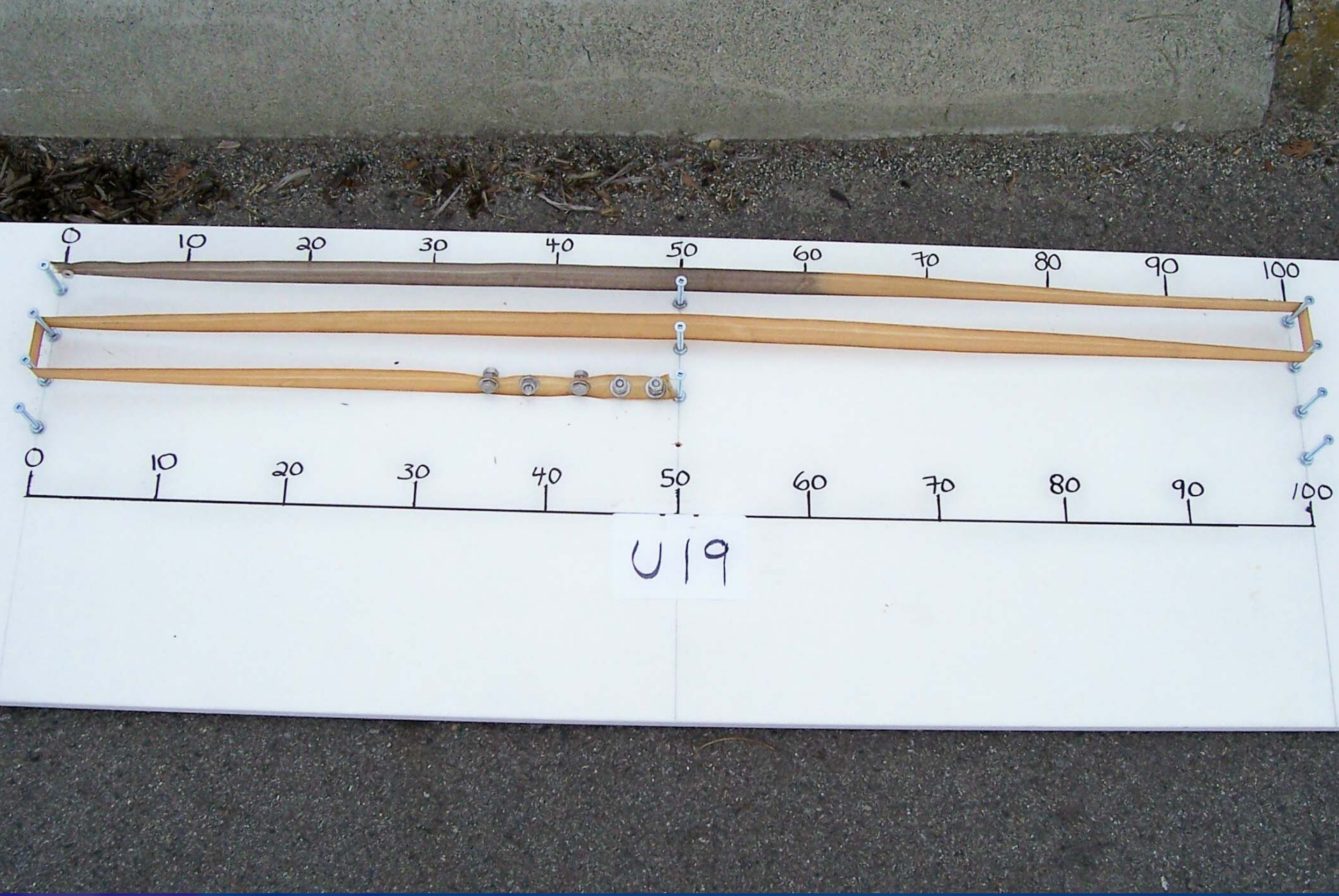
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0 10 20 30 40 50 60 70 80 90 100
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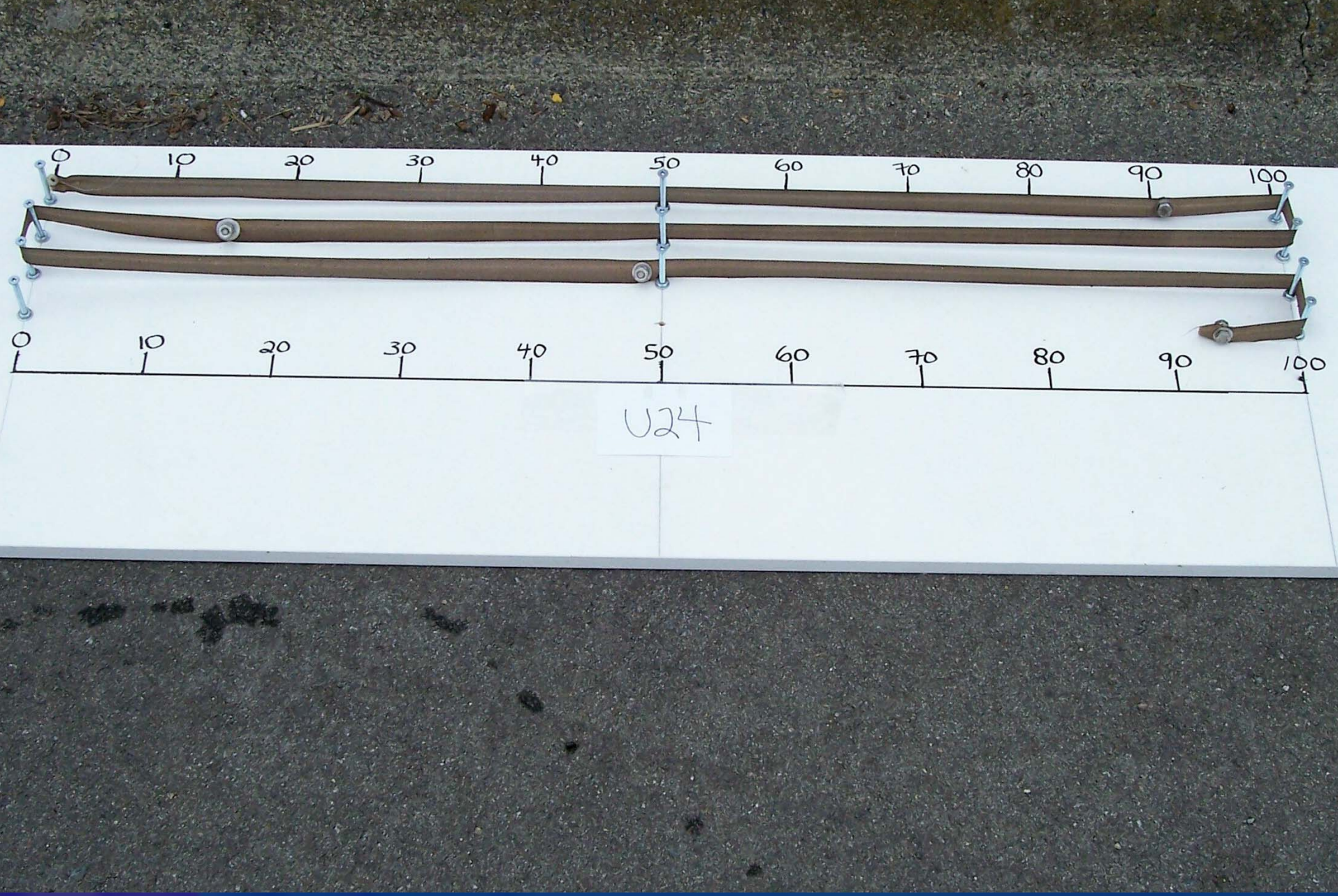
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Soil Vapour Inhalation Pathway Risk Assessment

- Vertical profile sampling of soil vapour in 8 locations over “source” area
- Ambient air sampling in parking lot over “source” area
- Current and future public and worker exposures to ambient outdoor and indoor air
- Future construction worker exposure to ambient outdoor air
- No unacceptable health risk unless undiluted soil vapour inhaled by construction workers

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Results of MNA and Risk Assessments

- Significant NA processes active at the site controlled the dissolved plume within 70m
- Acceptable human health risk level concluded for the parking lot for current and future scenarios
- Phase 2 – Passive Remediation started on the basis of these conclusions
- Recommended monitoring of COPCs in groundwater and ambient air for 1 year

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Post-Remediation Monitoring Program Results – Phase 2 End Point

- Ambient air quality monitoring
  - Still no unacceptable health risks in parking lot
- Groundwater quality monitoring
  - data trends in “source” and downgradient areas evaluated
  - contaminant plume extents modeled using BIOSCREEN-AT software
  - results confirmed 2006 conceptual attenuation model
- Phase 2 concluded

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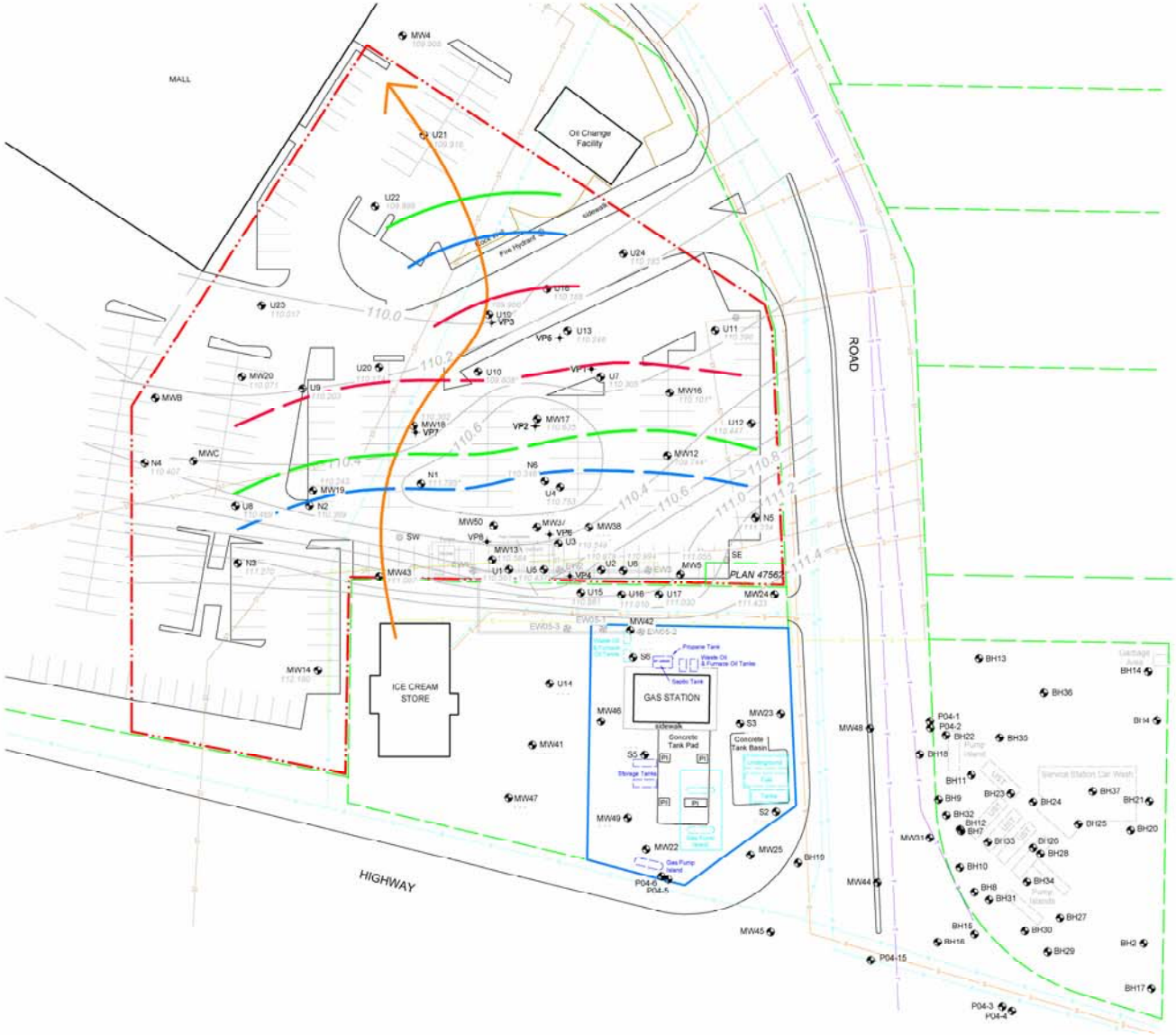

RESULTS OF BIOSCREEN ANALYSIS

Conclusions

- Combining active and passive remedial approaches is an effective and practical remedial strategy
- A phased remediation plan requires a clear scientific process
- Proving effectiveness of a passive approach demands several lines of evidence
- Working with the approval and input of regulators critical to success

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